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PRECONDITIONS FOR CREATING MACHINE TOOL INDUSTRY IN DEVELOPING COUNTRIES 1/

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I. Introduction

The present report deals with the problems on the promotion of the production of metal-cutting equipment in developing countries being at the initial stage of industrial development and having underdeveloped mechanical engineering with rather a poor experience in manufacturing machine tools or without it at all.

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To-day the rapid development of productive forces is characteristic not only of the industrially developed countries but also of many developing countries.

In these countries efforts are being taken for the organization and expansion of national industry as it is the most important basis for the successful settlement of the problem on the employment of numerous and ever growing population in developing countries, the increase of its living standard.

The structure of the industry in each developing country depends on the character of its natural resources, climatic and other peculiarities.

This structure may be determined by the necessity of the development of the industry on extracting various mineral resources, in particular petroleum and gas, by the construction of electric power stations; by the demands of the development of agriculture, railway, automobile and air transport, the building materials industry, the produce processing industry, in particular by the construction of rice-refining and jute plants, creameries, canneries, mills, textile, shoe and chemical enterprises as well as enterprises producing articles intended for manufacturing consumer goods, equipment for handicraft workshops and a number of other factories.

The necessity of the development of the above-mentioned and other industries requires various machines. In the initial period of

organizing the national industry these requirements are satisfied at the expense of import. With the growth of industry the import of the ever increasing number of machines becomes more and more unprofitable because the correlation of prices of imported machines, on the one hand, and of exported raw materials and agricultural products, on the other hand, is highly unfavourable for a developing country since in order to get means for purchasing machines it is necessary to sell a great number of raw materials and agricultural products (often needed for home consumption), the production of which requires much more human labour than it is necessary for the production of the machines acquired in exchange.

The imported machines used in industry need repair. Without national mechanical engineering, spare parts for the machines are purchased from other countries or produced on the machines bought abroad; furthermore, repair is often carried out by foreign specialists.

Such an unprofitable for a developing country situation, inevitable in the initial period of creating its national industry, with the expansion of the latter becomes a great drag on the development of national economy, makes this development dependent on other countries.

Therefore, it is natural that developing countries are striving for the creation of their own mechanical engineering which would give the possibility to meet ever increasing needs of the country in new machines and ensure the repair of working machines at the expense of national equipment and by the efforts of its own specialists.

During creation of national mechanical engineering, especially in the first period, there arise great difficulties caused by the lack of national specialists and skilled workers, any experience in the production of machines as well as by the lack of materials and a number of purchased parts which are necessary for producing machi-

nes.

An essential factor of the successful settlement of economic problems in developing countries is the planned change in the structure of economy aimed, in particular, at the rapid development of the industry as well as considerable government investments.

In the initial period of organizing the production of metal-working equipment it is very difficult for a developing country to compete with the firms of industrially-developed countries exporting their output to this country. In this connection government organizations in a developing country rather often have to take measures patronizing the development of machine-tool production, give this branch of industry the priority in the distribution of currency, purchase of licences, import of machine models etc.

The examples of some developing countries testify that in spite of considerable difficulties the development of industry, in particular the creation of national mechanical engineering, may be positively settled in comparatively historical terms.

The international cooperation between developing and industrially-developed countries as well as the use of the latter experience favours, to a great extent, the settlement of this problem and makes possible to reduce considerably the terms of creating mechanical engineering industry and preparing specialists and workers in developing countries.

The assistance rendered to developing countries by the United Nations Organisation is of a great positive importance.

II. Role of Metal-working Equipment Production in Mechanical Engineering

The production of metal-working equipment including the greater part of it - machine-tools - takes a particular place in mechanical engineering.

Metal-working equipment represents machines on which all other

machines are made.

Clocks, tractors and other agricultural machinery, cars, equipment for mining, light, food and chemical industries, metal domestic wares and all other sorts of metal wares cannot be manufactured without metal-working equipment employed.

Therefore, metal-working equipment is one of the most important bases of the whole mechanical engineering, consequently of all other branches of industry using various machines.

Providing of the handicraft industry usually developed in developing countries with small metal-cutting machines and tools is of great importance for its intensification.

Hence, it becomes clear that the development of metal-working equipment production is of great importance in solving the problem on the creation of national industry in a developing country.

Proceeding from the interests of the development of the whole industry it is considered to be correct that growth rates of the metal-working equipment production should be slightly higher in comparison with those of mechanical engineering production taken as a whole.

It should be noted that the manufacture of metal-working machinery is a labourious production requiring a great number of people which is an important factor from the point of view of population employment.

III. General Problems on the Development of Metal-working Equipment Production in Developing Countries

The development of metal-working equipment production in a country cannot be isolated from the development of other branches of industry.

The metal-working machinery industry purposed to meet the needs of various branches of industry in these machines cannot manufactur

them without the products supplied by other branches of industry such as metallurgical, electrotechnical, chemical and others.

Thus, the development of metal-working equipment production should be regarded in a complex with the development of the whole industry in a country.

One of the primary problems to be solved when starting the development of metal-working equipment production in a country is to determine what types and sizes of metal-working machines should be produced in the first place.

This is determined, firstly, by that what types and sizes of the machines are of prime necessity in the given period for the developing industry of a country and, secondly, which of the machines and in what quantity can be produced in a country taking into account all the circumstances which define the possibilities of their production.

Such an approach to the solution of the problem on the production of metal-working equipment is correct not only for the initial period of the development of its production in a country, but also for the following periods.

With every new period of time, on the one hand, there will grow the demands in nomenclature and quantity of metal-working machines and, on the other hand, with growth of the industrial base for their production, accumulation of experience and increase of specialists there will rise the possibilities of producing machines in wider nomenclature and greater quantity.

Since a certain period of time these basic statements will be added with the considerations on machine export.

Both in the initial and following periods of time it is necessary to determine the technically- and economically-advisable minimum quantity of concrete types and sizes of metal-working machines that will be sufficient to meet the demands of industry.

It is important because an unwarrantably great number of types and sizes of machines produced in a country reduces their serial production and, consequently, increases the cost of their production makes more complicated and expensive the repair and maintenance of machines when used by customers.

At the first stages of the development of metal-working equipment production it is advisable to produce first of all universal machines designed to perform a wide range of operations on machine components.

As for metal-cutting equipment it will be universal medium-sized machines:

lathes for maximum workpiece diameters 250, 320, 400, 500 mm;

drilling machines of maximum drilling diameters in steel 18, 25, 35, 50 mm;

boring machines with spindle diameters of 65, 80 mm;

shaping machines with ram strokes of 320, 500, 700 mm;

knee-type milling machines with table width of 200, 250, 320 m

circular grinding machines for maximum workpiece diameters 140 200, 280 mm;

surface grinding machines with table width of 200, 320 mm;

universal tool-grinding machines, hack and circular saws.

It does not mean that the above-mentioned types and sizes of universal machines should be produced all at once. Only some of them may be produced depending on the primary demands and possibilities.

It may appear to be advisable to master the production of some other types and sizes of universal machines besides the mentioned above, in particular small bench-type lathes, milling, drilling and tool-grinding machines to meet the needs of handicraft industry.

The production of heavy-duty machines is necessary for such a country as, for instance, India which has sufficiently developed machine tool industry and enterprises of heavy engineering industry

Along with general-purpose machines intended to perform a wide range of various operations it might be advisable for a certain branch of industry to master the production of single-purpose machines intended to perform only one operation on parts, the quantity of which is rather large.

The standard of technological development of metal-working equipment production in a country is determined not only by the number of machines produced but also characterized by the figure which is the sum of the products of the number of machine types produced and the number of machine sizes of every type.

Thus, for instance, if five sizes of lathes, three sizes of drilling machines and two sizes of milling machines are produced, then ten type-sizes of metal-cutting machines are produced all together.

It is estimated that approximately 1200 or 1500 type-sizes of machines which can be produced in batches, are necessary to completely meet the needs of up-to-date mechanical engineering in general-purpose machines. These figures do not include special-purpose machines intended to perform quite certain operations on certain parts.

Even industrially-developed countries do not usually produce all the type-sizes of machine-tools necessary for their mechanical enginnering. They select from the total number of types and sizes only those the production of which is considered to be most advisable proceeding from the demands of home mechanical engineering and export. The rest of the necessary machine types and sizes are purchased from other countries producing them.

All the more so, a similar solution is natural for developing countries where in the initial period there is a possibility to produce a small number of types and sizes of machines not complicated and having a small weight.

The growth of metal-working equipment production in a country

is characterized, along with the increasing number of machines produced, by the increasing number of their types and sizes.

At first the number of types and sizes is expressed by units, then by tens and subsequently by hundreds.

Therefore, arbitrariness should not be allowed in selecting types and sizes of machines to be produced. It is highly important from the very beginning to establish a certain scientifically-grounded regularity in sizes of machines of every type which will be put into production later on.

A scientific and engineering analysis shows that it is more advisable to form a range of sizes of machines of every type on the basis of geometrical progression with a coefficient which most often equals to 1.25, 1.4, 1.6. It means that every next size of a machine according to its main dimension (for instance, according to the maximum machining diameter for a lathe) is determined by the product of the main dimension of the previous machine and one of the mentioned coefficients which is chosen.

The scientific and engineering analysis shows that establishing of machine-tool sizes on the basis of geometrical progression allows to meet the needs of mechanical engineering in these machines with minimum number of their model and creates favourable conditions for the unification of parts and units among different sizes of machines to be produced. The mentioned factors assist in increasing the serial production of machine parts and, consequently, in reducing the cost of their production.

The decreased number of different machine models and unified parts and units forming a part of the machines is also a positive circumstance in using and repairing machines at customer's place.

In the initial period of the development of metalworking equipment production it is necessary to choose not heavy and sufficiently simple machines without complex automatics and complex hydraulic,

electric and electronic apparatuses.

With gaining experience and improving professional skill of specialists it will be possible to produce more and more complicated machines along with the simultaneous mastering of the production of hydraulic, electric and other apparatuses which are necessary for more complicated metalworking machines.

As far as metalworking equipment is concerned the practice of its production shows that usually in the initial period there is the following rough proportion among the numbers of general-purpose machines produced in a country:

lathes	35 per cent
drilling machines	30 per cent
boring machines	005 per cent
shaping and planing machines, slotting machines	8 per cent
milling machines	6 per cent
grinding machines of various types	4 per cent
tool grinding machines	3 per cent
cutting-off machines	2 per cent
others	10.5 per cent.

Depending on the specific demands of mechanical engineering in the given country the above-quoted proportion may be different.

Of metal-forming equipment the following machines of wide use are usually mastered in the initial period:

Compressed-air overhanging hammers with dropping parts weighing 100 kg;

High output presses with capacities up to 100 tons;

Piercing presses for hole diameters up to 30 mm in a sheet up to 10 mm thick;

Sheet metal shears for sheets up to 6 mm thick and 2000 mm long

Rolled bar shears for cutting round bars up to 50 mm diameter.

From the very beginning of the development of metalworking

equipment production in a country it is highly advisable to establish, on a national scale, a decimal digit designation of universal types of these machines.

Thus, for instance, the following classification may be established for metal-cutting machines.

Every group of machines is designated by a certain figure which is written the first in the digital designation of a machine type.

Group Nos	Name of Machine Groups (according to operatios performed)
1.	lathes
2.	drilling and boring machines
3.	grinding machines
4.	EDM and ECM machines
5.	Gear and thread cutting machines
6.	milling machines
7.	ploning machines
8.	cutting-off machines
9.	miscellaneous

Each of the main machine groups consists of subgroups. Every subgroup is also designated by one of nine figures which is the second in the digital designation of the model.

Thus, for instance, the subgroups in the lathe group constitute such machines as universal lathes, turret lathes, turning-and-boring lathes, multiple-tool lathes, automatic lathes etc.

The subgroups in the drilling and boring machines group will be column drilling machines, radial drilling machines, horizontal boring machines, precision jig-boring machines and others.

The last figures in the designation of a model show the main dimension of a machine. So, for example, the main dimension for universal lathes is the maximum turning diameter, for drilling machines

it is the maximum diameter of drilling in steel.

According to the classification mentioned above the digital designation for the column drilling machine of 35 mm maximum diameter of drilling in steel is "2135".

In this digital designation of the machine model the first figure "2" indicates that the machine refers to the group of drilling and boring machines; the second figure "1" indicates that the machine is a column drilling machine; the third and fourth figures "35" indicate that the maximum diameter of drilling in steel for this machine is 35 mm.

The machine groups and subgroups may be designated by other figures if it is considered to be more reasonable.

If the machine model is subject to modernization then for the distinction of the modernized model from the old one the letter "M" is added to its designation. For example, the modernized model of the drilling machine will be designated as "2135M".

On the above-stated principle a designation classifier is made for universal machines including their main types.

Using such a classifier the state organization which is responsible for this, gives the numbers to new models of metalworking machines being developed in the country and registers them.

Such a system of designation and registration of machine models is convenient in planning the production of machines and in their utilization.

Special models of machines produced according to the customers' single orders for performing certain operations are not included in the classifier and designated according to the systems established by the manufacturers.

In catalogues, prospectuses, drawings, letters and other documents, naturally apart from the digital designation, the machine type is also indicated; the main dimensions and other data being given

in its specifications.

Since the development of metalworking equipment production should be effected in a close contact with all other industries being developed in a country, the latter determine types, sizes and the number of metalworking machines which are to be produced in every period of time. The long-term plans for the metalworking machines production should proceed from the long-term plans for the development of the whole industry in a country.

Moreover, for every long-term period it is necessary to determine what metalworking machines can be produced in a country and which of them should be imported.

Gear-cutting and broaching are the machine-tools which should be imported in the first period of the industrial development of a country because they require for their production rather high skill.

In solving the problem on the import of machines, apart from the possibility to produce them in a country, it is also necessary to proceed from the expedience of importing those types of machines which are needed in small quantities, striving to put into production machines required in large quantities.

With the development of metalworking equipment production the number of types and sizes as well as the number of machines produced in a country will increase in total deliveries of this equipment for the mechanical engineering industry, and accordingly the share of imported machines will be reduced.

The development of metalworking equipment production depends to a great extent on the development of those branches of industry which produce metals (cast iron, steel and others) and various purchased articles necessary for the production of metal-cutting machines, such as electric motors, electrical equipment, antifriction bearings, driving belts etc.

For the production of metalworking equipment it is necessary

to use as much as possible metals and various purchased articles produced in a country.

In the initial perod of the development of national industry many of these materials and purchased articles have to be imported, but with the development of various branches of national industry this import will be reduced.

Simultaneously with the development of metalworking equipment production in a country there should be also envisaged the production of cutting, abrasive and measuring tools.

Metalworking equipment and its tools may be produced both at the enterprises intended for their production only and at machine-building plants manufacturing other machines too. In the latter case metalworking machines are usually made in a separate shop of the enterprise.

If the possibilities are available it is necessary to utulize to the greatest extent the existing jobbing enterprises and shops for the production of simple small metalworking machines , their separate mechanisms, cutting and measuring tools. The facilities available at these enterprises and workers having some experience in machining will favour rapid adopting of metalworking machine production.

If there is a considerable quantity of wood in a country and the development of woodworking industry manufacturing furniture and other wooden ware is advisable then it will be evidently correct to provide the production of wood-working machines and their tools. Since woodworking and metalworking machines are very much alike in their design the problems concerning the production of the former and the latter machines should be solved together.

The creation and development of the production of metalworking (and woodworking if possible) equipment in a developing country requires for systematic and thorough studying of the industry needs

in these machines. With further development it is necessary to properly determine the types and sizes of metalworking machines to be produced in a country or imported from other countries in different periods of time.

There should be done the work on designing of new machines and modernizing of old ones produced in a country, the work on standardization and normalization in the field of metalworking machines; as well as the purchase of licences for the production of machines; the manufacture and test of machine prototypes, solving problems concerning cutting and measuring tools for the machines. This work should also include the training of specialists in the field of designing, manufacturing and proper servicing of machines, the translation into the language of a country various necessary foreign papers on questions of metalworking machines and metalworking as well as the preparation and duplication for industrial workers various technical manuals concerning metalworking. There should also be done the work on studying machines purchased from other countries, on rendering assistance in putting into production and proper servicing of metal-cutting equipment imported or produced in a country as well as many other kinds of work concerning the development of production of metalworking machines in a country.

IV. Organizations Responsible for Solution of Technical Problems on Metalworking Equipment Production in Developing Countries

The necessity of accomplishing the above-mentioned and other numerous kinds of work concerning the production of metalworking equipment in a developing coutry requires for the establishment of appropriate organizations there.

Evidently, recommendations on this matter should be different depending on the standard of industrial development of a country.

To consider these recommendations it will be advisable to conventionally divide the developing countries of Asia into two groups

according to their industrial development.

The first group includes countries where there are engineering enterprises and, in particular, metalworking equipment is produced, even if the volume of its output is small.

The second group includes countries where mechanical engineering does not exist as it is, at best there are small shops to repair imported machines and primitive shops to manufacture and repair simple metal wares of domestic use.

A. Recommendations for the First Group of Countries Having Mechanical Engineering and Producing Metalworking Machines

Because of rather a small number of specialists in the field of metalworking equipment in developing countries referred to the first group and comparatively a small scale of metalworking equipment industry it is advisable to concentrate the most skilled specialists on metalworking machines as well as those graduated from higher and secondary technical schools in the country and abroad in a single scientific and engineering centre* which should be responsible for accomplishing the above-mentioned complex of work concerning the development of the national production of metalworking (if possible woodworking) machines.

It is reasonable to subordinate the scientific and engineering centre to a corresponding government body responsible for the development of national industry.

The activity of the scientific and engineering centre may be financed by the government bodies completely or partially. In the latter case a certain part of means may be given by firms which will use the results of the work carried out by the centre. Some part of means may come into the budget of the centre from the payment for certain kinds of work carried out by the centre according to the contracts with firms.

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* The name of the organisation may be different.

Subdivisions (Departments) of the Scientific and Engineering Centre and Their Tasks:

Subdivision I

- To study the needs of industry in metalworking equipment and determine types and sizes of necessary machines.

- To study metalworking equipment production potentialities in the country.

- To work out, for the forthcoming planned period and for every year of this period, proposals containing a list of types and sizes of machines the production of which is advisable and possible in the country (with enterprises recommended for the production of certain types of machines) and recommendations on the number of machines of every type to be produced.

When recommending enterprises manufacturing metalworking machines it is necessary to concentrate the production of identical and similar by design types of machines at the minimum number of enterprises. This will result in the increase of the serial production of machines and make it cheaper.

- To work out recommendations on certain types and number of machines which are to be imported in the forthcoming planned period.

- To give, according to the classifier, numbers to new and modernized machines produced in the country and register them.

The approximate number of workers in the subdivision is six.

Subdivision II

- To study machines imported and produced in the country, their design, operation and service rules.

- To translate into the language of the country the specifications and service manuals for imported machines to be used at the customer's place.

- To render assistance to customers in setting-up and proper servicing of machines imported or produced in the country.

To carry out this work the scientific and engineering centre

should have a demonstration hall where specimens of machines imported or produced in the country must be placed.

The study and investigation of these machines are carried out with the use of received specifications as well as with the help of representatives of organizations and firms supplying these machines.

It is advisable to utilize the demonstration hall also for teaching the representatives of various enterprises of the country to operate these machines. Such training must be organized in a proper way.

It is necessary to organize here consultations, for the industrial workers, on various questions concerning metalworking equipment.

In the demonstration hall certain parts may be produced by orders at a corresponding charge.

The kind of parts and their number should be suitable for machining in the demonstration hall so that it will be possible to demonstrate visually the operation of a machine and tools, methods and technique of machining. The fulfilment of such orders should on no account turn the demonstration hall into an ordinary production shop and prevent from carrying out the tasks which this hall is intended for.

If foreign government bodies and firms wish to show their machines in the demonstration hall, such an opportunity may be offered to them free of charge or at a corresponding charge.

Such a form of additional showing foreign metalworking machines will allow, without any expenses, to get acquainted with equipment produced in other countries. This is important not only for selecting models of interest for their purchase or purchase of licences for their production but also for training specialists of the scientific and engineering centre and mechanical engineering workers. The approximate number of workers in the subdivision is 15 to 30.

Subdivision III

This subdivision carries out the work on creating new models of machines intended for serial production at the national enterprises as well as the work on improving the designs of machines produced in the country.

It includes senior, medium-level and junior designers. On the basis of work done by the first subdivision in determining types and sizes of machines to be produced in the country this subdivision selects those which are necessary to be designed.

Before starting to design a machine it is necessary to get thoroughly acquainted with machines of similar purpose applied in industry and their operation, to study similar machines produced in other countries through the available publications and to determine specifications most suitable for the country conditions which the model under construction should meet.

In the initial period of the development of the national metalworking machine production when there is no experience in developing new machines the reproduction of some foreign machines at the national plants may be advisable.

This may be done by means of purchasing licences or giving drawings on the basis of special agreement with corresponding foreign government bodies or firms.

When there are no patent obstacles (in particular, when a machine was produced many years ago and taken off the production abroad long ago) it may be possible and advisable to copy drawings of a machine used at a national enterprise for its serial production.

In the first case representatives of a firm or organization that have sold licences or given drawings usually take part in putting the machine into production since together with the machine drawings they also share their experince of producing it.

If by chance the technical documentation is made up in the inch

system and in the country the metric system is adopted then it is necessary to convert the date given in the inch system into the metric one.

This work as well as manufacturing of the machine prototype and its testing will assist to a great extent in improving the skill of the personnel of the design subdivision at the centre.

When it is decided to start producing a machine model chosen from those working at national enterprises the design subdivision copies the machine drawings making, if necessary, alterations and improvements. This work itself is a good school to improve skill of designers.

In the process of machine designing there usually arises the necessity to test and investigate its separate parts.

Performing these tests, investigations and experiments requires for stands and apparatuses .

Investigations may be carried out by designers themselves or research workers.

In the design subdivision it is advisable to have a research laboratory where the experimental and research work mentioned above will be carried out. (A list of equipment for the research laboratory is attached in Appendix I).

In the process of manufacturing a model of a new or modernised machine according to the drawings worked out by the design subdivision the designers render assistance to the production workers in the settlement of arising engineering difficulties.

After the prototype of a new or modernised machine is produced it is put to detailed laboratory test on which basis all necessary alterations are made in the drawings.

If by chance the prototype required considerable changes it may be advisable to produce, according to the amended drawings, the second prototype which is also thoroughly tested.

It is reasonable to produce, according to the amended drawings,

a small batch of 5 or 10 machines and install them at the enterprises for field tests. These tests may also reveal additional defects in the machine which should be taken into account by the drawings before passing them for the machine serial production.

In the period of the serial production of machines and their use in industry the specialists who have worked out the drawings systematically observe the operation of the machines, are interested in the remarks of production workers concerning their performance and, if necessary, make changes and improvements in the machine drawings.

It is advisable to install a machine prototype or one of the first specimens of its serial output in a workshop of the scientific and engineering centre in order to systematically observe the operation of the machine, such a shop being a production base of the centre.

With expanding scope of work of the scientific and engineering centre, in particular with increasing nomenclature of new and modernized machines produced there it is necessary to implement the specialization of designers on different types of machines.

In the staff of the design subdivision it is reasonable to have groups dealing with the following types of metalworking machines:

- metal-forming machines
- turning machines
- drilling and boring machines
- planing, slotting, milling and cutting-off machines
- grinding machines
- gear-cutting machines.

If it is necessary to produce woodworking machines then there should be a group on woodworking machines.

The availability of national standards and normals on metalworking equipment is of extreme importance for the improvement of design

ing work and production in this field of technology, considerably facilitates and speeds up the fulfilment of work on designing and manufacturing of machines, allows to save up substantial means and time.

Therefore due attention should be given to the problems of standardization and normalization.

While working out national standards on metalworking equipment and tools it is necessary to use as much as possible corresponding recommendations of the International Standards Organization (ISO).

To considerably facilitate and speed up the working-out of national standards and to avoid possible rough mistakes made in them it is necessary to use corresponding standards of an industrially-developed country with which there are wide commercial, scientific and engineering contacts.

The limited number of points necessary to satisfy the requirements of designing and manufacturing of metalworking equipment should be selected from these and ISO materials, proceeding from the standard of its production in the country and taking into account the prospects of the development. An unwarrantably wide nomenclature of normalized parts unnecessarily complicates and makes more expensive their production and application.

It is advisable to issue branch normals on originally normalized parameters or parts. These normals can be transferred into the category of national standards provided that they will prove to be good after their verification for several years.

Standards on some parameters and parts may be worked out at once.

Normals and standards are made for the machine main dimensions, accuracy grades, materials, fasteners (screws, nuts, pins etc.), fittings and other machine elements.

The recommended list of materials on normalization and standar-

dization (except for normals and standards on machine main dimensions and accuracy grades) is given in Appendix II.

The design subdivision should also include groups dealing with electrical, hydraulic and lubricating equipment for metalworking machines.

These groups should have at their disposal laboratories furnished with appropriate apparatuses. (The list of equipment for these laboratories is given in Appendixes III and IV).

Though it will be untimely to produce machines with rather complicated hydraulic drives in the initial period of organizing the production of metalworking equipment in a developing country, nevertheless it is advisable to start at once training specialists on hydraulic equipment and establish a corresponding group of the design subdivision.

Such a group studying foreign hydraulic equipment and papers on this matter will solve problems concerning the application of simple hydraulic drives which are to be employed in machines in the nearest future.

Hydraulic equipment specialists will be also required in the country in connection with the delivery of foreign hydraulically-driven machines.

Specialists on hydraulic drives will be of great value when in the course of time machines with more and more complicated hydraulic systems start to be designed and produced in the country.

It should be taken into consideration that hydraulic systems are widely employed not only in metal-cutting equipment but in many other modern machines too. Therefore training of specialists in the field of hydraulic equipment and, in future, the creation of its production in the country is of great importance not only for the metalworking equipment industry but for other branches of mechanical engineering too.

Depending on the standard of the development of national metal-working equipment production and the scope of work of the scientific and engineering centre the design subdivision may number from 25 to 100 persons.

Subdivision IV

This subdivision deals with the problems of:

- iron and non-ferrous casting
- steel and its heat treatment
- torch cutting; electric and gas welding of metals; plastics and rubber technical wares for metalworking equipment
- lubricants and varnish paints; painting of machines.

This subdivision should have founding/metallographic and chemical laboratories furnished with appropriate apparatuses which allow all the necessary investigations and tests to be carried out.

The subdivision should also have a laboratory for heat treatment of metals, facilities for mechanical tests of metals (lists of equipment for founding/metallographic and chemical laboratories, heat treatment laboratory and equipment for metal mechanical tests are given in Appendixes III, IV and V).

Depending on the scope of work performed at the scientific and engineering centre and the necessity to carry out all kinds of work mentioned above, the subdivision may consist of 10 to 25 persons.

Subdivision V

The subdivision deals with the problems of metal working technique as well as cutting and measuring tools. The specialists of thi subdivision studying corresponding foreign materials in this field, in particular normals and standards for tools imported from a country which renders technical assistance, work out normals and standards for cutting and measuring tools used in the national industry, which will be a base for organizing their centralized production.

On the basis of studying foreign materials the subdivision works out reference tables on metal-cutting conditions which are duplicated and sent to be utilized in industry.

Specialists of the subdivision study the achievements of world engineering in the field of metalworking technique and take measures to introduce those of them which are of interest to be utilized.

If necessary, experimental and research work on cutting and forming metals may be carried out in the subdivision.

The subdivision should have a laboratory furnished specially for practical checking and mastering various new metalworking procedures.

These procedures may be of great interest for many enterprises or decide specific tasks arising at firms' plants in the course of their work. In the latter case research work is carried out according to the firms' orders.

The work of the subdivision may be performed not only in the laboratories of the scientific and engineering centre. In some cases it is advisable the work to be carried out to a considerable extent at the enterprises for which it is intended.

The subdivision should also have groups dealing with abrasive and measuring tools.

The number of workers at the subdivision is 10 to 25.

Subdivision VI

It deals with questions of proper service and repair of metalworking equipment.

The subdivision works out recommendations and manuals on proper service and repair of metalworking equipment.

It gives consultations and renders assistance to enterprises employing metalworking equipment, on questions of its proper service and repair.

Subdivision VI

It takes up questions of scientific and technical information, in particular popularizes the work carried out at the scientific and engineering centre by means of distributing information materials and informs on the achievements of interest in metalworking industry in other countries.

The subdivision should have a group of translators which, according to the instructions of other subdivisions, must make translations into the language of the country of various technical materials that are of interest both for the scientific and engineering centre and national machine-building enterprises.

The subdivision

- effects the accumulation and storage of technical documentation at the scientific and engineering centre;

- draws up and duplicates drawings, manuals and other papers worked out at the scientific and engineering centre and distributes them among the enterprises and organizations being interested in them;

- according to the management instructions, takes measures to acquire technical papers of interest, in particular technical literature published in the country and abroad;

- ensures the accumulation of papers at the technical library of the scientific and engineering centre and organizes its work.

At its disposal the subdivision should have apparatuses and personnel for duplicating of drawings, printing of text materials, photographing, stitching as well as a dispatch office to distribute materials. The library and technical archives are subordinate to the subdivision.

The total number of workers at the subdivision is 10 to 30.

Thus, at the scientific and engineering centre in the first period of its existence the total number of production workers will

amount to 80 to 220 persons and with addition to this number of service personnel making up 50% of production workers the total number will be 120 to 310.

The above-mentioned structure and number of workers of the scientific and engineering centre as well as the contents of works carried out are given as a model. There may be some differences depending on the specific conditions of a country.

The scientific and engineering centre cannot fruitfully and effectively work and its activity will not be of a success if from the very beginning it has no corresponding industrial and experimental base (experimental plant) to manufacture various stands, instruments and parts required for carrying out research and experimental work as well as for producing prototypes of metalworking machines and various mechanisms which will be designed at the scientific and engineering centre and after their testing and mastering passed to the industrial plants for their serial production.

The industrial and experimental base of the scientific and engineering centre should represent an enterprise having at its disposal all the necessary equipment which enables, without great dependence on other enterprises, to produce parts of machines and mechanisms developed at the scientific and engineering centre as well as assemble and test them.

If there is an opportunity to receive rather quickly iron and non-ferrous casts (together with the manufacture of their patterns) from other enterprises, the experimental base may not have a foundry and a pattern (maker's) shop. If there is no such an opportunity, the experimental base should have its own founding production even if it is small.

Engineering and toolmaker's shops of the enterprise should have the following machines:

- for cutting off blanks

- for turning
- column drilling, radial drilling
- boring and precision jig-boring
- gear milling, gear shaping and gear grinding
- circular grinding, internal grinding and surface grinding
- tool grinding
- cutting off

Other types of machines may also be required.

The number of machines is determined by the dimensions of the scientific and engineering centre and the scale of work of its industrial base. Approximately it amounts to 40 to 100 units. (A list of machines is given in Appendixes VI and VII).

It is necessary to have shops or sections for heat treatment of metals, gas cutting, electric and gas welding of metals as well as for manufacturing parts of sheet.

The assembly shop should have electrotechnical, painting and packing sections.

It is necessary to have a store of materials and purchased goods. In connection with the experimental character of production it is advisable to have large stocks of materials and purchased goods both in assortment and quantity.

The enterprise should have in proper places cranes of 3 to 5 tons hoisting capacity.

It is highly desirable that the enterprise would be provided with up-to-date equipment and well organized production, apply advanced methods of work and thus would be able to serve an example for plants producing metalworking equipment, so that the representatives of these plants could get acquainted with advanced technological processes in founding, mechanical, thermal and other kinds of working.

Since usually the equipment and personnel at the enterprise

of the scientific and engineering centre cannot be completely occupied with work in manufacturing stands, instruments, prototypes of machines and mechanisms it is advisable to use 50% of the enterprise capacity for manufacturing and selling small batches of machines and mechanisms which have been developed by the scientific and engineering centre before and are in demand in industry. It will be highly profitable for the financial state of this centre.

The experimental enterprise should have:

- an engineering department to work out the procedure of manufacturing machines and mechanisms and to design accessories and tools required for this purpose;

- a checking department (equipment for which is given in Appendix VIII);

- material supply department providing the enterprise with materials, purchased goods, cutting, abrasive and measuring tools.

The total number of workers of the experimental base is 50 to 300.

The area of sheltered premises is 800 to 3000 sq.m.

The total number of workers of the scientific and engineering centre together with the personnel of the experimental enterprise will approximately range from 170 to 610 depending on the specific conditions of the country.

The management of the scientific and engineering centre should consist of the director (whom the experimental enterprise is subordinate to), commercial director, chief engineer responsible for the solution of technical problems, manager of the experimental production (subordinate to the director).

(The staff of the management and names of posts may be different).

It is advisable to locate the scientific and engineering centre in a place where enterprises producing metalworking equipment are

concentrated or not far from it, the latter case is possible if sufficiently good means of conveyance and communication between the enterprises are available.

The scientific and engineering centre and its experimental plan may be located in buildings specially intended for them or (especially in the first period) in a part of production and administrative premises of an existing enterprise producing metalworking equipment.

While functioning the scientific and engineering centre should have contacts with plants producing metalworking equipment and enterprises of other branches of mechanical engineering.

If there are higher and secondary technical schools it is necessary to establish business contacts with these educational institutions and their teaching staff, the activity of which concerns metalworking equipment.

It is advisable to engage the teaching staff of appropriate faculties of technical educational institutions as well as students of the fourth and fifth courses in carrying out works concerning their speciality at the scientific and engineering centre.

The work plans of the scientific and engineering centre are worked out proceeding from the needs in the development of national metalworking production for the forthcoming period and taking into account the needs of mechanical engineering in this equipment (in due course the needs of export) and the achievements in the field of metalworking equipment in other countries.

One of the most important functions of the scientific and engineering centre may be the training and improving the skill of specialists for the metalworking equipment industry.

In this connection at the scientific and engineering centre there may be provided draftsmen courses and seminars to improve the skill of specialists employed at metalworking equipment plants and machine building enterprises as well.

At the seminars qualified specialists of the scientific abd engineering centre acquaint industrial workers with the work carried out by the centre and achievemnets obtained in metalworking equipment and technology in the country and abroad.

Every 3 or 4 years the scientific and engineering centre may hold conferences for representatives of metalworking equipment enterprises and those of mechanical engineering to discuss questions concerning the development of its production in the country.

One of the ways to improve the qualification of specialists employed at metalworking equipment enterprises is to send them to the scientific and engineering centre to work for 1 to 3 years. During the time when industrial specialists work at corresponding subdivisions of the centre according to the programs agreed beforehand they extend their knowledge in general problems of technology and especially in those fields which they are engaged in.

Thus, the scientific and engineering centre will be replenished with a certain number of production specialists who improving their skill at the centre will simultaneously contribute to its activity.

A similar form of work of industrial specialists at the scientific and engineering centre useful both for the centre and enterprises may be officially registered by corresponding agreements envisaging, probably, some financial fees of the enterprises.

A set system of successful supplying industry with metalworking machines is a problem of great importance.

For this purpose it is adviasble to set up a state organization or private firm selling national metalworking machines to industry. Such an organization or firm must have close contacts with enterprises producing and utilizing these machines. Its staff should include specialists capable of giving proper recommendations on required machines, rendering assistance in setting them up and putting into use.

In case of a state organization it is advisable to envisage rewarding its workers with a premium to stimulate their activity; its rate making up a certain percent of the cost of sold machines.

It may be reasonable to establish certain forms of joint activities of the mentioned state or private firm and the scientific and engineering centre.

b. Recommendations for Developing Countries Having No Mechanical Engineering

In developing countries where mechanical engineering has not yet existed, there are no national engineers and workers acquainted with the production of machines and their parts.

Repair and maintenance of various imported machines and equipment available in the country is carried out by the representatives of foreign firms - suppliers of the machines. Spare parts produced by these firms are utilized in this case.

Mechanical engineering in such countries may be expressed only in the form of production of spare parts for various mchines working in industry and repair of these machines.

As a form of training national specialists to repair machines available in such countries as well as to acquire elementary knowledge in mechanical engineering it is recommended to establish one or several industrial training centres to repair machines. The name of such organizations may be different.

The main tasks of such centres should be:

- to get the listeners acquainted with the main types of machines available in the country and the rules of their operation
- to teach the listeners to read drawings and make simple drawings of finished parts;
- to get the listeners acquainted with the main metal working problems, machines employed for that, the technology of machining parts, main rules and methods of machine repair.

The industrial training centre should have an industrial train-

ing enterprise furnished with main types of universal metalworking machines. It must have forging, founding, welding, thermal and painting departments.

Listeners of the centre study theoretical subjects on questions mentioned above and get practical knowledge of how to operate metalworking equipment and manufacture parts for machines to be repaired. They also study service instructions of machines widely used in the country.

Practical knowledge in locksmith work may be acquired by repairing various equipment carried out at the industrial training centre according to the contracts with customers. For this purpose a repair shop should be set up at the industrial training enterprise or separately.

Skill in repairing machines can also be acquired by carrying out repair work under contracts at places of machine exploitation.

Practical training of service instructions for machines widely used in the country is effected at corresponding enterprises.

To acquire elementary skill in mechanical engineering and realisation of goods produced by the industrial training enterprise in the process of teaching it is reasonable to manufacture there a small number of simple machines such as bench metal-cutting machine-tools for handicraft shops, simple agricultural and other machinery. Such work intended for training purposes will also be of positive importance for the budget of the industrial training centre.

Persons having completed their studies at the industrial training centre are employed as repairers by existing and newly created repair shops as well as by different enterprises of the country.

With growing number and qualification of specialists who has acquired skill in mechanical engineering through repair production as well as with increasing number of repair shops in the country it is possible to gradually raise problems on creating the produc-

tion of simple and necessary machines in the most qualified repair shops. In particular, it is possible to organize the production of various kinds of small machine-tools (turning, drilling, tool grinding and others which are usually quite necessary for numerous domestic ware repair shops.

For the industrial training centre, new buildings may be constructed or, if reasonable, the existing ones may be adapted after being reconstructed and repaired.

Projecting, construction, reconstruction and organization of work of the industrial training centre are better to be carried out under contracts with the help ofspecialists from industrially-developed countries.

If there are no national specialists to work as teachers at the industrial training centre and its enterprise, it is advisable to invite them from an industrially-developed country on the basis of corresponding contracts. Furthermore, all the required training appliances visual aids and text-books as well as main technical papers to be studied by the listeners of the industrial training centre should be provided by the industrially-developed country.

The industrial training centre should have an office making translations of foreign papers into the language of the country, duplicating them to teach the listeners and distribute some of them inquired by various enterprises, organizations and private persons.

Model structure and number of workers employed at the industrial training centre:

- a group of teachers on theoretical subjects and masters on production training numbering 10 to 30 persons;

- an office making translations, preparing, duplicating and dispatching educational papers and visual aids, is of 5 to 20 persons;

- a subdivision providing drawings and other technical documen-

tation for spare parts, developing the technology of their manufacture, organizing their production and storage, purchasing materials to manufacture spare parts - 10 to 30 persons;

- governing body of the industrial training centre, its administrative and executive and service personnel - 15 to 40 persons;

Thus, the total number of personnel of the industrial training centre will approximately amount to 30 to 120 persons.

The area of the premises of the industrial training enterprise at the centre is about 500 to 2000 sq.m.

The number of various metalworking machines employed there is 25 to 80 units.

With developing industry and metal working and increasing demand for metalworking equipment in the country it is advisable to use additional forms of training specialists in metal working industry and its development in the country.

Moreover, it is possible to use in ever increasing scale some forms recommended for developing countries having mechanical engineering and metalworking equipment production.

It is of no exception that it may be advisable for a developing country having metalworking industry to establish industrial training centres performing the same functions as those in the countries which have no mechanical engineering.

V. Scientific and Technical Assistance of Industrially Developed Countries

In the first period of creating the production of metalworking equipment in a developing country when there is no sufficient experience in manufacturing machines and when it has an extremely limited number of specialists which are not highly skilled, it is very important to make use of the experience of industrially developed countries by inviting specialists who have experience and qualification in designing and manufacturing metalworking machines and organising their

production.

Such assistance to a certain firm in a developing country on the part of specialists from industrially developed countries may take place in case of purchasing a licence for producing a machine by this firm.

A corresponding agreement about this assistance is usually made when purchasing a licence.

In this case the assistance of specialists from an industrially developed country usually consists in giving consultations on technology and organization of production of a certain machine which is an object of the licence. Here, a technological process of production of this machine applied in the developed country is usually used with appropriate changes made with regard for the local conditions of production.

There may be cases when specialists from a developed country are invited consultants to a functioning enterprise to render assistance in increasing the technological standard and industrial efficiency of the enterprise.

Specialists from a developed country may be invited [redacted] to the corresponding government institutions as consultants on questions of creating and developing the production of metalworking equipment in the country.

In the period of creating the production of certain wares in a developing country when it is necessary to construct for this purpose a new enterprise or to reconstruct an existing one, agreements are very often made with government institutions or firms of a developed country to work out, on the basis of reference data agreed by both parties, a project of the enterprise including buildings, production technique, necessary equipment, organising the production and other questions.

In case of the realisation of the project specialists of an

industrially developed country come to exercise, together with national specialists, technical guidance in bringing about the project

Carrying out this work specialists from a developed country share their experience in constructing enterprises and organizing the production, which is a good school for training specialists and workers in a developing country.

Having taken the decision on creating a certain branch of industry with the help of a developed country, a developing country rather often sends its specialists and workers to the enterprises of a developed country to study corresponding specialities necessary for work at its enterprises.

It became a common practice to send a certain number of young specialists from developing countries to study at higher educational institutions of industrially developed countries.

Besides theoretical study students take practice at enterprises of a developed country, acquaint themselves with the experience of that branch of industry where they will have to work on returning home.

Cases are not rare when teachers of certain subjects from higher educational institutions of a developed country are invited to higher educational institutions of a developing country.

In case of establishing a scientific and engineering centre in a developing country it is highly advisable to invite specialists from a developed country to render assistance in organizing its work and improving professional skill of its staff.

There may be invited specialists of various profiles such as those who organize the work of the scientific and engineering centre designers, researchers, manufacturing engineers, repairmen, specialists in science of metals and persons of other specialities depending on specific demands.

It is useful to send specialists from a developing country to

the scientific and engineering centres of industrially developed countries for 1 to 3 years to study designing, research work, technology and other fields.

The program and term of studying specialists at the scientific and engineering centre is determined by a corresponding agreement.

It may be advisable to use some of the above-mentioned ways of applying experience of an industrially developed country for training specialists and workers and improving their qualification as well as for rendering assistance in developing production of metalworking equipment in a developing country.

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This report concerns the promotion of the production of metalworking machines in developing countries which is one of the most important bases for producing the rest of industrial equipment in the country.

The recommendations mentioned in the report may be considered, with regard for specific features of other branches of mechanical engineering, as model ones to be used in creating the production of other types of industrial equipment.

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The recommended lists of laboratory equipment for the scientific and engineering centre attached to the report in eight appendixes as well as lists of equipment for engineering and toolmaker's shops of its experimental enterprise may also be used for supplying laboratories and shops of plants producing metalworking and other machines.

APPENDIX I

L I S T

of equipment for testing and investigating metalworking machines, their mechanisms as well as for performing investigations in the field of metal cutting

Primary equipment

1. Π - shaped compression dynamometers for 250, 500, 1000kg loads.
2. Ring-type traction dynamometers for 250, 500, 1000kg loads.
3. 500 and 5000kg calibrating dynamometers.
4. Trade-type dial scales, up to 5kg.
5. Mail-type scales, up to 50kg.
6. Technical scales, up to 1kg.
7. Inertia dynamometer (with an indicator) for measuring cutting forces.
8. Seconds timer.
9. Profilometer (surface finish gauge).
10. Hardness tester (Poldy-type).
11. Screw or hydraulic press (for dynamometer calibrating)
12. x6 and x10 magnifiers
13. Prony brakes for power up to 5kw, 10kw and 20kw.
14. Band brake with a stand.
15. Laboratory thermometers, up to 150°C
16. 0,01mm dial indicators with measuring supports.
17. 0.002mm dial indicators with measuring supports.
18. Minimeter, 0.002mm graduation.
19. 0.02mm per 1000mm frame level.
20. Special angle protractor for measuring cutting tool angles.
21. Revolution counter.
22. Precision surface plate.

23. Cheking centres.
24. Block gauges.
25. Thread gauge.
26. Feeler.
27. Set of angle gauges.
28. Set of hairline gauges.
29. Height gauge, 0.02mm graduation.
30. Slide callipers up to 350mm, 0.05mm graduation.
31. Slide callipers up to 150mm, 0.02mm graduation.
32. Micrometers for diameters up to 100mm.

Electric Equipment

1. 0.3 grade laboratory electromagnetic voltmeter, up to 600v.
2. 0.5 grade laboratory electromagnetic voltmeter with a set of shunts for measuring direct current from 0.1 to 150A.
3. Universal resistance bridge.
4. Set of small-sized electric measuring devices.
5. Various laboratory rheostats.
6. Recording wattmeter.
7. Laboratory autotransformer.

The above list of tools and devices should be considered as original.

With the development of production of metal-cutting equipment and the improvement of skill of specialists more sophisticated devices should be acquired and used:

I. Oscillographs.
2. Amplifiers.
3. Detectors of variables rotary and rectilinear motion.

4. Time recorder with intervals varied from 0.1 to 1sec.

Small - inertia devices for measuring:

5. forces
6. torques
7. cutting forces
8. vibrations and others.

Appendix 2

L I S T

of normalization and standadization items recommended to be developed in view of utilizing them in designing and centralized production of metal-working equipment

Serial Nos.	Norms and standards classes	Approximate number of norms used
1.	General norms	45
2.	Materials	15
3.	Fasteners	50
4.	Fittings	40
5.	Normalized parts-various	50
6.	Normalized units - various	10
7.	Lubricating systems	30
8.	Cooling systems	3
9.	Hydraulic drive	20
10.	Electric equipment	40
11.	Pneumatic equipment	8
12.	Auxiliary tools	5
13.	Cutting tools	50
14.	Measuring tools	20

APPENDIX 3

L I S T

of equipment for founding / metallographic and chemical laboratories

Primary equipment

1. Bench drilling machine for sampling chips and specimens for chemical and metallographic analysis - drilling diameter up to 12-15mm.
2. Laboratory mixing runners with 0.05m^3 cup for preparing test molding and core sands.
3. Universal molding sand tester for compression, tensile, shearing strength etc. in cold and hot state.
4. Molding and core sand tester for gas penetration.
5. Molding and core sand samples drying chamber heated up to 400°.
6. Portable hardness tester for large-sized and heavy parts - snap-gauges or devices of dynamic action.
7. Molding and core sand moisture tester with measuring limits up to 7 percent - stationary, portable.
8. Hardness tester for measuring surface hardness of molds and cores.-

   test in wet state

   test in dried state.
9. Set of equipment for preparing technological cast samples (pouring, chill, shrinkage etc.).
10. Styloscope
11. Carbon detector (sample is fired in a tube).
    - universal gasanalyzer.
12. Porcelain and glass wares and reagents.
13. Water distillating apparatus.
14. Muffle furnaces.
15. Electric heaters.

With higher technical standard of founding production and skill of specialists it is advisable to acquire auxiliary equipment:

1. Induction high-frequency furnace for melting ferrous and non-ferrous metals in a pot up to 50kg (calculating on ferrous alloys).

2. Chamber heating stove for heat-treating castings; overall dimensions of working chamber - 1500x800x600mm and heating temperature up to 1000°C

3. Recording multi-point potentiometer for recording temperatures when cooling castings with measuring up to 1600°C.

4. Screen analyser of original molding and core materials.

5. Device for measuring clay content in molding and core sands.

6. Equipment for precision quantitative spectrum analysis of metals.

7. Electrolysis apparatus for electrochemical analysis.

8. Spectrophtometers.

9. Photocolorimeters.

10. "Mars" stoves.

APPENDIX 4

L I S T

of equipment for metal heat-treatment laboratory

Primary equipment

1. Metallographic microscope.
2. Rockwell hardness tester
3. Vickers hardness tester.
4. Brinell hardness tester.
5. Laboratory portable potentiometer for measuring temperatures (with thermoelectric couples chromel- alumel and platinum-platinum - rhodium)
6. Grinding machine for preparing metallographic specimens.
7. Polishing machine for preparing metallographic specimens.
8. Draught hood for preparing and and storing reagents and etching metallographic specimens.
9. Laboratory bench-type electric stove for heating up to 1000°C
10. Laboratory bench-type drying chamber for heating up to 350°C.
11. Reagents and laboratory ware.

With developing production and improving skill of specialists it is advisable to acquire auxiliary equipment

1. Binocular microscope (stereoscopic)
2. Microhardness tester.
3. Micro- and macrophotography device.
4. Universal magnetic flaw detector.
5. Bench-type shaft electric furnace for heating up to 1200°C.
6. Accessories for photographic room.

APPENDIX 5

L I S T

of equipment and devices for metal mechanical tests

Primary equipment

1. Universal test machine for laboratory testing metals for tensile, compression and crippling with loads up to 1200kg.
2. Pendulum impact testing machine. Maximum energy supplied by the raised pendulum is 30 kgm.
3. Brinell hardness tester - up to 3000kg load.
4. "Poldy" hardness tester.
5. Brinell microscope.
6. Rockwell and Brinell metal hardness tester.

Auxiliary equipment

1. Portable hardness tester for testing hardened parts by elastic come-back of the metal.
2. Universal testing machine with a pulsator - up to 30000kg.
3. Vickers and Brinell hardness tester.
4. Portable gear hardness tester.
5. Microhardness tester.

APPENDIX 6

L I S T

of equipment for machine shop of experimental works at the scientific and engineering centre

Serial Nos.	Name of machine-tools	Main dimensions mm	Quantity	Meaning of figures in the 3-d column
1.	Engine lathe	dia. 250x500	2	Max. machining diameter and length
2.	Engine lathe	dia.400x1000	10	
3.	Engine lathe	dia.400x1400	2	
4.	Engine lathe	dia.630x1400	1	
5.	Engine lathe	dia 630x2800	1	
6.	Vertical lathe	dia 1400	1	Max. machining diameter.
7.	Bar stock turret lathe	dia 63	2	Max. bar dia.
8.	Chuck turret lathe	dia.500	1	Max. dia. of chucked work-piece.
9.	Horizontal boring machine	dia.90	2	Spindle dia.
10.	Horizontal boring machine	dia.110	1	
11.	Bench-drilling machine	dia.12	5	Drilling dia. in Steel.
12.	Upright-drilling machine	dia.35	2	
13.	Radial drilling machine	dia.55	2	
14.	Shaping machine	dia.700	2	Ram stroke
15.	Planing machine	dia.3000x900	1	Table dimensions
16.	Slotting machine	Stroke 200	1	Ram stroke
17.	Broaching machine	20 tons	1	Tractive force

1	2	3	4	5
18.	Knff-type horizontal milling machine	dia.1250x320	2	Table dimensions.
19.	Knff-type vertical milling machine	dia.1250x320	6	
20.	Knff-type vertical milling machine	dia.1600x400	2	
21.	Gear milling machine	dia.500x m6	2	Max. dia. and Module of work-piece.
22.	Bevel gear planing machine	dia.500x m6	1	
23.	Gear shaping machine	dia.500x m6	1	
24.	Gear grinding machine	dia.500x m6	2	
25.	Spline-shaft milling machine	dia.250x2000	1	Max.machining dia and length.
26.	Circular grinding machine	dia.100x200	1	
27.	Circular grinding machine	dia.150x700	1	
28.	Circular grinding machine	dia.250x1500	1	
29.	Surface grinding	dia.300x1000	2	Table dimensions
30.	Rotary surface grinding machine	dia.700	1	Table diameter.
31.	Longitudinal grinding machine	dia.2000x800x x500	1	Max. machining dimensions
32.	Internal grinding machine	dia. 3 + dia.50	1	Max. dia. and length.
33.	Internal grinding machine	dia.25 + dia. 200	1	
34.	Rough grinding machine (for tool grinding)	dia.400	2	Dia. of grinding wheel
35.	Level press	5 tons	1	Force
36.	Metal saw	dia.1010	2	Saw dia.
37.	Hack saw	-	2	
		Total:		

APPENDIX 7

L I S T

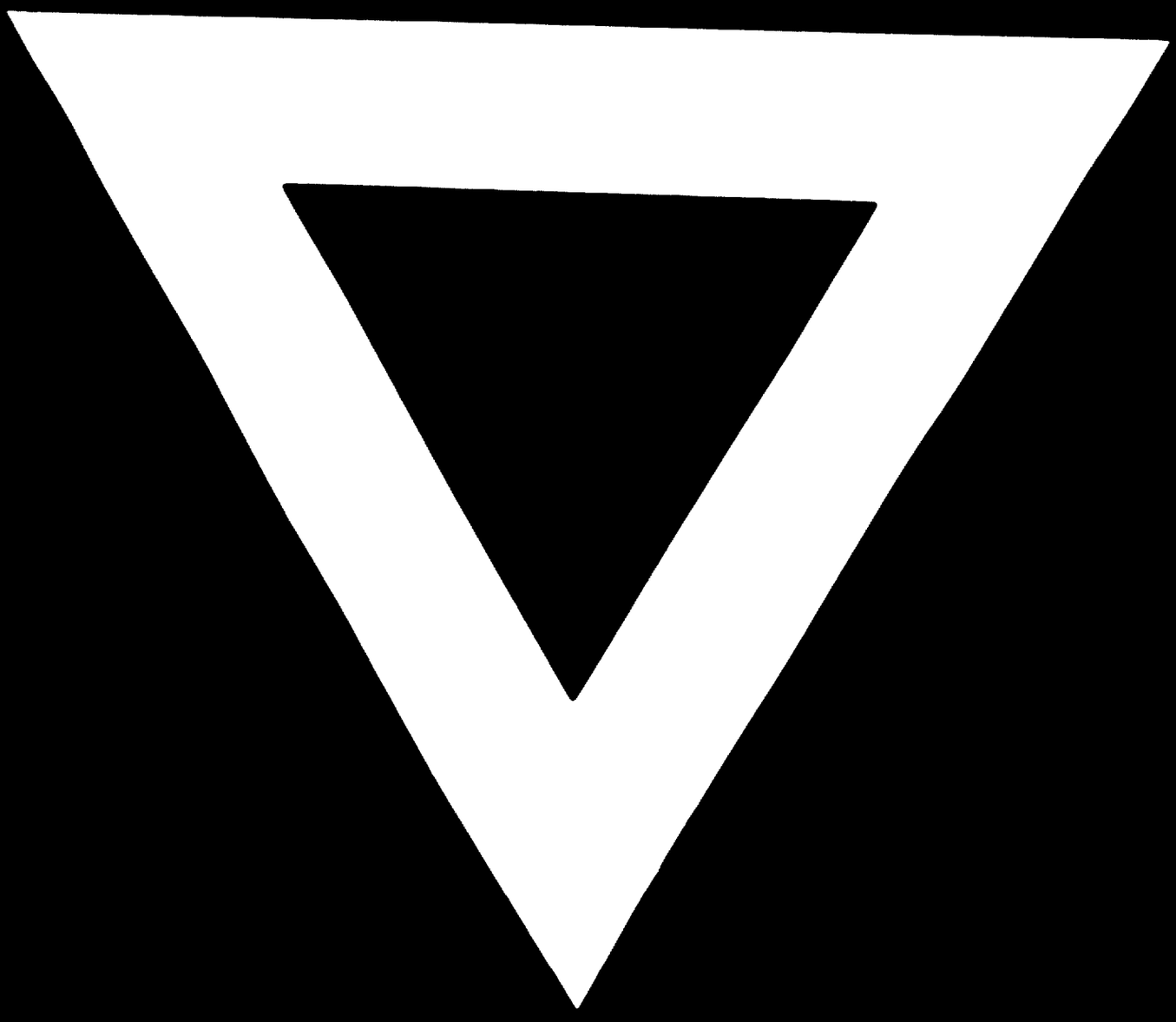
of equipment for tool shop of Experimental works at the scientific and engineering centre

Serial Nos.	Name	Main Dimensions mm	Quantity	Meaning of figures in the 3-d Column
1.	Engine lathe	Ø 250x500	1	Max. dia. and length of machining.
2.	Engine lathe	Ø 400x1000	3	
3.	Engine lathe	Ø 400x1400	1	
4.	Backing-off lathe	Ø 240x450	1	
5.	Bench drilling machine	Ø 12	2	Max. drilling dia.
6.	Upright-drilling machine	Ø 35	1	
7.	Jig-boring machine	Ø 1100x690	2	Table dimensions
8.	Shaping-machine	Ø 700	1	Ram stroke
9.	Knee-type horizontal milling machine	Ø 1250x320	1	Table dimensions
10.	Universal milling machine	Ø1250x320	1	
11.	Knee-type vertical milling machine	Ø1250x320	1	
12.	Universal circular grinding machine	Ø100x500	1	Max. dia. and length of machine.
13.	Universal circular grinding machine	Ø150x700	1	
14.	Internal grinding machine	Ø5 + Ø100	1	Max. dia. and length of machining.
15.	Surface grinding machine	Ø1000x300	1	Table dimensions
16.	Thread grinding machine	Ø250x700	1	Max. dia. and length of machining
17.	Universal cutter- and tool grinding machine	Ø250x630	2	Max. dia. and length of machining
18.	Broach grinding machine	Ø100	1	Max.machining dia.
19.	Circular saw grinding machine	Ø200x1010	1	Range of saw diameters to be ground
20.	Rough grinding mach. (for tool grinding)	Ø400	1	Dia. of grinding wheel

APPENDIX 8

LIST
of measuring equipment for checking department of the works
(Equipment accuracy grade YT6-YT8)

1. Surface plate dimensioned up to 1000x150mm
2. Straight-edge and scraping rules (with broad working surface) V-edges.
3. Angles.
4. Centre heads with surface plate.
5. Frame and bar levels.
6. Sets of gauge blocks up to 100mm long (YT2 - YT3).
7. Surface micrometers with measuring range up to 250mm.
8. Gear-tooth micrometers, from 0 to 50mm.
9. Tread micrometers, from 0 to 50mm.
10. Slide callipers, from o to 500mm.
11. Height gauge, from 30 to 300mm.
12. Depth gauge, from 0 to 500mm.
13. Dial indicators with measuring range. from 0 to 10mm and 0.01mm graduation.
14. Indicator measuring supports.
15. Dial bore gauges, from 10 to 300mm.
16. Test indicators.
17. Depth indicators.
18. Gear tooth callipers, M 1-18mm.
19. Angle gauges from 0° to 360°.
20. Sine bars 0 to 90°
21. Angle gauges with accessories.



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