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Development of Metalworking Industries in Developing Countries

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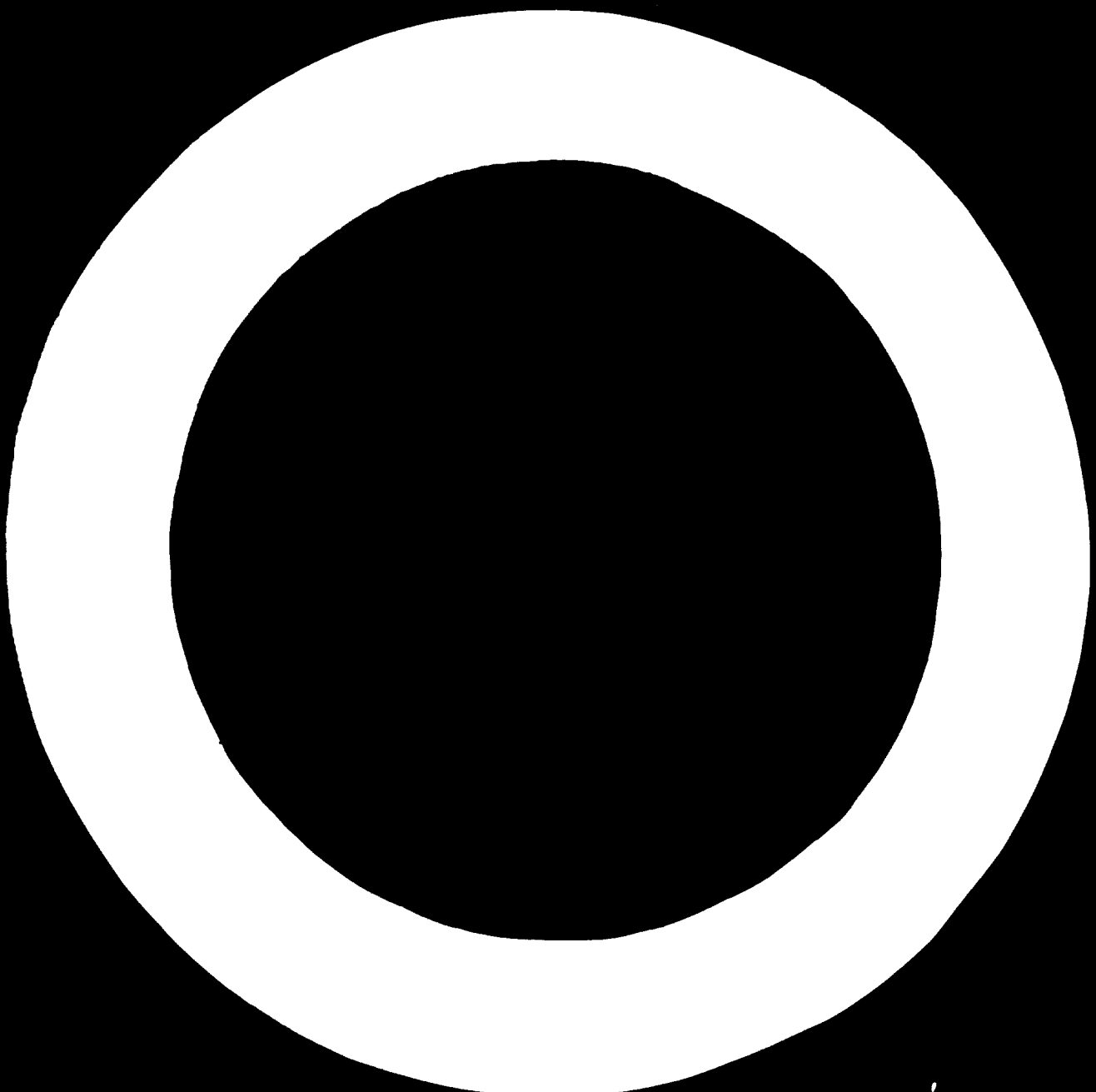

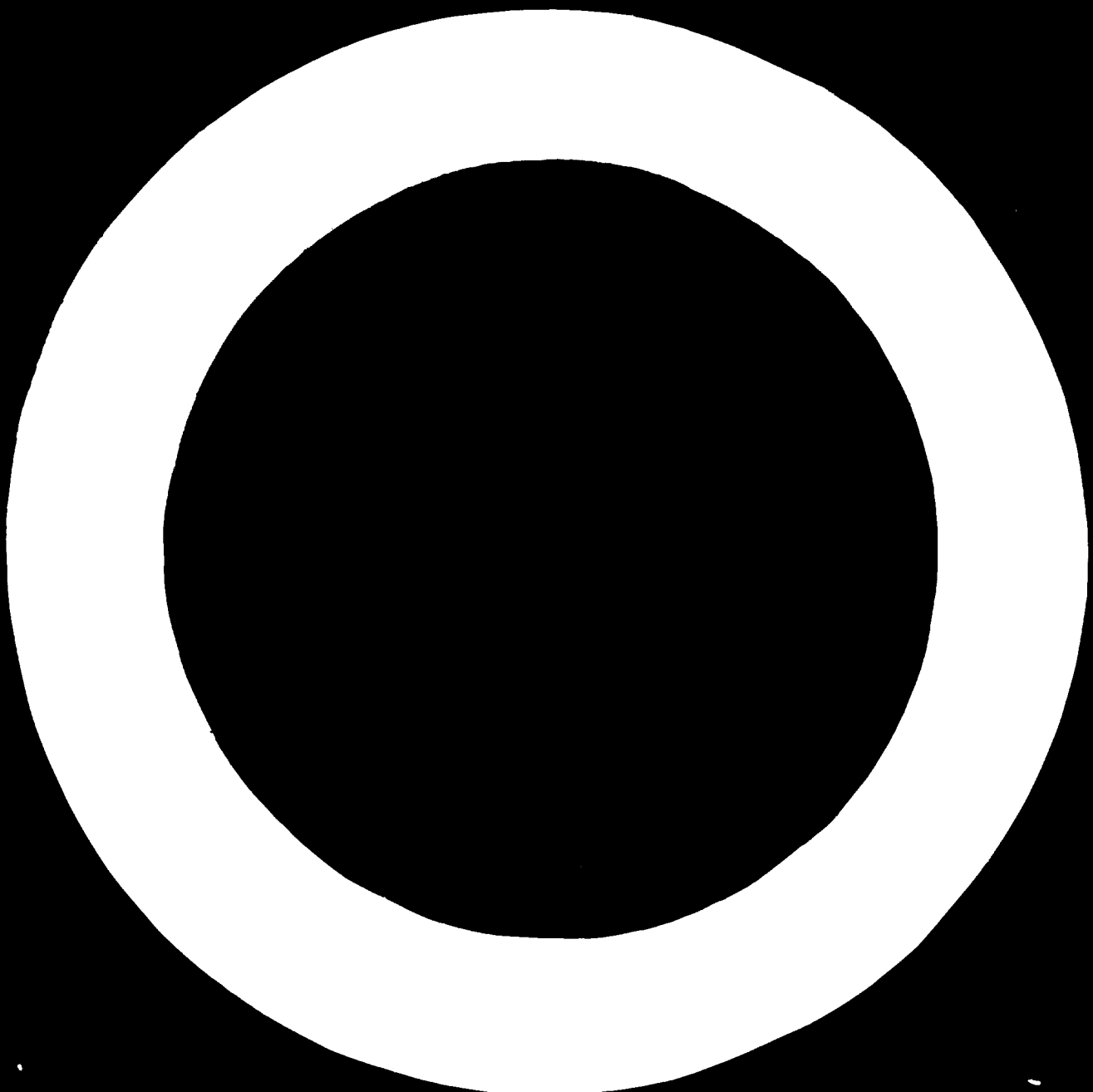

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MINIMUM NOMENCLATURE OF METAL-CUTTING EQUIPMENT RECOMMENDED FOR PRODUCTION IN DEVELOPING COUNTRIES

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Technical revolutions are characteristic features of the present epoch. Countries which are technically developed achieve new success by continuously developing productive forces and improving the means of production. New means of mechanization and automation of work processes have been widely adopted by all branches of industry. During the past fifteen to twenty years, industrial production has acquired a new form and new contents. Advances also have been made by some countries which until recently were considered to be lagging in industrial development. Humanity has not known any other period in its thousand-year history during which productive forces, means of production and techniques developed so rapidly, widely and comprehensively. This is why we call the occurring industrial development a real technical revolution.

Science and technology occupy special places in this development of industry. Science practically becomes the motivating power of the technical progress which would be impossible without the latest and newest discoveries. Rapid development would be impossible if countries were isolated from the experience and achievements of others. This is especially clear in industrially backward countries with small populations. Rapid technical progress is possible only on the basis of mutually beneficial scientific and technical collaboration and production cooperation among individual countries.

The machine-tool industry is most important in the development of machine construction because it produces machines for the manufacturing of machines. As the decisive factor, machine-tool equipment determines the technical culture of machine construction and dictates the rate of its technical development.

On this basis, it is possible to say that the development of any national industry leads to the creation of national machine and machine repair industries. The latter cannot exist without a national machine-tool industry. The development of a machine-tool industry is an objective necessity for every developing country. This has been proved to us by history and current practice. It is explained by the fact that the availability of a machine-tool industry allows a nation to realize its potentialities with new machines and construction and to modernize existing equipment. This is the most reliable guarantee of continuous technical progress. It is considered correct that the rate of growth of the machine-tool construction sector should be greater than the rate of growth of the machine construction sector.

Main kinds of metalworking machines required by individual branches of industry in developing countries

It is typical in the economies of most developing countries that there exist simultaneously both small and handicraft production of a wide assortment of machines and industrial production of machines for industry. The necessity to repair and maintain machines (which as a rule are supplied by different manufacturing firms) leads to the use in various branches of industry of a wide assortment of metalworking machines.

It is expected that till 1980 individual and handicraft machine production will continue to furnish a considerable part of the total production of the developing countries. As a rule, the sector needs the so-called standard types or universal machine tools and metalworking machinery, such as: universal lathes; drilling and radial drilling machines; plain cutting-off machines; hacksawing machines; shapers and planers; universal surface and cylindrical grinding machines; gear-cutting and gear-finishing machines; eccentric and friction presses; and spring and pneumatic hammers of small and medium sizes.

In the machine branch, the most important factor for the selection of machines is the kind of article (refrigerators or television sets, wireless sets, tractors and other agricultural machines) and yearly production. However, general purpose machines of the so-called standard types are required at the initial stages of production in all cases. Special and specialized machine tools with programmed controls should be used only after additional calculations of their efficiency in each specific case.

Despite the diverse nomenclature of machines manufactured in the sphere of individual and small production, the quantity of machine tools (by types and sizes) used in machine construction of the developing countries may be reduced to a certain minimum with the help of rational planning.

As for the other branches of the economy which need machine tools, the situation becomes more complicated because of their unequal development in different countries. Most of the countries have one-sided economies and partially developed textile industries.

In the developing countries, machine tools are used in all branches except machine production (including the electrical industry) mainly for the repair and maintenance of basic equipment and rarely for the manufacture of complete equipment. This makes it difficult to

recommend the necessary machine tools to different branches.

For example, such branches of the textile industry as those dealing with processing flax, cotton, hemp, etc., and knitting enterprises need mainly light, general purpose, standard machine tools.

On the contrary, mining, power, metallurgical and paper industries need large machine tools of low efficiency but notable for a wide technological range (chucking machines and turning-and-boring mills, machines for regrinding rolls for metallurgical works).

As a rule, the repair workshops of these branches need both universal standard type machines of medium weight and some special and large size machines, recommended by specialists.

Main groups of machine tools recommended for production in developing countries

Among the most important factors determining the main groups of machine tools to be recommended to developing countries are:

(*a*) Requirements of the country must determine the profitability of production. The lower limit of profitable production of universal standard type machines may be considered fifty to sixty pieces per year.

(*b*) Availability of native raw materials and finished and half-finished products (such as: electric motors, electrical equipment, hydraulic elements, castings, etc.). It follows that from the economic point of view the most expedient method is mastering universal machines of the main standard types shown in table 1.

Table 1

Nos.	*Name and basic parameters*
1.	Universal lathes with the maximum machining diameter up to 630 mm
2.	Drilling (column type and bench type) machines with the maximum drill diameter up to 5 mm
3.	Milling machines with the maximum width of table from 200 to 300 mm
4.	Shapers with the maximum length of stroke up to 630 mm
5.	Main types of hacksawing machines for cutting off material having diameters of 160, 250 and 400 mm
6.	Universal and plain cutter and tool-grinding machines
7.	Boring machines for repair of engines
8.	Universal cylindrical grinding and surface grinding machines
9.	Horizontal boring machines

The mastering of these main groups of machines is a natural road to development in the field of machine-tool construction. Besides, all this is bound up with the following:

(*a*) These machines are necessary for machine construction and machine repair in different branches of industry of the developing countries. They can make up about 65–75 per cent of all required machines. Therefore, it is expedient to manufacture them within the country;

(*b*) Accumulation of experience in manufacturing these machines makes it possible to pass in the future to the production of machine tools having higher performance.

Basis for choosing main parameters

The designing of new machine tools of any kind (except unique ones) should be preceded by the typification of these machines. The typification is accomplished on the basis of a general analysis of existing machines of a similar type which have been manufactured during the last three to five years. Typification is necessary because the practical operational range of a kind should be covered by a minimum number of sizes. Among the aspects of typification are construction, technological, operational and repair likenesses and the possibilities of vertical and horizontal unification of some constructional elements and eventual use of the assembly principle for general purpose machines; nomenclature limitations of production programme; and organization of serial production with all ensuing economic advantages.

It is necessary to determine the limits of the whole scope of machine-tool series with respect to basic parameter and eventually with respect to parameters following it, to classify the necessary sizes within the whole scope, to determine basic technological data, e.g., geometrical dimensions of an article manufactured with the help of the given machine, connecting or fastening surfaces).

Parameters and sizes are selected in conformity with a series of recommended numbers according to the standard used in the country (e.g., TOCT 8032-60). The recommended numbers form the basis of a series of linear dimensions (e.g., TOCT 6636–60) which are decimal series of geometrical progressions with the following exponents:

For series R5	$\sqrt[5]{10}$	1.60
For series R10	$\sqrt[10]{10}$	1.25
For series R20	$\sqrt[20]{10}$	1.12
For series R40	$\sqrt[40]{10}$	1.60

Parametric series and dimensional series are determined for each kind of new machine tool. The parametric series is a series of numerical values of one or several parameters of a machine. The dimensional series is a series of basic parameters of machines of the same type.

The problem of the density of series of basic parameters for machine tools of the same type is important. A series too dense results in a large nomenclature of machines similar by parameters. A greatly rarefied series deteriorates the technical and economic indices of machine operation since it is necessary to use larger machines instead of the excluded small ones. Determination of the optimum series of basic parameters is an important task which demands a detailed technical and economic grounding. The optimum series is a series of machine dimensions which always ensures that losses are minimized during the manufacture of machines and during their operation.

When creating a new series of machines of the given type, it is profitable to begin with a rarefied series which may become more dense when necessary. Thus, the common shortcomings of the series are eliminated by a small number of sizes, and improvements connected with

experiments are also performed with the help of a small number of machines.

In grounding the selection of series, it is necessary to consider in succession the following factors: overhead expenses change, annual programme in pieces, material expenditures, machine cost price, annual programme cost price, annual amortization assignments, additional expenditures during operation and total annual expenditures.

Countries belonging to CMEA have agreed to adopt common basic parameters and series of numerical values of parameters of machine tools. For instance, adopted as the basic parameter of universal lathes is the maximum machining diameter, numerical values series being according to R10 with exponent ϕ 1.25. The range from 100 to 630 mm is covered by nineteen machines.

The basic parameter chosen for drilling machines is the maximum drill diameter in steel with σ_b 50 60 kg/mm^2. Numerical values series are:

Bench-type drilling machines: 1.5, 3, 6, 10, 12, 16, 20, 25;

Vertical drilling machines: 12, 16, 20, 25, 32, 40, 50, 63, 75–85, 100.

The series of bench-type drilling machines from 1.5 to 6 inclusive is rarefied after two numerical values and corresponds to series R10; from 10 to 25, series R10 is complete. The series of vertical drilling machines is in conformity with the complete series R10.

Universal lathes manufactured in the People's Republic of Bulgaria have the following numerical values of the basic parameter: 200, 320, 400, 500 and 630 mm. This corresponds to series R10. (Lathe with basic parameter of 250 mm is not mastered.)

In order to ascertain the mastering of series it is necessary to compare the basic parameters of mastered lathes and then to compare basic parameters of lathes which are being mastered at present.

There are two parallel series of mastered machines differing in their completeness and additional parameters.

Models of lathes

Basic parameter	200	320	400	500	630
Basic series	CY201	CY321	C11M	C10M	C13M
Additional series	—	C8	C5	—	—

Lathes of the basic series are more powerful. They are intended for heavy duty operation in main workshops with a high degree of organization. Lathes of the additional series are intended for auxiliary use.

The basic series was mastered after the additional one on the basis of experience.

Methods of mastering minimum nomenclature of machine tools

There are mainly four ways of creating and developing machine tools:

(*a*) By individual scientific and technical research, design and technological work;

(*b*) By joint scientific research, design and technological work;

(*c*) By documentation or samples of existing machines;

(*d*) By buying licences.

The first method is typical of all countries, but mainly for those which in addition to many years of experience and with traditions in production, laboratory and operation research, possess great engineering technical and economic potential.

The second method of development is used almost by all countries regardless of technical level in the given branch. However, it is characteristic that this method of solving scientific research and design problems is selected by those countries which have equal or similar achievements in the given sphere and common technical and economic interests.

The third way of gaining results in this field is typical of countries which are backward qualitatively or quantitatively when they design and manufacture machine tools. This method also is characteristic of some socialist and developing countries.

The fourth method of development is used almost by all countries wishing to miss some stages which are necessary for making articles at a high technical level but would entail considerable losses in time and means. For many countries with the material and technical bases for the timely and effective mastering of a new article in full compliance with the licence bought, this is the only way of quick achieving a high standard of manufactured produce which would meet all competition in domestic and world markets.

The third and fourth methods are most important for developing countries. Therefore, they will be discussed in more detail.

Documentation or samples are given by countries advanced in the branch. They are chiefly used by those countries which are backward in the sphere of development and mastering of machines.

The use of documentation bought at low prices represents great advantages for the developing countries. Making documentation which is sold at seller's prices also has advantages for the developing countries, but documentation can be made at a high level only by organizations which have great experience. Such organizations are not available in the developing countries. When using documentation, the specialists of a new plant use specific experience and quickly raise their qualification. Machine flow sheets help to organize production better, more easily and in conformity with existing conditions and to use the available equipment, experience and traditions to a greater extent. There is considerable reduction of the total time required for the mastering of the machine, because no time is spent on designing, making and testing the pilot model and it is possible to start the adoption of the zero series immediately.

In Yugoslavia, the production of machine tools was mastered in a comparatively short time using documentation supplied by the Soviet Union. In that way, such machines as horizontal boring machines, models 2620A, and 2630, planer type milling machine, model 6642,

vertical boring mills and lathes with basic parameters of 1,000 and 3,000 mm, were mastered.

In the United Arab Republic, on the basis of documentation received from the Soviet Union, the production of a universal lathe, model 1A62, and a surface grinding machine, model 3 Б722 with a basic parameter of 320 mm, was mastered. Considerable assistance in the rational designing of cylindrical grinding machines, surface grinding machines and planer type milling machines was rendered to the People's Republic of Bulgaria which received corresponding technical documentation from the Soviet Union and Czechoslovakia.

France occupies first place among countries which sell licences, followed by Switzerland, the United States, West Germany, the United Kingdom, and Italy. Japan is first among countries buying licences. India, Yugoslavia, Hungary and Spain come next in that order.

The purchase of licences is especially profitable for the developing countries. Usually, when drawing a licence purchase contract, they stipulate conditions ensuring that the technical level of the buyer will be raised by the firm selling the licence. This is done by means of supplying the necessary equipment and machinery, by training personnel and by passing on production experience or know-how. The buyer gets the right of know-how. This allows a new enterprise to quickly gain that which takes tens of years in other countries. Machines manufactured by licence sell better in domestic and world markets because the firms possessing rich experience and traditions enjoy confidence.

On the basis of studying the mastering of new machine tools, it is possible to draw the following conclusions:

(*a*) Most developed countries make progress in designing and developing machine tools mainly through their own scientific and technical research and designs. Joint scientific-research works and designs come second, mainly used by partners equally developed in the given sphere, whose joint activity is caused by common economic interests. Although the buying of licences is not a principal method of development for these countries it is used for the sake of maintaining continuously high technical levels in the branch.

(*b*) Countries which are backward in the production of machine tools more often use the third way of development, i.e., documentation or samples. The purchase of licences is also very important to these countries.

(*c*) The majority of countries which buy licences do so because of the absence or shortage of engineering staff (e.g. India, Yugoslavia, Hungary and Spain). If the engineering staff and material and technical basis are adequate, licences are bought for the sake of quickly and efficiently mastering new articles. Other countries buy licences mainly to ensure the highest technical level in all fields of the branch so as to secure domination in home and world markets. A typical example in this respect is Japan. The developing countries buy licences which ensure the delivery of required equipment and machinery and assistance in training personnel. This is the shortest and most reliable way of quickly mastering machine production.

Regardless of the method selected, it is possible to master a minimum nomenclature of machine tools only in case there is available an industrial enterprise with necessary machines and equipment. The minimum set of equipment depends to a great extent on the possibilities of co-operation inside the country and abroad. The machines mentioned below are necessary in case the enterprise operates in the conditions of limited possibilities of co-operation. Usually the developing countries have such conditions.

When selecting an initial set of machines, it is necessary to select those most suitable for every purpose. This should be done on the bases of the scale of production, possibility of delivery and successful use of new and high-efficiency machines.

For the machining of frame works it is necessary to use milling machines with a table width of 350 mm, planer-type milling machines and planing machines. But depending on the scale of production it is possible to have only some of these machines. In a larger series, the group of machines for processing frame works must include special grinding machines for guides.

Horizontal boring machines are necessary for processing openings and faces of frame works. At small enterprises, it is possible to use radial drilling machines fitted with suitable conductors. It is expedient to use such machines at large enterprises as well in addition to horizontal boring machines.

For machining such articles as axles, shafts, gears and rings it is necessary to have universal lathes and also turret and copying machines.

For the machining of drive screws it is possible to use high-accuracy screw cutting lathes. But in most cases it is necessary to have special lathes or milling machines.

For the manufacturing of main spindles use is made of precision cylindrical grinding machines for external and internal grinding. It is advisable that grinding machines used for machining main spindles should not be used for grinding other articles.

Machine-tool production needs a great number of gears, most of which are ground. Therefore, it is expedient to master the technology of grinding gears. For processing gears, it is necessary to have basic gear hobbing, gear tooth rounding and gear grinding machines.

Depending on the scale of production and kind of mastered machines, a number of additional machines is added to the basic set of machines to increase the efficiency and accuracy of machining.

For the processing of precise openings, it is recommended to have a precision boring machine. Keyways and splined openings of gears are machined with the help of broaching machines.

Auxiliary departments are of great importance for the development of an enterprise. They include tool, forge, founding, thermal, maintenance and other shops. It is necessary to have them in the plant or constant and stable co-operation with other plants or shops.

The machines and equipment recommended for a complete small machine-tool plant cannot have equal production loads, especially when the scale of production is minimal. In view of this, some machines are to be used with reduced efficiency and for unusual operations. In

order to keep special machines running at full capacity, it is practical to accept orders from other enterprises, especially those dealing with machine-tool repair.

Structure of machine-tool production in developing countries

The analysis of machine-tool application in developing countries shows that besides the machine industry, these machines are used in light and extractive industries and motor transport mainly for repair work. The requirements of these branches, which are key ones in developing countries, determine the necessary composition of the stock of machine tools in operation.

Proceeding from the experience of Bulgaria pertaining to the same stage of development at which at present are some developing countries, we can accept an approximate structure of the stock of machine tools which will be in operation in the developing countries by 1970. This structure is shown in table 2.

At the first stage of development, the production of machine tools should be organized on the basis of internal needs of the country. It is also necessary to take into consideration the fact that it is most economically effective to master those machine tools which are in the greatest demand in the domestic market.

It should not be forgotten that at the initial stage some countries will not have enough skilled personnel and experience. Consequently, these countries must begin with mastering those machines which are comparatively simple.

We consider it to be most expedient and profitable for the developing countries to have by 1970–1975 the approximate structure of machine-tool production as found in table 3.

Table 2

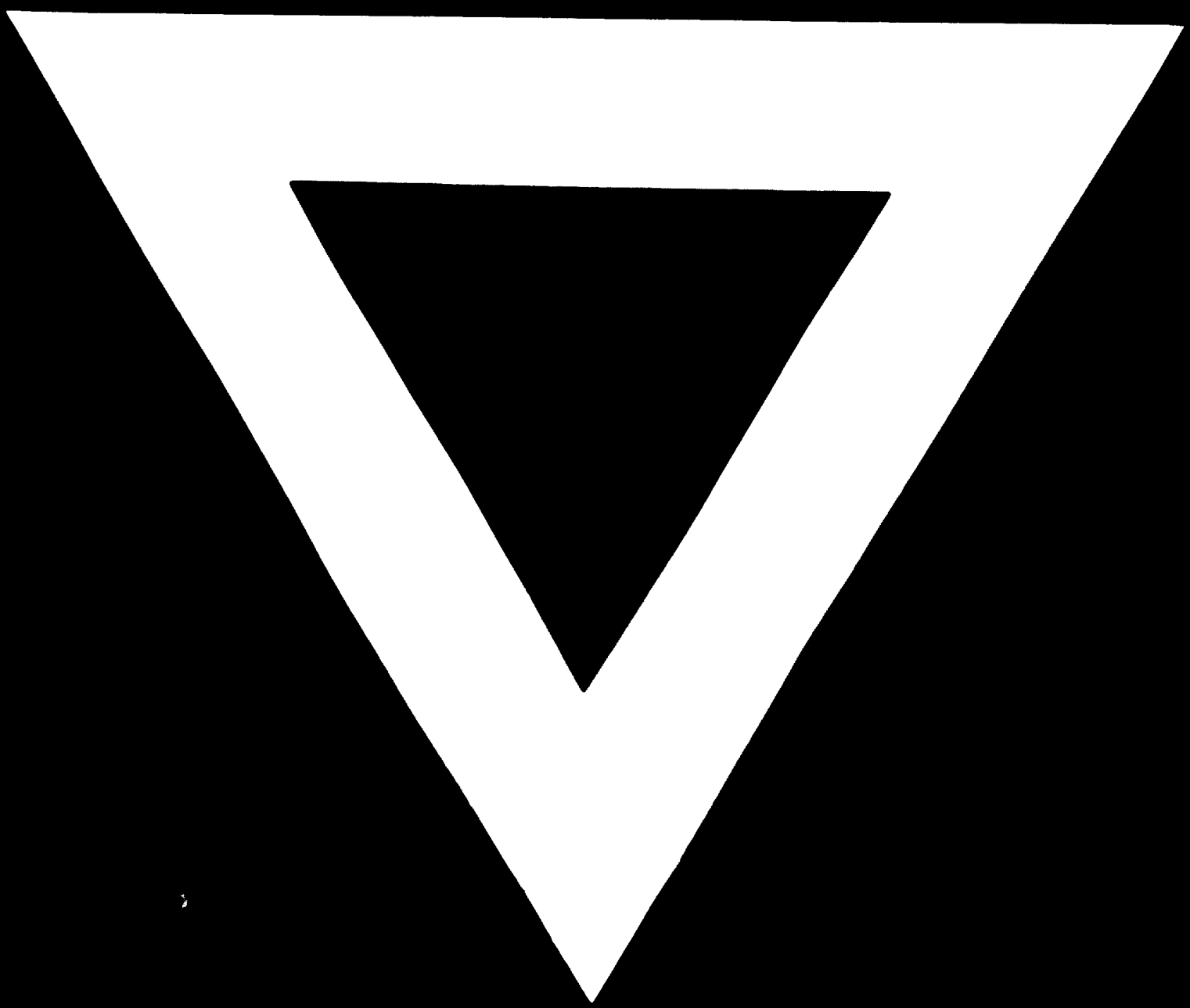
Approximate structure of machine-tool stock in developing countries, 1970–1975

	(per cent)
Lathes 44%	
Copying	2.0
Turning-and-boding	1.5
Universal	95.5
Chucking	1.0
Milling machines 8%	
Knee type, universal, horizontal and vertical	96.7
Planer type	0.3
Copying and engraving	2.5
Special purpose	0.5
Drilling and boring machines 25%	
Vertical drilling	95.5
Radial drilling	2.5
Horizontal boring	1.5
Jig boring	0.5
Grinding machines 4%	
Universal cylindrical	43.0
Internal	15.0
Cylindrical internal	7.0
Surface	35.0
Honing, lapping and tool and cutter grinding machines 1.5%	
Honing	60.0
Lapping	5.0
Tool and cutter grinding	35.0
Shaping, slotting and broaching machines 9%	
Planing	30.0
Shaping	50.0
Slotting	20.0
Gear-cutting and thread-cutting machines 3%	
Gear cutting and gear shaping	24.0
Gear milling and spline milling	76.0
Cutting-off machines 5%	
Other machines 0.5%	

Table 3

Structure of machine-tool production in developing countries by 1970–1975

	(per cent)
Lathes 40%	
Universal	100.0
Milling machines 7%	
Knee type, universal and vertical	100.0
Drilling and boring machines 40%	
Vertical drilling	95.0
Precision boring	5.0
Grinding machines 4%	
Universal cylindrical	85.0
External	15.0
Honing, lapping and tool and cutter grinding machines 2%	
Tool and cutter grinding	100.0
Shaping and slotting machines 3%	
Shaping	80.0
Slotting	20.0
Cutting-off machines 4%	



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