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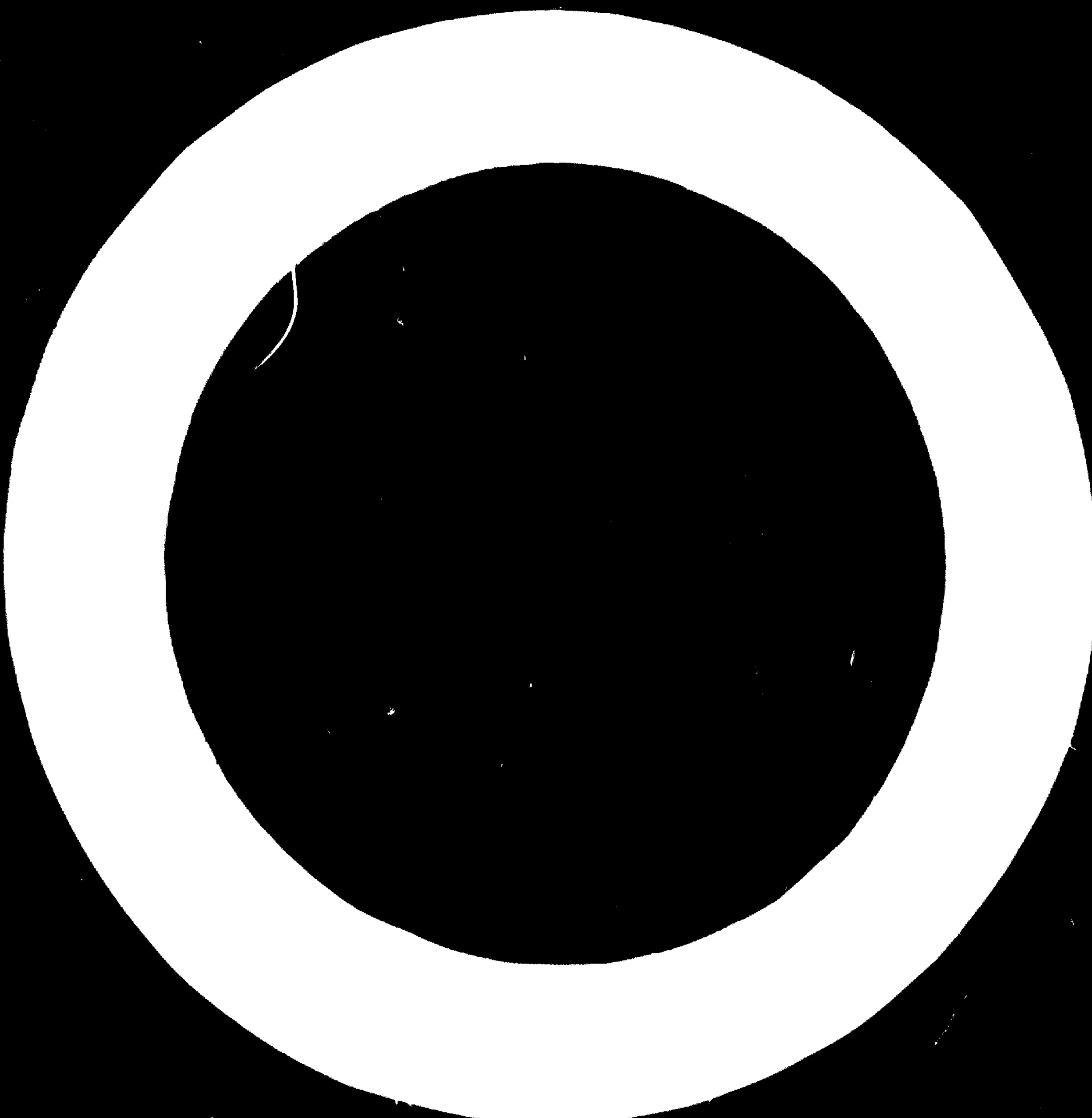

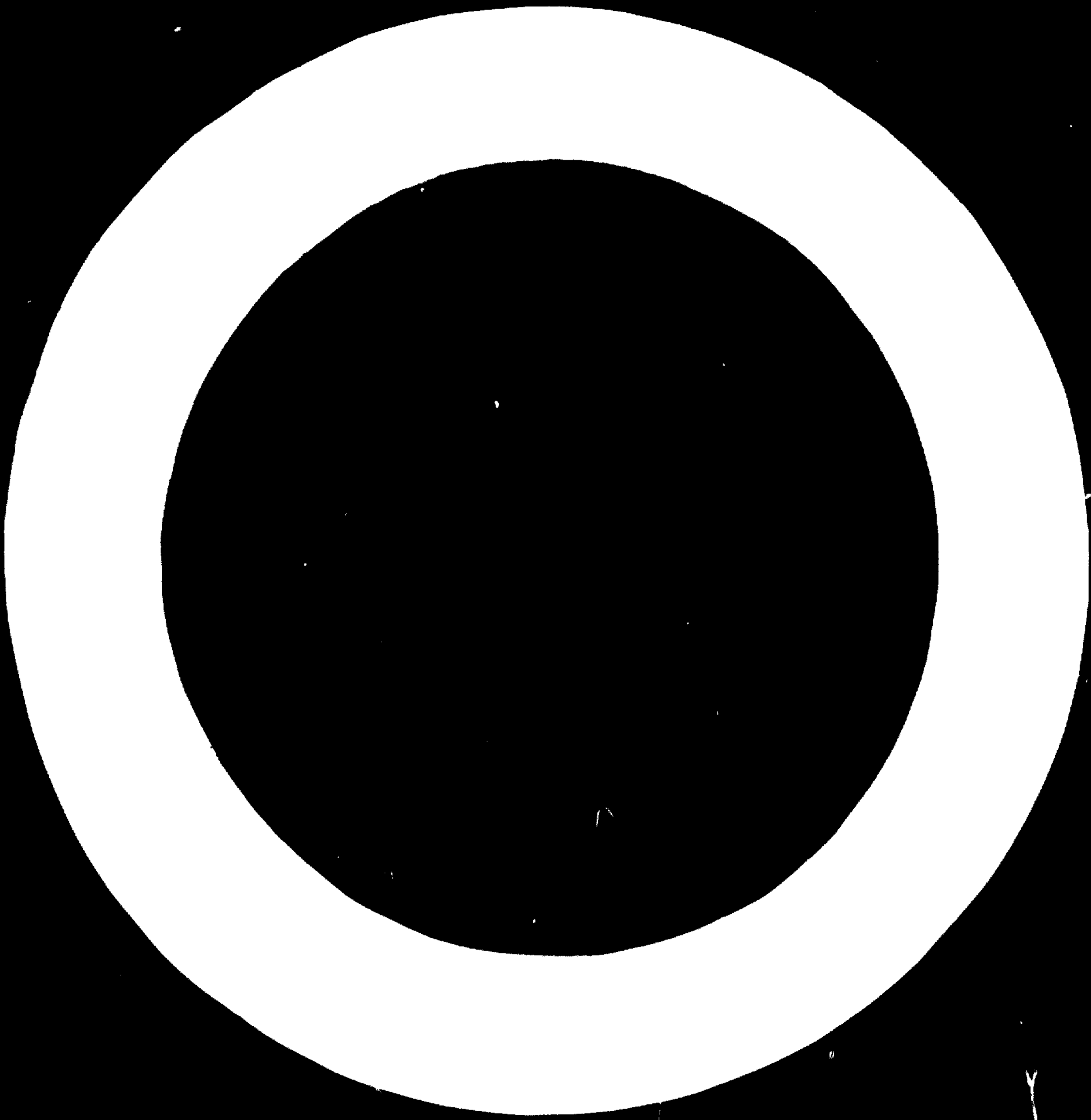

SIMPLIFIED SYSTEMS OF PROGRAMME CONTROL FOR UNIVERSAL MACHINE TOOLS

Ede Sador, Director, Development of the Machine Tool Works, Hungary

One of the problems encountered in preparing the present paper was the fact that the "level of industrial development" of the countries concerned must be considered a very large spectrum of development. However, depending upon the concrete fundamentals prevailing in the various countries, it is not obligatory for those countries to undergo all the steps of evolution which were experienced by the more industrialized nations during the industrial revolution and in their subsequent development. Rather, it is necessary for the developing countries to become familiar with the current technology, to become initiated into it and to introduce it into the developing national industries. This procedure evidently requires—in addition to the necessary investments—the accelerated education of specialists.

The industries which provide the means of production, including mechanical engineering and the machine-tool industry, must receive top priority in the development of the national industry. In this way, each country may, at the same time, safeguard its economic independence.

The current world-wide technical revolution tends increasingly towards automation. The metalworking field is being revolutionized by programme-controlled machine tools. The highly developed, automatic machine tools permit the organization of standard-quality production with only a certain number of specialized craftsmen and a larger staff of trained workers, which hitherto could only have been achieved by employing a large number of high-quality workers having ample experience.

This paper deals with the simplified programme-control systems for machine tools. It does not touch upon the numerical controls of machines, machine systems and production lines. Neither do the limitations of this paper permit the discussion of detailed theoretical principles. The aim is, rather, to present a methodical review of the question, to outline the development and justification of programme control, to introduce some examples of the control types which are currently being applied more widely and to draw attention to the economic and perspective features of the question. At the same time, this paper presents an account of the industrial development and training of specialists which have been achieved in Hungary.

I. Description of control systems and definition of terms

In the operation of machine tools, the working process and its direction are to be discerned. Direction is an operation by means of which the beginning or termination of a process, as well as the desired quality of its progress, can be ensured. Two cases of the directional operation are the control and the feed-back control. Automation is the realization of the directional operation by means of a directing equipment functioning independently from human interference. Automation is, consequently, the mechanization of the directional operation (see fig. 1).

Figure 2 summarizes the tasks of automation in connexion with metal-cutting machine tools.

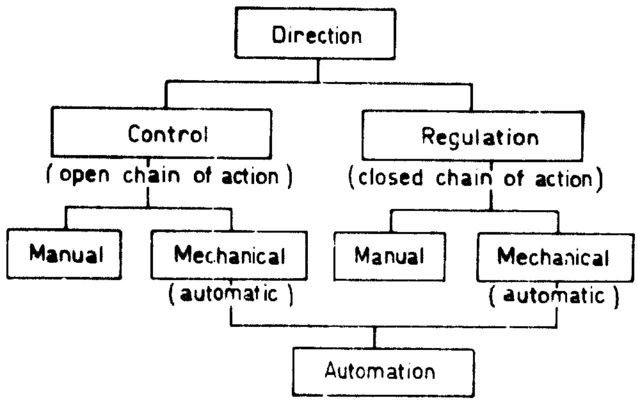

Figure 1

Relationship of the concepts of direction and automation

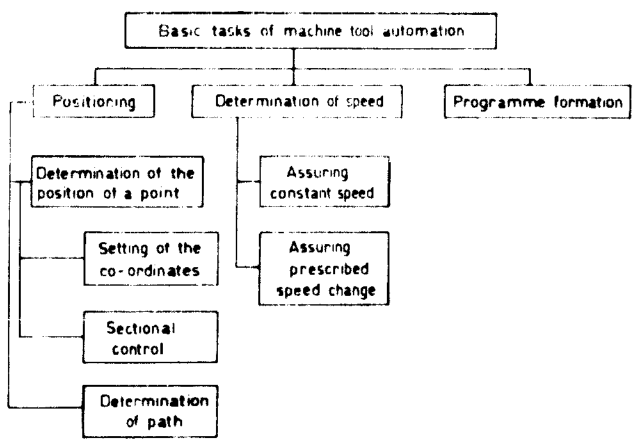

Figure 2

Basic tasks of machine-tool automation

The task of positioning is to define the size values of the co-ordinates which determine a point, or some points, of a co-ordinate system. Definition of speeds means the determination of the characteristics of rotating and advance main and secondary motions according to the postulate of the technology, as well as the ascertainment of their occurrence. The programme is the prescription defining the directed characteristics of the directed process, as well as their interconnexion. The connexions of the directed characteristics are defined basically by space or time co-ordinates. The space-based programme can be a neat-movement programme; in this case, the contour will be formed by a corresponding spatial placement of the major cutting edge. In the case of a movement programme combined with a programme tool, the shaped tool with an appropriately long cutting edge has to perform only a unidirectional movement (see fig. 3).

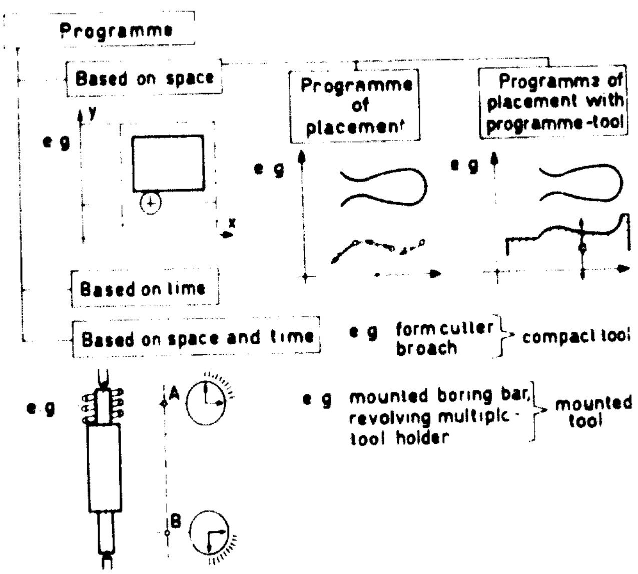

Figure 3

TYPES OF PROGRAMMES, DEPENDING UPON BASIC VARIABLE

The programme generally comprises the whole machining process to be executed on one machine. Direction in accordance with the programme of the machine is ensured by the automatic directing device, i.e., the programme-control equipment.

Depending upon the extent and elasticity of the programme the following systems can be discerned:

(*a*) Cyclic programme-control systems serve for the realization of certain typical cases of the space-based programmes. The cycles are reiterative process-sections, built up identically of movement-sections of equal speed and generally forming a closed movement-circle (see fig. 4);

(*b*) The programme-switch control system is a more complex system, if compared with cycle control, as regards the variety of parameters to be directed. In this system not only the lengths of ways, but also the related speed-values, can be programmed. The continuous course of the process, however, is not automatic;

(*c*) In the case of programme-controlled machines the composition of the programme is elastic, as regards the dimensions of the movement-programme and the speed values of the main and secondary movements belonging to the various sections, as well as their interconnexion; this control generally produces a semi-automatic operation.

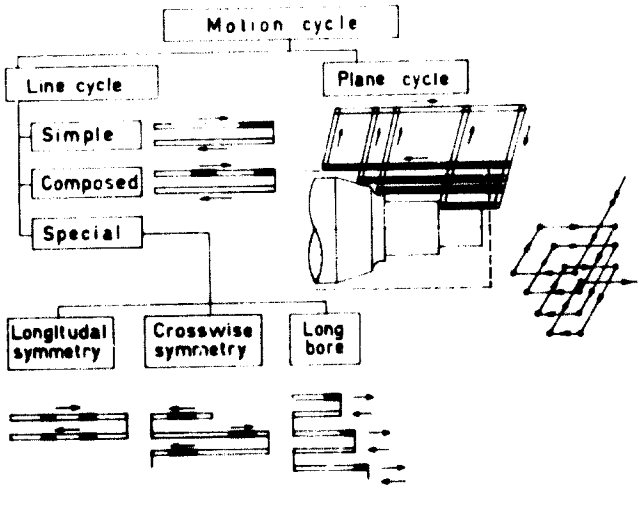

Figure 4

CHARACTERISTIC MOTION CYCLES

The connexions of cycle control, programme-switch and programme control are shown in figure 5.

Programme-control systems differ in the way in which they communicate the programme data to the machine: (*a*) in control systems with stops, the programme carrier is the direct contact with the machine; (*b*) in numerical-control systems, the programme carrier is in indirect contact with the machine. A control system with stops requires manual setting of the stops.

The essential characteristic of numerical control is that the size of the characteristics of the directed process—ways of displacement, speeds etc.—is expressed by

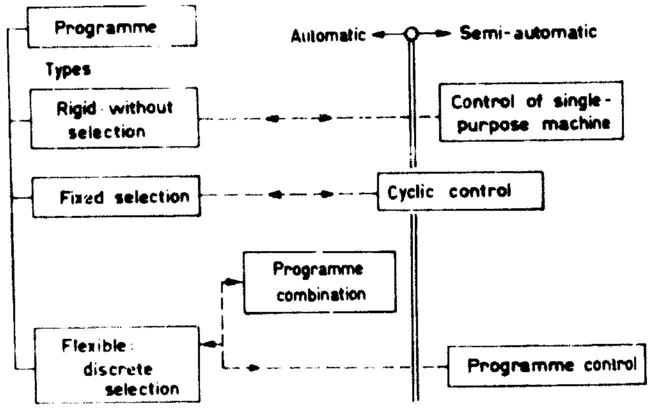

Figure 5

TYPES OF PROGRAMMES AND CONTROL SYSTEMS, AND THEIR RELATIONSHIP numbers. These are written by means of symbols of some mode of expression on the programme carrier (which is independent of the machine) and are fed into the machine through its directing equipment.

Figure 6 presents a further division of the stop-control and numerical-control systems according to their basic operating characteristics.

System of programme communication / Character of task	Stop control (direct)	Numerical (indirect)
Point - position and discontinuous control	Positional programme-switch Cyclic control Programme-switch Programme control	Positional (in free running) Process control (in free running and under load)
Path control	Copying	Interpolated or computerized

Figure 6

BASIC CHARACTERISTICS OF MACHINE-TOOL DIRECTIONAL EQUIPMENT

This paper aims at the review of simple programme-control systems. Stop controls are considered simple programme controls, as in their case no special command-transfer (code and logic, etc.) systems are needed for the determination of programme commands and for the realization of the directional process.

II. BRIEF SURVEY OF THE DEVELOPMENT OF MACHINE TOOLS

In the development of machine tools there are three main periods to be discerned; there is, however, a very intense temporary overlapping of these periods. The first period was characterized by mechanical devices and the second, by the combined (mechanical, hydraulic and electric) solutions and controls connected with weak-current electronics, while semi-conductor techniques are illustrative of the third period.

In the first period (up to approximately the 1920's), the development of machine tools tended towards the satisfaction of the continually widening circle of technological demand by means of increasingly mechanized and motorized appliances in the field of universal machine tools. After solving the main displacements of the machines by central drive, the power engine, the first task was the mechanical feed of slides and tables. Individual drives and mechanical main and secondary drives, as well as different mechanical disconnecting stops and devices for the disengaging of mechanical feed, were created through the development of metalworking tools and the frequent alteration of the technological parameters.

Considerable economy in accessory time has been realized by one-arm control systems and the so-called "control stick". The second half of this period was characterized by mechanically constructed pre-selection equipment, which permits the pre-selection of the technological values of a following operational sector during the effectuation of the technologies belonging to the various working sectors. After finishing a certain operational sector, the technological values relating to the new sector can be communicated to the metalworking machine with one single phase by setting a handle into action.

In the second period of development (until the 1950's and continuing up to the current time), control solutions were found suited to the continuous automatic direction of the complete machining process to be performed on the machine. It is no longer possible to satisfy these requirements economically by merely applying mechanical constructions. Various hydromechanical, electromechanical and other solutions are being applied, as mixed systems prove most expedient in the specific cases. Hydraulic copying attachments were evolved and have promoted the automation of the processing of shaft-shaped and other contoured workpieces. Various programmable main and secondary drives to be switched under load have been developed in order to change the technological parameters belonging to certain sections of the automatic working process according to the programme. Semi-automatic machine tools with programme-switching using various position sensors and stops, as well as with programme-control provided with limit stops, serve to ensure the continuous automation of the complete machining process. These machines although having a universal character can be employed most economically in large-batch production.

The demand for automatic machining equipment which can be employed economically in individual and small- and medium-batch production lays the foundations for the third period of development (which began in the 1950's): this period is characterized by weak-current techniques and semi-conductor techniques. Governing systems using these techniques perform the positioning and the setting of other technological parameters according to numerical information. Automatic tool-changing mechanisms and tool-pre-setting equipment have been developed for small-batch production. Automatic programmings have been originated in order to diminish the preparation of the programme; and, in order to realize the mechanization of the definition of the optimal technology and the different systems of programming, languages have been developed.

In summation, the development of machine tools and their control has always been brought about by the demand for increasing productivity and economical machining. The equipment employed was always characterized by the technical level of the given period.

III. TECHNOLOGICAL JUSTIFICATION AND POSTULATES OF TECHNOLOGY

The necessity for and technological justification of programme control can be ascertained by an examination of the production time. The production time (T_1) related to the machining of one workpiece is composed of the following time elements:

$$T_1 = t_1 + t_2 + t_3 + t_4$$

where t_1 = preparation time, t_2 = main machining time, t_3 = subsidiary time and t_4 = time for technical and organizational servicing of the work-station and lost time.

One must consider the fact that only 20–25 per cent of the production volume of the industrialized countries runs in large batches or in mass production. The remaining three-quarters of the mechanical-engineering production is carried out individually or in small or medium batches. This fact emphasizes the necessity of automating the machine tools used for individual, small- and medium-batch production, as well as of creating machine tools which are adapted to such production conditions. If one substitutes general practical values in the formula given above, one obtains the following results (in percentage) for small- and medium-batch production on universal machine tools:

$$T_1 = t_1 + t_2 + t_3 + t_4$$
$$100 = (4\text{–}2) + (20\text{–}40) + (50\text{–}70) + (6\text{–}8)$$

Thus, it is obvious that 20–40 per cent of the time is employed for the machining process, while 50–70 per cent of the production time is allocated to subsidiary time.

By automating the subsidiary operations and performing them simultaneously with the machining, the productivity can be considerably increased. Upon examination of the time-fractions employed for the different elements of subsidiary time, one finds, for various machine tools, the following data:

(*a*) Control of the machine (0.3–0.7) t_3;
(*b*) Clamping and unclamping of the workpiece (0.1–0.45) t_3;
(*c*) Tool change (0.1–0.15) t_3;
(*d*) Measuring (0.06–0.25) t_3.

These data provide roughly outlined information about the tasks to be solved and the technological and economic need for automating the subsidiary time elements. Considering that the quota of subsidiary time employed for controlling purposes is decidedly high, the primary aim of the development of machine constructions consists in their reduction, and this tendency manifests itself, in the case of small- and medium-batch production, in the propagation of the different variants of programme controls. Another possibility of reducing subsidiary times is the introduction of grouped machining technology; this is an effective technological medium of the production process not only with manually controlled machine tools, but also with those which have been automated to a certain level.

Technology puts various demands upon the machine itself, as well as upon its control equipment.

Programme-controlled machines must—as a matter of course—possess the technical characteristics of the traditional machines, but they must also have increased accuracy and rigidity.

Programme-control equipment must be able to direct the various movements, i.e., perform the positionings with adequate accuracy; direct the switchings of speeds and the different units as needed; and it must, in compliance with the foregoing, possess an appropriate programme-storage capacity. It is a postulate, furthermore, that the programme should be prepared at a minimal cost, but it must be easily alterable. It is an important requirement that the possibility of manual intervention should be guaranteed in order to modify metal-cutting data and to correct tool wear.

IV. Examples of stop controls

A. *Discontinuous controls*

As an example of cyclic control, a brief description of an internal-grinding machine model KL-100 (see fig. 7), which was developed and is produced in Hungary, is given below.

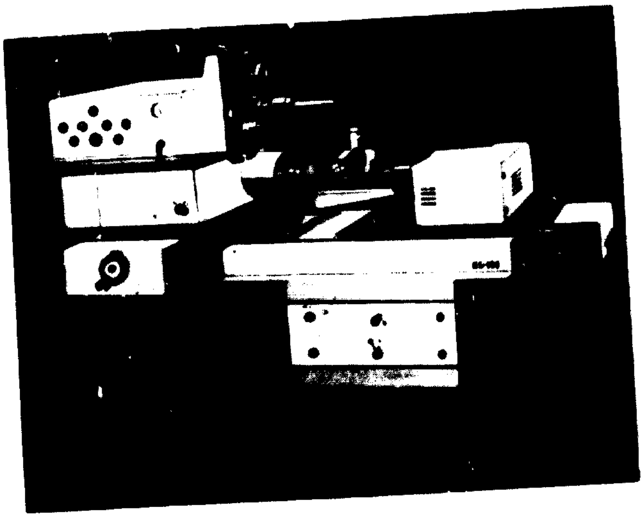

Figure 7

Semi-automatic internal-grinding machine, Model KL-100

This machine is suitable for the manually controlled or semi-automatic cycle-controlled machining of passing-through and blind holes. Setting of working cycle consists of setting the respective positioning stops and the selective switches of the electrical-control equipment.

In accordance with the pre-set working cycle, the machine performs the following tasks: rough grinding, automatic dressing and compensating of the grinding-wheel, switching from roughing to finishing and stopping automatically after having attained the pre-set size. At the end of the cycle, the grinding slide runs in its initial position; the cut is automatically interrupted; and, after changing the workpiece, the next cycle can be started with the push-button. The machine is electro-hydraulically controlled and it performs this fixed cycle continuously (see fig. 8) with such amplifications as are provided for by the pre-selection switches, e.g., the setting of single or double dressing etc.

Perception of the final size can be effectuated in three different ways:

(*a*) If only normal accuracy is needed or a blind hole is to be ground, automatic differential measuring can be applied. This means, essentially, that the machine—being controlled by the pre-set stop—automatically dresses the mantle of the grinding-wheel 0.05 mm before reaching the final size. The machine grinds the 0.05 mm after the dressing position;

(*b*) When grinding a larger number of workpieces and passing-through holes, a size-gauging control is advisable. Its essentials are as follows: the gauge enters the ground hole when final size is attained and sends a signal in order to stop the machine;

(*c*) Active measuring equipment can be applied in all grinding cases, its substance being the following: by means of the gauge of the measuring equipment, which is extended into the hole, the diameter of the ground hole is felt continuously. The control switches automatically from roughing to finishing, according to the pre-selected technology, and stops the machine after having obtained the final size.

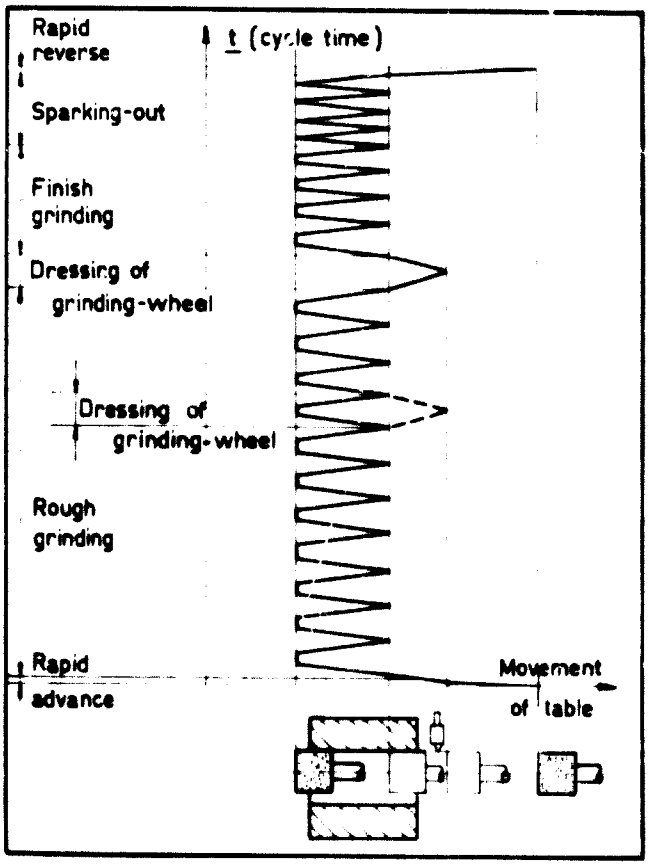

Figure 8

CYCLE DIAGRAM OF SEMI-AUTOMATIC INTERNAL-GRINDING MACHINE, MODEL KL-100

Loading equipment can be inserted in the automatic cycle and mounted on the machine, thus ensuring its wholly automatic operation.

As an example of a programme control with stops, figure 9 shows a programme-controlled milling machine, Model MUL-320, which is produced in Hungary.

The machine can be operated as a basic type or with cyclic control, or it can be programme-controlled with punch cards.

On the basic machine starting of the milling spindle,

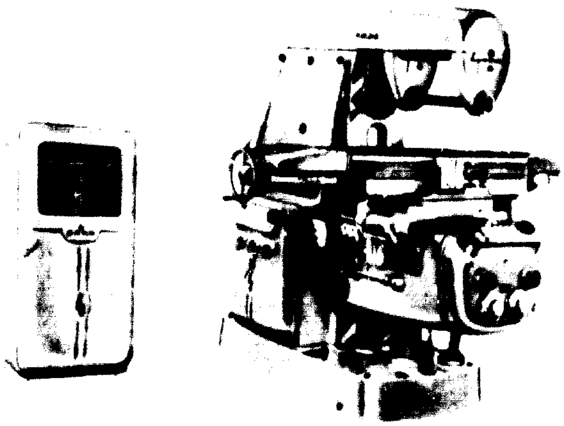

Figure 9

PROGRAMME-CONTROLLED MILLING MACHINE, MODEL MUL-320

its braking, its feed or the rapid motion of any part of the table can be switched by means of push-buttons.

Various cycles or simple programmes can be set in all three directions on the cycle-controlled machine by means of stops and switches.

With a simple cycle, the table returns to its initial position after having performed the machining process. In the receding cycle, the workpiece retires from the tool, thus ensuring that the tool leaves no scratch marks on the workpiece during the rapid reversion of the table.

Two workpieces can be clamped simultaneously on the table in the pendulum type of cycle, and the machine automatically switches the rotation of the main spindle according to the placement of the table.

The machine automatically switches the necessary movements of the table when executing a simpler programme, e.g., milling all sides of frames, and it stops at the end of the programme.

In the case of punch-card control, the punch card is prepared according to the determined technology and the plug-field is plugged in conformity with the card. The machine automatically performs the programme fixed by the plugs. The programme can consist of forty subsequent sectors.

Any discrete placement of the machine can be obtained within each sector by switching fourteen different circuits according to an appropriate combination. The programme board is thus a switching field consisting of forty rows of contactors, fourteen in each row, with their overall number consequently being 560.

The fourteen programme points of the programme board are, from left to right, the following: A, main spindle to right; B, main spindle to left; C, traversing slide to right; D, traversing slide to left; E, cross-slide advance; F, cross-slide retire; G, knee up; H, knee down; J, change of feed and rapid motion in similar direction; K, rapid motion; L, slow motion; M, change of speed of main spindle and feed; N, stepping device in final position; O, change of group, by stops.

When changing from one programme section to the next during operation, the stepping device — known from telecommunication techniques — is actuated by the impulse supplied from the position switch, which itself is operated by a stop fastened to the prescribed spot. The stepping device switches out the respective horizontal row of the programme field by means of its wipers and switches on the underlying row. The stepping device has twenty-five arc terminals, and it executes one interval at each impulse, which means the changing over from one row to the following one. One unit of the manual plugboard having twenty rows, the stepping device steps the surplus five terminals automatically in open circuit.

Two groups of stops can be employed on the machine, evidently by employing two stepping devices also. Only one group, however, can operate at one time; the stops belonging to the other group remaining ineffective despite their impact. When programming a change of the stop groups, the position switches and stops of the other group can influence the switching. Such a separation of the stops ensures the possibility of operating the second group of position switches in some other programme row and advancing in the same direction, after having finished a certain milling operation; thus, it will be possible to machine longitudinal sizes differing from those of the previous milling.

If an accurate stoppage is required at the end of a certain programme section, this should be programmed by the plug E — slow motion — and, in such cases, the table stops within a range of ± 0.03 mm.

The machine can effectuate any desired number of rapid-motion feed changes within one programme section, that is to say, within similar direction of the table, by employing plug J (the number is limited only by the geometric sizes of the stops). Two main spindle speeds and two feeds can be employed according to programme; one of these can be set on the machine, with the speed-change disc, while the setting of the other is effected in the programme box. These can be interchanged optionally by means of the plug M.

Plugs A and B, which determine the direction of rotation of the main spindle, elicit the braking and re-starting of the motor within the identical programme sector. Should the machine have completed the operation which consisted of only fourteen sectors, it stops at the end of the fourteenth sector; from the fifteenth row of the programme board, only plug N is needed to unreel the stepping device into its initial position.

The machine stops after having completed a whole programme operation and its re-starting is effectuated by pressing the starter-button of the cycle.

B. *Path control*

Contouring tasks can be solved without a measuring system by means of copying systems. These systems ensure, at a prescribed accuracy, the relative position of the workpiece and the tool along a plane or space curve determined by some template, that is to say: they control the position.

As regards their operational principle, they can be divided in two main groups: (*a*) continuous operation; and (*b*) discontinuous operation.

In continuous contouring, the gauge touching the template gives a continuous signal and the movement of the tool (or the workpiece), that is, the controlled characteristic, is continuous also.

In discontinuous systems, the gauge gives signals only in case of those placements which are similar to discrete placements of the controlled characteristic. Discontinuous systems are mainly employed on milling machines and on milling and boring machines, whereas continuous systems are frequently found on lathes, because of the smaller bend radius of the tool.

From the point of view of the control direction, the copying attachment can be one- or two-dimensional. The executing system used is most frequently hydraulic, electric or electro-hydraulic.

A semi-automatic copying lathe, Model EM-250, which is produced in Hungary, has cyclic control with stops also (see fig. 10).

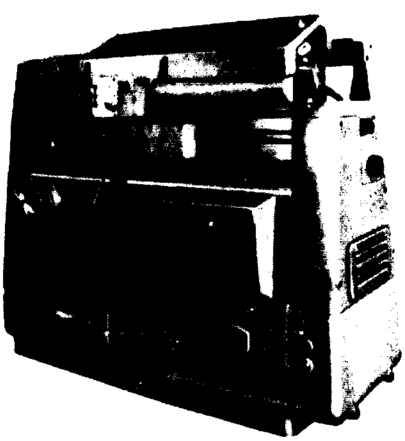

Figure 10

SEMI-AUTOMATIC COPYING LATHE, MODEL EM-250

This machine was constructed for the machining of shaft-shaped workpieces with diameters ranging from 18 to 40 mm. Its main drive has eight stages, two of which can be programmed automatically by means of a change-speed motor.

It possesses an infinitely variable feed range. In addition to the pre-selected feed, two additional feeds can be programmed: one for the bisection of the feed when machining shoulders; the other for finish copying.

The cycle-controlled hydraulic copying attachment mounted on the carriage can execute five roughing and two finish-copying phases. Feed can be effected only in direction of the main spindle, and it has a rapid reversing motion.

Figure 11 shows the structure of the cyclic control. The copying attachment has one main gauge and one secondary gauge. The secondary gauge, No. 1, touches the stops, No. 2, for depth of cut, according to the preselected depths of cut of the roughing phases. These

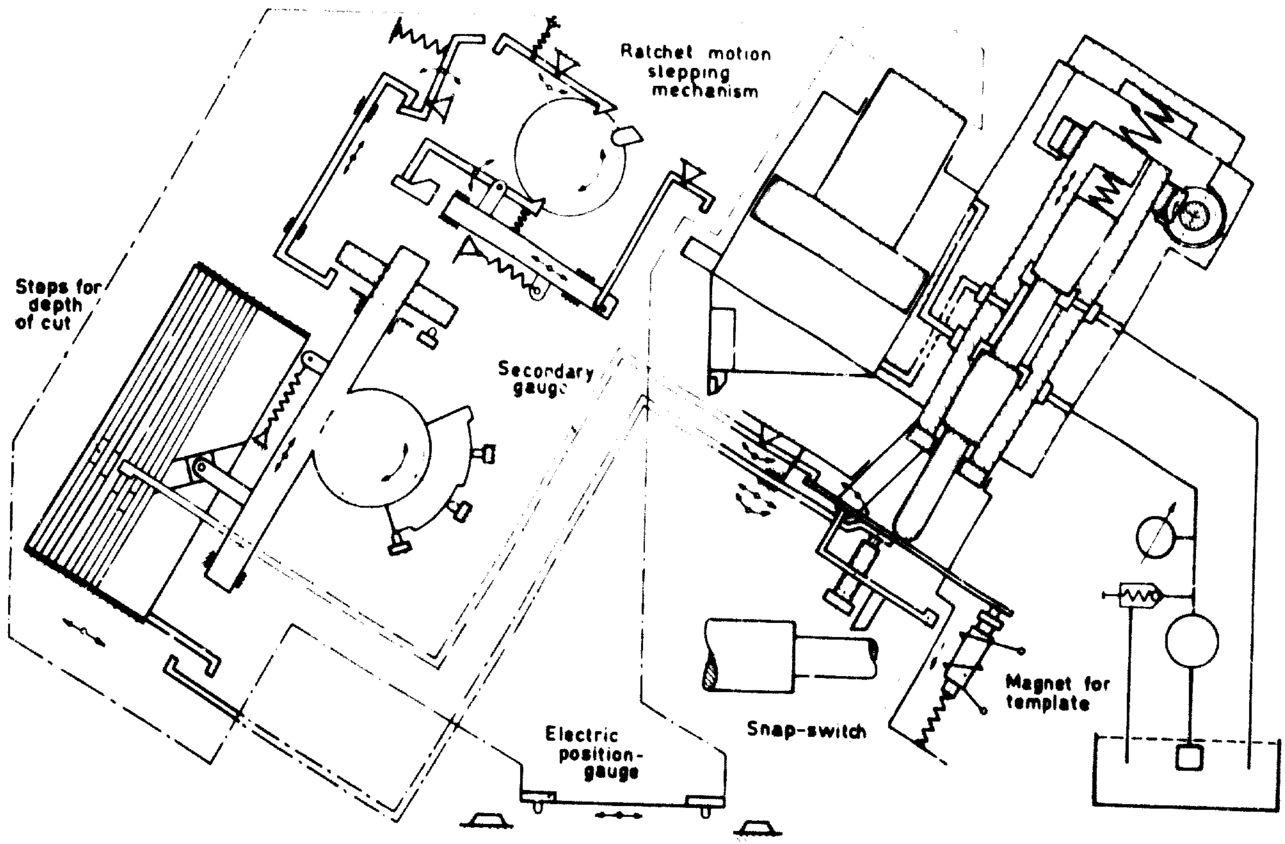

Figure 11

SKETCH OF CYCLE-CONTROLLED COPYING ATTACHMENT

stops for depth of cut are situated in an easily extractable flapper which can be set outside of the machine.

The snap-switch, No. 3, which is located under the main gauge, init ates, in the roughing phases, the reversing of the copying slide when the gauge bumps against the shoulder of the template (the magnet No. 4 releases), and it also initiates the reversing of the carriage. During the reversing of the copying attachment, the ratchet motion stepping mechanism, No. 5, lifts the next two stops for depth of cut into the impact plane of the secondary gauge.

The snap-switch, No. 3, is ineffective in the rough-copying or finish-copying phase. Reversing of the copying slide and the rapid retraction of the carriage are switched by the electric position-gauge, No. 6, which is actuated by the carriage. This construction shortens considerably the programming time, because the template itself serves as a longitudinal stop. Switching of the bi-sections of feed when machining the shoulders in the copying phase is also effected by the template. In the course of programming, only the following organs have to be set: template, stops for the depth of cut; pre-selected main spindle speed; and basic feed.

The necessary number of phases for the machining of one workpiece can be set optionally for either the roughing or the copying phase. Such pre-selection and setting is also possible when only a copying phase is inserted into the machining of the workpiece.

V ECONOMIC APPLICATION OF PROGRAMME CONTROLS

Machines belonging to the same type, but possessing different control levels, have, respectively, specific fields of application in which they can be employed with the optimum efficiency. The technical conditions of application have to be ensured primarily. The operation of machines with a higher level of control sets up continually greater claims on the works organization and on the technical standards of the whole factory, in proportion to the complexity of the control (e.g., technological matters, tooling, production programming, etc.).

"Rentability" of production means essentially to produce high-quality products at the least possible cost. It cannot be decided, in general, which batch size makes a certain machine with a simple programme control economically preferable, in comparison with a manually controlled universal machine or with a machine of some other control system.

Individual calculations have to be made. Those parts of the production costs which are influenced by the different types of machines must be examined.

Figure 12 shows the different components of the production costs and refers to the changes in the proportions of the costs when comparing programme-controlled machines with manually controlled types.

In order to present an example, a determination has been made of the production time of the workpiece for a universal centre lathe (see fig. 13a) and for the semi-

Cost components	Base of reference	Influencing factors	Relative change of costs, compared with manually controlled machines
Productive wages K_2	Hourly wages for work-time	t_1 t_2 t_3 t_4	↘↗ ↘ ↘ ↘
Machine costs K_3	Machining time for one piece	Price of machine (amortization, interest,) maintenance, yearly time-base of machine	↗ ↗ ~
Factory overhead K_4	Productive wages	Technical preparation Production engineering Serving Energy Building Others	↗ ↘ ↘ ↘ ~
Cost of production equipment K_5	All pieces machined	Type of machine workpiece (fixture), etc.	~ ↗
$K_1 = K_2 + K_3 + K_4 + K_5$			
↗ increasing	↘ decreasing	~ identical	

Figure 12

COMPONENTS OF THE PRODUCTION COST OF ONE WORKPIECE (K_1): TREND OF CHANGE IN COSTS WITH USE OF PROGRAMME-CONTROLLED MACHINES

automatic copying lathe Model EM-250 (shown in fig. 10), which has cycle control.

Figure 13b illustrates the production time, t_{g1}, in the function of the batch size. It can be observed that the cycle-controlled copying lathe is more proc ive if the batch contains more than approximately eight pieces. Figure 13c, however, draws attention to the fact that only in case of n 15 can a real economic profit be expected of the semi-automatic, cycle-controlled copying lathe. This is due to the differences between preparation times, wages of the operator, prices of the machines and other incidental costs (see fig. 12).

In the case of the previously reviewed internal-grinding machine (Model KI-100), cyclic-control system and automatic measuring reduce the production time of one workpiece to such an extent that the employment of the stop-controlled machine is economical, notwithstanding its higher price and its more expensive operation, even in the case of very small (eight to ten pieces) batches. Gauge control raises somewhat the preparation time of the KI. type of machine and this extends the limit of the economical batch size to about twenty to twenty-five pieces. The KI type of machine is more productive in grinding bores of, e.g., 28H6, even for five pieces or upwards; and the production time diminishes by 30 per cent if the batch comprises twenty workpieces. As regards economic feasibility, the employment of this machine is advisable for batches from ten pieces and upwards.

Both types referred to in the examples can be operated according to the system whereby several machines are handled by the same operator.

There are, of course, several factors in addition to those already mentioned which exert considerable influence on the problem of application. As mentioned before, the advisability of adopting some machine with one or another advanced control is decided mainly by the technical level of the production. As the level of the adopted control increases, the intellectual performance expected of the operator decreases, but in this case, the tasks concerning the technical preparation of the production also show a considerable upward tendency. There is no doubt, however, that under appropriate conditions the productivity and "rentability" of the production, as well as the interchangeability of the machined parts, can be substantially increased by the employment of machines with simple programme controls.

VI. CONCLUSION

This paper has dealt with control systems belonging to the second period of the development of machine

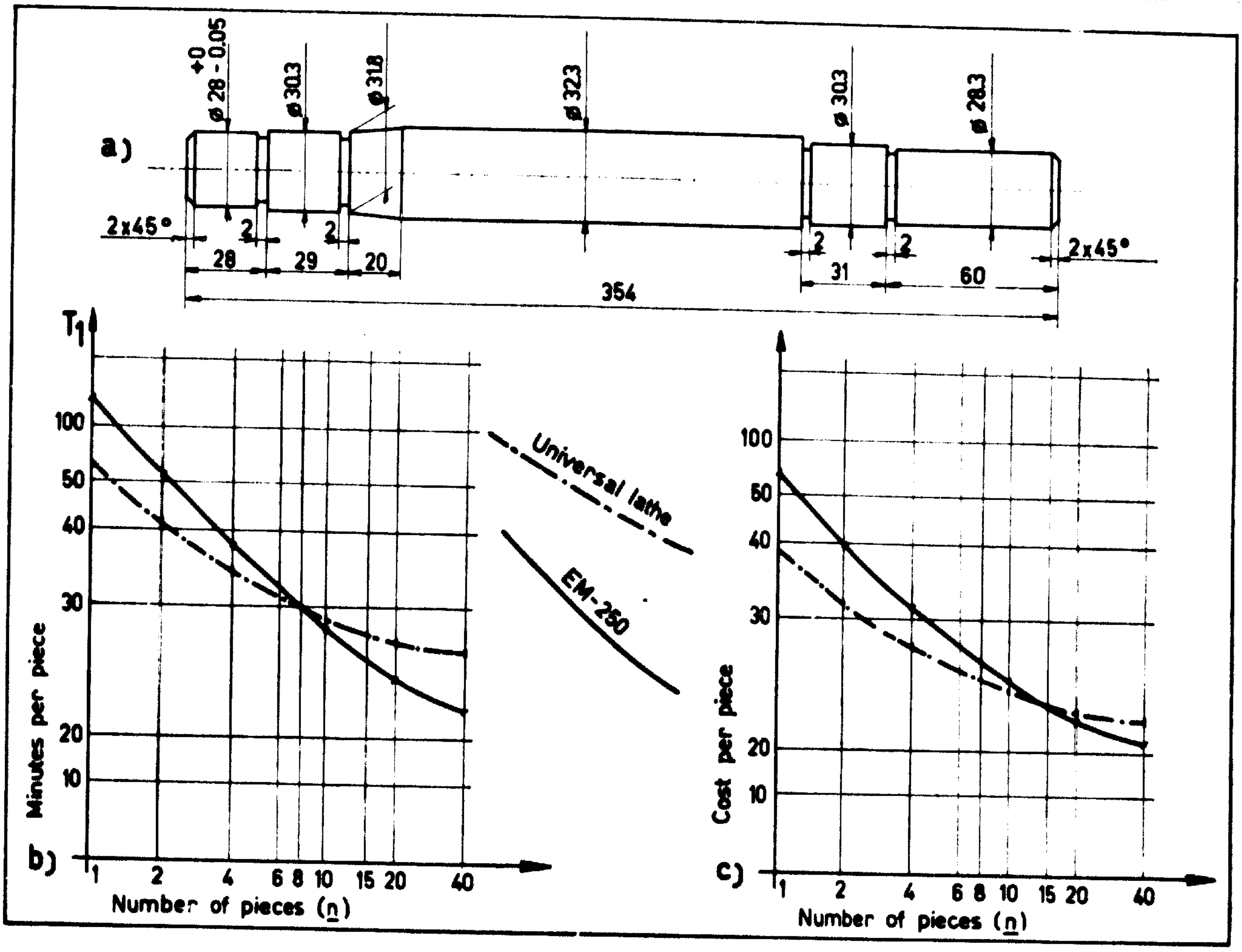

Figure 13

EXAMINATION OF THE ECONOMICS OF SHAFT PRODUCTION

tools—more precisely, to the last phase of this period. Simplified controls are being increasingly employed in the metalworking industry. The trend of future development points towards simplified constructions, increased operational reliability and further improvement of the ratio of unproductive and productive (machining) time.

Although this paper does not take into consideration the numerical controls which are characteristic of the third period of development, it is, nevertheless, necessary to point out their progressive importance in revolutionizing small- and medium-batch production. A tendency towards simplification is to be observed in the realization of numerical control also. Considering the great number of types of numerical controls which are available, great importance must be attached to international unifying and standardizing activities.

Hungary has also endeavoured to pass on its experiences to the specialists of developing countries, in the forms mentioned below:

(*a*) Hungarian experts have installed industrial equipment delivered to developing countries and have transmitted their own operational and handling experiences;

(*b*) Several specialists from the developing countries have taken their degrees at Hungarian universities and this programme is continuing;

(*c*) Hungarian lecturers and professors have travelled to several countries, at the invitation of those countries, in order to promote the education of specialists.

Within the bounds of its possibilities, Hungary wishes to continue to serve the accelerated technical evolution of the developing countries.

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