

МТ23

6 семестр

Министерство высшего и среднего специального образования СССР  
Ленинградское отделение ордена Ленина и ордена Трудового Красного Знамени  
высшее техническое училище имени Н.Э.Баумана

---

Степанова Л.М.

Утверждена  
редсоветом МВТУ

МЕТОДИЧЕСКАЯ РАЗРАБОТКА  
ПО СПЕЦИАЛЬНОСТИ АМ-123

СТАНКИ

ч. II

Под редакцией Л.Т.Розач

---

1978

## \$1. A FEW WORDS ON MACHINE TOOLS.

What is a machine tool? A machine tool is a power-driven machine used to produce objects out of metal. Machinery is used to fashion metal objects because, with machines, the work can be performed much more precisely than by hand, with virtually no muscular effort and, much more rapidly. But not all machine tools perform precision work. Some, by their nature, are suited only for rough work, removing large chunks of metal and leaving relatively rough surfaces which are, later, to be smoothed and brought more closely to size<sup>1)</sup> by other machine tools better suited to fine work.

Some machine tools are 200 feet or more in length, - e.g. special "transfer machines" which perform a whole series of operations in timed sequence.<sup>2)</sup> Others are small enough to be carried by one man.

Some machine tools require great skill to operate. Others are semi-automatic and require only that the operator load the work into them, press a button or move a lever, and they do the work without further direction. Still others are so completely independent of human skill<sup>3)</sup> that, by virtue of what are called automation devices and numerical control - to be discussed later - they can load themselves, start, perform their function, stop, and unload, and can repeat the cycle of operations until stopped by hand or until the supply of workpieces is exhausted.

Some slowly fashion massive pieces. Others handle light work, producing it in but a fraction of a minute.\* Some machines have a light, delicate touch and can drill a hole, crosswise, through a human hair. At the other end of the scale stand the huge forging presses, the so-called "elephant tools" that can exert a squeezing force of 50,000 tons and are used for producing large light-metal forgings for the aircraft industry.

It is evident, then, that size and weight do not help much in classifying machine tools. Nor does the machine's product help<sup>4)</sup> to classify it, for the same result may often be obtained from several different basic types of machine. It is what a machine tool does, and how it does it, that tells us what kind of a machine it is.

Machine tools are the backbone of the metalworking industry without which no other machines could be made, and they are the only man-made objects capable of reproducing themselves. In fact there is scarcely anything made for the use of man that does not owe its existence, directly or indirectly, to the machine tool.<sup>5)</sup>

Notes:

- 1) which are, later, to be smoothed and brought more closely to size - которые позднее должны быть обработаны начисто и доведены до более точного размера
- 2) in timed sequence - в рассчитанной по времени последовательности
- 3) still others are so completely independent of human skill - третьи настолько не зависят от мастерства человека
- 4) Nor does the machine's product help - и продукция станка также не помогает ... (эмфатическая инверсия)
- 5) that does not owe its existence, directly or indirectly, to the machine tool - что, прямо или косвенно, не было бы связано своим существованием станку.

Words and word combinations to be remembered.

direction - указание, инструкция  
to fashion - придавать форму путем обработки  
fine (work) - точная (обработка); (работа с малыми допусками)  
to handle - обрабатывать  
lever - рычаг  
to load - загружать ; to unload - разгружать  
machine tool - станок  
semiautomatic machine tool - полуавтоматический станок  
transfer machine - автоматическая линия  
numerical control - цифровое программное управление  
to operate - управлять  
to perform (an operation) - выполнять (операцию)  
power-driven - с механическим приводом  
precisely - точно  
rapidly - быстро  
rough (work) - черновая (работа)  
skill - умение, мастерство  
smooth - ровный, гладкий; сглаживать, обрабатывать начисто  
to suit - подходить, соответствовать

rapidity

Exercises.

I. State the function of the Infinitive in the underlined sentences and translate them.

II. Give the nouns corresponding to the adjectives and translate them:

precise, rapid, natural, rough, long, skillful, direct, independent, human.

III. Look through the text once more and find equivalents for:

a  
намного точнее, чем вручную; выполняет точную работу; доведена до более точного размера; нажать кнопку; без дальнейших указаний; цифровое программное управление; запас заготовок; всего лишь за долю минуты; основа металлообрабатывающей промышленности; прямо или косвенно.

IV. Insert the proper Infinitive, state its function and translate the sentences.

a) to be carried, b) to be used, c) to load, d) to operate, e) to be loaded, f) to press, g) to handle, h) to exert.

1. The work ... into the machine-tool is a circular casting.
2. Automation devices can handle pieces which are too massive ... by a man.
3. Some machine-tools require great skill. ... such a machine-tool one should acquire proper knowledge and experience.
4. Our new laboratory received machinery ... for precision work.
5. ... light work, some machines have a light, delicate touch.
6. Our country produces huge forging presses which are large enough ... a squeezing force of 50,000 tons.
7. The operator only has ... a button ... the work into the automatic machine.

V. Answer the questions.

1. What is a machine tool?
2. What are the three main advantages of a machine tool?
3. Do all machine tools perform precision work?
4. Of what size are machine tools?
5. Is it equally difficult to operate different machine tools?

- What are the functions of an operator when operating a semi-automatic machine tool?
7. How much time does it take a machine tool to fashion a work-piece?
  8. Where are huge forging presses used?
  9. Are machine tools classified according to their size, or weight, or product?
  10. Why are machine tools considered to be the backbone of the metalworking industry?

VI. Retell the text.

VII. Make a written translation using a dictionary. (time limit 10 min.)

Ever since Roman times, man had known of the power energy of steam, but it was only after the proper machine tool had been built that an engine could be made sufficiently steam-tight to put that power to work in driving machinery.

It was the steam engine that brought about the Industrial Revolution that led, eventually, to our present high standard of living and to the production of immense quantities of goods. Yet the practical development of the steam engine by James Watt had to wait upon the invention of the boring machine (a machine tool) by another man. And even as we stand at the beginning of the Atomic Age, it is well to remember that neither the original splitting of the atom, nor the subsequent developments to apply its energy to man's use could have been achieved without machine tools to make the necessary equipment.

VIII. Make up a summary of the above text.

§2. THE LATHE. ✓

*exempli gratia  
Kанпушеп*

The metal-cutting lathe is the oldest of all standard machine tools. More types of operations can be performed on it than on any other machine. According to the shape of tool employed, the way in which it is mounted, and the direction and the rate at which it is fed to the work, it is possible to perform a wide variety of operations, (e.g.) turning, boring, drilling, facing, etc.

These are only a few of the many operations that can

be performed on the "engine lathe", so called because the earliest types were driven by steam engines.

There are other types of lathes that vary in their ability to perform work automatically, ranging up to the automatic screw machine which, as its name implies, is fully automatic in operation.

Lathes are made in a wide variety of designs and sizes<sup>1)</sup>, nevertheless, every lathe consists essentially of a bed, headstock, tailstock and carriage.

The main casting of an engine lathe is a horizontal member called a "bed"<sup>2)</sup>. Planed surfaces on top of the bed, called "ways" or "vees", align the headstock and tailstock and guide the carriage so that it moves longitudinally parallel to the axis of the machine. A chip pan under the bed collects chips and cutting fluid when one is used.

The headstock is mounted on the inner ways at the left end of the bed. On some lathes the headstock casting supports shafts and encloses a train of gears that rotate the headstock spindle at rpm which are suited to the operating conditions of different jobs.

The tailstock is mounted on the inner ways, at the right end of the bed, to align it with the headstock. It is adjustable on the bed longitudinally so that it may be positioned wherever needed<sup>3)</sup> to support workpieces that are held on centers. When the workpiece is held with a chuck or on the large faceplate, the tailstock holds tools that may be used to perform operations.

The lathe's carriage is a subassembly that is mounted on the outer ways of the machine between the headstock and tailstock. Its function is to hold and move the turning and boring tools that are used on the machine. The principal parts of the carriage are the saddle, the cross slide, the tool post, and the apron.

#### Notes:

- 1) Токарные станки изготавливаются самых разных размеров и конструкций.
- 2) Основная литая часть токарного станка - это горизонтально-расположенный узел, называемый станиной.
- 3) Ее можно перемещать по станине в продольном направлении, так

чтобы установить там, где нужно.

Words and word combinations to be remembered:

adjustable - регулируемый  
to align - устанавливать соосно, центрировать  
apron - фартук  
bed - станка  
carriage - суппорт  
to guide - направлять  
headstock - передняя бабка  
lathe - токарный станок  
engine lathe - (универсальный, токарно-винторезный станок)  
longitudinally - продольно, в продольном направлении  
member - элемент (конструкции)  
pan - поддон  
to position - устанавливать  
saddle - салазки  
shaft - вал, ось  
subassembly - узел  
tailstock - задняя бабка  
vees - V-образные направляющие  
ways - направляющие (станка)  
automatic screw machine - винторезный автомат  
cross slide - поперечные салазки суппорта  
cutting fluid - смазочно-охлаждающая жидкость  
r p m - revolutions per minute - оборотов в минуту  
tool post - резцедержатель  
train of gears - система (набор) шестерек

Exercises.

I. Look through the text once more and find equivalents for:

чем на любом другом станке; в зависимости от того, как он укреплен; самые первые типы; много различных операций; как показывает само название; вплоть до; режим работы; смазочно-охлаждающая жидкость; он (резец) подается к заготовке?

II. Put the verbs in brackets into Active or Passive and translate the sentences.

1. The lathe bed is the foundation on which the lathe (to build).
2. There are two sets of ways on the lathe, the outer ways (to guide) the carriage, and the inner ways (to keep) the headstock and tailstock in line.
3. The headstock, carriage, and tailstock (to align) parallel to the axis of the spindle through the entire length of the bed.
4. The main spindle (to revolve) on two bearings.
5. The main spindle (to control) the speed of the work when the work (to revolve).
6. The live centre, which (to fit) into the main spindle, (to call) so because it (to act) as a bearing surface on which the work (to rest).
7. The motor and driving mechanism (to enclose) in the cabinet under the lathe headstock.
8. Metal-cutting lathes (to use) to perform a wide variety of operations.
9. The direction and rate at which the tool (to feed) to the work can be changed whenever needed.

III. Read the following text without using a dictionary. Make up a summary of the text.

#### LATHE PARTS.

The lathe bed is the foundation on which the lathe is built. It must be substantially constructed and scientifically designed. There are two sets of ways on the lathe, the outer ways guide the carriage, and the inner ways keep the headstock and tailstock in line.

Prismatic V ways are the most accurate type of ways for lathe beds. The V ways of the lathe bed are very carefully machined so that the headstock, carriage, and tailstock are perfectly fitted and aligned parallel to the axis of the spindle through the entire length of the bed. The complete headstock comprises the headstock casting, the main spindle, the necessary mechanism for obtaining the various spindle speeds, and also certain gears.

The main spindle revolves on two bearings<sup>1</sup>), one at each

end of the headstock. The main spindle controls the speed of the work when the work revolves. It must be perfectly aligned because the spindle in imperfect alignment, or with improperly adjusted bearings, will cause trouble. The main spindle is threaded to receive a chuck or faceplate.

The motor and driving mechanism are fully enclosed in the cabinet leg underneath the lathe headstock. There are no exposed pulleys, belts, or gears.

1) Bearing - onopa

#### IV. Answer the questions.

1. What operations can be performed on a lathe?
2. Why were the earliest types of lathes called "engine lathes"?
3. What kind of automatic lathes do you know?
4. What are the principal parts of a lathe?
5. What aligns the headstock and tailstock?
6. What does a chip pan collect?
7. Where is the headstock mounted?
8. What is the function of the train of gears in the headstock?
9. Where is the tailstock mounted?
10. In what direction can the tailstock move?
11. What does the tailstock support?
12. Where is the carriage mounted?
13. What is the function of the carriage?
14. What are its principal parts?

#### V. Retell the text.

### §3. THE MILLING MACHINE

The milling machine is a machine tool in which metal is removed by means of a revolving cutter with many teeth, each tooth having a cutting edge which removes its share of the stock. The work is supported by various methods on the work table, and may be fed to the cutter longitudinally, transversely, or vertically. A great variety of work may be done on a milling machine.

The machines for the milling operations fall into three main classes: 1. Horizontal plain <sup>gear</sup> milling machine. 2. Vertical milling machine. 3. Universal milling machine.

In the horizontal milling machine the table with the work mounted on it moves in a longitudinal direction with a reciprocating motion under the revolving cutter. The table can be raised and lowered, and can also be given a cross traverse motion at right angles to this motion and the motion of the table in the longitudinal direction.

Many improvements have been made in milling machine design, and latest improvements incorporate a dial which calculates the speeds, feeds, and cutter diameters for various materials. Machines incorporating this feature are known as dial-type milling machines.

The dial calculates the correct cutting speed, enabling efficient milling and lengthening the cutter life accordingly. By setting the type of cutter and its diameter in the windows of the dial, the cutting speed and spindle r.p.m. can be read off on the circular scales.

The vertical machine, as its name implies, has a vertical spindle, and apart from this, the general principles of the plain horizontal milling machine are applicable here. The table has the same movements of longitudinal <sup>cross</sup> traverse, cross traverse, and elevation (raising and lowering). In addition, the cutter mounted on the vertical spindle can also be raised and lowered to suit the work.

The universal milling machine is similar to the plain horizontal miller, but in addition has an added table movement which enables the table to be swivelled about its vertical axis. The swivel of the table, usually up to  $30^{\circ}$ , enables spiral milling of helical milling to be performed, and the table of this type of machine is provided with a dividing head. This latter enables work to be indexed and its circumference to be divided up into any number of divisions.

Words and word combinations to be remembered:

- applicable - пригодный, подходящий, применимый  
cutter - фреза  
dial - лимб, шкала  
to divide - делить      division - деление  
efficient - эффективный, производительный, экономичный  
elevation - подъем  
to enable - давать возможность  
helical - винтовой, спиральный

reciprocating -

! (составить шкалу)

опред. конструктор-проект. станок

длина окружности

index - поворачивать (на определенный угол)  
 to incorporate - включать (в себя), объединять  
 to mount - устанавливать, монтировать  
 to reciprocate - двигаться обратно - поступательно  
 to set - устанавливать  
 stock - материал, заготовка  
 to swivel - поворачиваться, swivel - поворот  
 transverse - поперечный  
 cutter life - срок службы (стойкость) фрезы  
 dividing head - делительная головка  
 cross traverse - поперечная подача (перемещение)  
 longitudinal traverse - продольная подача (перемещение)  
 work table - рабочий стол (станка)  
 apart from this - кроме этого  
 in addition - кроме того

### Exercises.

I. a) Give the verbs corresponding to the following adjectives and translate them:

low, long, correct, applicable, cross, general, modern, various, suitable.

b) Give the nouns corresponding to the following verbs and translate them:

to divide, to move, to swivel, to add, to cut, to improve, to design, to direct, to revolve, to operate, to remove, to reciprocate, to calculate, to elevate.

II. Insert words from your active vocabulary. Translate the sentences.

1. <sup>a</sup> ~~1. dial~~ enables the operator to calculate the correct cutting speed. *reciprocates*
2. The table ... under the revolving cutter. *stock*
3. The cutting edge of each tooth removes a certain part of ...
4. <sup>the</sup> ~~...~~ of the table about its vertical axis <sup>enables</sup> helical milling to be performed. *incorporate*
5. The latest designs of milling machines ... dials for calculating speeds and feeds. *dividing head*
6. The universal milling machine is provided with a ... which enables the work to be <sup>indexed</sup> and divided up into any number of ...

III. Translate the sentences paying attention to the modal verbs of obligation.

The production engineers ought to decide what operations are to be performed on the raw material to transform it into the finished product. They should specify the exact sequence in which these operations have to be performed, and the various types of machine tools required for each operation or group of operations. And after they have made up the production plan, they must go farther and design the special work-holding fixtures and tools needed to carry out the plan rapidly and with precision.

IV. Translate the sentences paying attention to the Absolute Participial Construction.

1. The spindle of the drilling machine being modified, the cutting tools are fed vertically to the work.
2. The spindle holding the tool in the drilling machine, the carriage is not needed.
3. Like all other machine tools drilling machines are made in a wide variety of sizes, the mechanical principles of speed and feed changes not differing from those in lathes.
4. The work table being vertically adjustable, various heights of work can be mounted.
5. In drilling machines the work can be seated on the base, with the work table swiveled up to  $90^{\circ}$ .

V. Answer the questions.

1. By what means is metal removed from the stock on a milling machine?
2. In what directions can the work be fed to the cutter?
3. What main classes of milling machines do you know?
4. How does the table in the horizontal milling machine move?
5. What are the latest improvements in the design of milling machines?
6. What does the dial enable the operator to do?
7. What is the main difference between the vertical milling machine and the horizontal one?
8. What kind of milling operations can be performed due to the swivel of the table?
9. What is the table <sup>provided with</sup> ~~and what for?~~
10. What is the dividing head used for?

VI. Retell the text.

11. Read the text without using a dictionary. (Some words are given below.) Describe the drilling machine.

A vertical drilling machine is, essentially, a lathe which is arranged so that its tailstock end rests on the floor. The spindle of the machine is modified to hold twist drills and other cutting tools and to move them vertically to feed them to the work. Since the carriage is not needed to hold tools, it is omitted from the construction. And the tailstock is modified so that it becomes a horizontal arm that supports a table for holding the workpieces.

The vertical drilling machine or drill press, has six or more spindle speeds and three or more automatic feeds. The head, which carries the sleeve, spindle, and feed gears, is in many models bolted to the frame and, to accommodate different heights of work, the worktable is vertically adjustable.

The standard drill press may have either a rectangular or a round worktable. There are three ways in which this worktable may be adjusted for position: (1) The supporting arm (and table) may be raised or lowered; this provides for different heights of work. (2) The supporting arm may be swung to substantially 90 deg. either side of center, and (3) the table itself, being pivoted at its center, may be swiveled through 360 deg. The adjustments (2) and (3) in combination provide for locating, directly under the cutting tool, any given spot on the work when the work is clamped or is for some other reason impracticable to move about on the table.

drilling - Сверление

twist drill - спиральное сверло

drill press - вертикально-сверлильный станок

column - колонна, стойка

base - основание, плита (фундаментная)

#### §4. MULTIPLE-SPINDLE AUTOMATICS

Many more operations can be combined, and production thereby speeded up, if more than one piece is being worked on at the same time. This can be done in the multiple-spindle automatic screw machine which may have four, six, or eight working spindles. As the number of spindles goes up, the cost of the machine rises correspondingly. Use of an eight-spindle machine,

therefore, is justified only when it is necessary to perform a large series of operations on a piece and when the quantities to be produced are quite large. For one thing<sup>1</sup>, the special tooling required is expensive, and it takes a long time to set up these machines. It would scarcely pay<sup>2</sup> to make a set-up unless the machine is to be operated continuously for at least three or four days before changing to another job.

Very often, such machines run for weeks at a time<sup>3</sup>, the only stops being made for sharpening tools and inserting new bars of stock.

The choice between the number of spindles to be employed lies in the relative simplicity or complexity of the work. If there are comparatively few operations, the work can be handled on a four-spindle machine; if there must be a large number of operations, a six- or eight-spindle machine will be needed, provided always that the quantities required will justify the long set-up time involved in changing over the machine from one job to another.

On a six-spindle automatic, for example, the progressive action is obtained in this way: the group of spindles is mounted in a cylindrical carrier. Opposite each spindle, end-working tools are mounted on a hexagonal slide. For some of the spindle stations, there are cross-feed tools mounted on slides. These move in and out radially, but remain in their relative positions. As in the case of a single-spindle automatic, the tools are fed into the work and withdrawn at the end of the cut. When the main tool slide is withdrawn, the entire spindle carrier is rotated a sixth of a turn to bring each of the spindles and their revolving workpieces in front of the next set of tools. Spindle No.1 is presented successively to six sets of cutting tools, and right behind it<sup>4</sup> comes Spindle No.2.

This sequence of operation is repeated continuously, so that at each indexing of the spindle carrier a piece is completed, although, actually, it has been worked on at six different stations. This is what makes the multi-spindle machine so highly productive.

Notes: 1) For one thing - прежде всего

2) It would scarcely pay - едва ли (окупится) выгодно

3) such machines run for weeks at a time - такие станки

работают в течение нескольких недель без перерыва  
4) right behind it - сразу же за ним

Words and word combinations to be remembered:

automatic - автоматический (n.) - автомат  
bar - пруток, полоса  
carrier - держатель  
to change over - переводить (станок), переключать  
comparatively - сравнительно  
correspondingly - соответственно  
expensive - дорогой, дорогостоящий  
piece - деталь, обрабатываемая заготовка  
progressive - последовательный  
sequence - последовательность  
set-up - наладка to set up - налаживать (станок,  
slide - салазки, каретка  
station - позиция, положение  
successively - последовательно  
tooling - оснастка (станка)  
to withdraw - удалять, отводить  
multiple-spindle machine - многошпиндельный станок  
set of tools - набор инструментов  
tool slide - резцовые салазки  
cross feed tool - резец поперечной подачи  
end-working tool (end-cut tool) - резец с передней режущей кром-  
кой

Exercises.

I.a) Give verbs corresponding to the nouns and translate them:

combination, production, speed, cost, justification, performance,  
operation, requirement, choice, employment, involvement, action,  
withdrawal, rotation, revolution, set.

b) Give the adverbs corresponding to the adjectives and  
translate them!

comparative, corresponding, progressive, successive, rapid, pre-  
cise, rough, smooth, longitudinal, efficient, helical, recipro-  
cating, transverse.

II. Look through the text and find equivalents for:

одновременно, с увеличением числа шпинделей, целый ряд (большое  
число) операций, требуется много времени, по крайней мере, про-  
вести наладку, такие станки работают неделями, для заточки рез-

лов, выбор ... зависит от, заготовку можно обрабатывать, большее время наладки, расходуемое на переключение, следующим образом, они выдвигаются и втягиваются в радиальном направлении, в конце прохода (инструмента), поворачивается на  $60^\circ$  (1/6 оборота), подается последовательно, сразу же на нем, последовательность операций, вот, что делает..., перед следующим набором инструментов.

III. Arrange the following words in groups of synonyms:

1 piece, 2 revolve, 3? present, 4 carry out, 3? feed, 5 rise, 2 rotate, 5 use, 3 go up, 1 work, 4 perform, 8 employ.

IV. Translate the sentences paying attention to the verbal forms.

1. By increasing the number of spindles, several operations can be performed on the same machine tool, thus speeding up the production.
2. The main tool slide withdrawn, the spindle carrier is rotated a sixth of a turn.
3. The number of spindles employed depends on the complexity of the work.
4. Multiple-spindle automatics can run for weeks at a time without being set up.
5. While choosing between a four-, six-, or eight-spindle machine one should think of the number of operations needed.
6. On setting up a multiple-spindle automatic the operator stops it only for sharpening tools and loading new bars of stock.
7. All the operations performed, the piece is completed and unloaded from the machine.

V. Translate the following text without a dictionary.

(time-limit - 10 min.)

There are several types of multiple-spindle automatics, all of them having distinguishing features but having certain fundamental principles of operation in common.

To understand more clearly the action of such machines, let us see how a particular piece is made in a six-spindle bar-type automatic. The various carriers are actually arranged in a circle.

The first operation on the bar takes place at Station VI. At this point, the bar is fed forward through the spindle auto-

...ally until it hits a stop bar<sup>2</sup> which is set to govern the length of the piece to be made. The stop bar then swings out of the way and the first end tool, a drill, is fed forward into the revolving bar. This is done by advancing the entire tool slide as a unit.

While the bar is being drilled at Station VI, a form turning tool<sup>3</sup> is advanced radially into it from a cross-slide at the rear of the machine. When the drill has been fed to depth, it is automatically withdrawn, the cross-slide is withdrawn too, and the whole spindle carrier is indexed one-sixth of a turn to present the partly machined piece to Station I.

Meanwhile, a second bar is being fed out and worked upon at Station VI.

- Notes:
1. bar-type automatic - прутковый автомат
  2. stop bar - упор, стопор
  3. form turning tool - фасонный резец

#### VI. Answer the questions.

1. How can production be speeded up?
2. How many spindles can a multiple-spindle automatic screw machine have?
3. In what cases are eight-spindle machines used?
4. Why are they not used for small quantities?
5. Will it pay if the machine is operated for less than three days?
6. What are such machines usually stopped for?
7. What does the number of spindles depend on?
8. Where are the spindles mounted?
9. What is mounted opposite each spindle?
10. How do cross-feed tools move?
11. When are the tools withdrawn out of the work?
12. How is the entire spindle carrier rotated each time?
13. When is a piece completed in a multiple-spindle automatic?
14. At how many stations is the piece worked on?

#### VII. Retell the text.

VIII. Read the text without a dictionary and explain the main difference between the multi-spindle automatic bar machine and the multiple-spindle chucking machine.

Many operations, particularly, form turning and cutting off, are done with tools mounted on cross-slides. A multi-spindle automatic bar machine has cross-slide tools and each of its spindle is able to take a bar.

The multi-spindle automatic bar machine will continue to operate without attention until all the bars are used up. There is another type of automatic, that is quite similar in character but semi-automatic in operation. It is known as a multiple-spindle chucking machine. In these machines, the various operations are performed on individual pieces, such as castings or forgings, instead of on barstock. Special chucks are provided at the end of the spindles, or standard power-operated chucks may be used. Each time the main spindle carrier indexes, a piece is released.

## §5. NUMERICAL CONTROL IN MACHINE TOOLS

Numerical control started a revolution in manufacturing technology. It has won an ever increasing role as a method of controlling machine tools and other production equipment.

Any system that accepts a symbolic numerical value as an input and converts it to a physical value, such as a dimension, as an output is providing numerical control. NC means that a program of machine operating commands directs some or all of the fundamental operations of a specific machine tool.

Consistency is one of the advantages of an N C-programmed machine tool. It will do precisely what it has been told to do within the limit of its capability, and will not vary from its programmed instructions. The only exception to this would be wear or breakdown of one of the machine parts. The working efficiency of an N C machine tool is usually much higher than the most skilled manual effort. As, what an operator does visually, is done here electronically by a control unit.

Quite often, new developments cause significant changes. However, NC has not changed individual metal cutting operations as much as it has changed the machine tools doing the operation.

The result has been a three-step development of machine tools influenced directly by N C. First, conventional machine tools were redesigned specifically for operation by N C. The second trend has been that of combining several operations in a

... machine. The benefits here are obvious. If drilling, boring and milling can be accomplished on one machine at one set-up with one operator the savings in setup time and in time required to move the workpiece are immediately apparent. The third development - the machining centre - has made the greatest impact, thus far, in NC machine tool design.

Words and word combinations to be remembered:

apparent - очевидный, несомненный

benefit - выгода

breakdown - авария, поломка

capability - способность, возможность

consistency - постоянство

control - управление

conventional - обычный, стандартный

efficiency - производительность

impact - толчок, воздействие

input - ввод, входной сигнал

obvious - явный, очевидный

output - выход, выходной сигнал

saving - экономия

trend - направление, тенденция

value - значение, величина

wear - износ

thus far - до сих пор

machining centre - обрабатывающий центр

manufacturing technology - технология производства

numerical control - числовое программное управление

Exercises.

I. Look through the text and find equivalents for:

технология производства; все возрастающая; любая система; в качестве ввода, команды, управляющие машиной;; данного (определенного) станка; станок с числовым программным управлением; в пределах своих возможностей; производительность труда; новые достижения приводят к значительным изменениям; отдельные операции резания; обычные станки; за одну наладку; до сих пор; три этапа развития.

the verb in brackets into the form of Participle I or Participle II and translate the sentences.

1. When (to introduce) numerical control started a revolution in manufacturing technology. 2. Although highly (to train) an operator is unable to perform the operations more precisely than an NC-programmed machine tool. 3. While (to accept) a symbolic numerical value as an input the system provides numerical control. 4. When (to wear) one of the machine parts should be removed and replaced by a new one. 5. Though (to change) the machine tools the new method of controlling has not changed individual metal cutting operations. 6. (to influence) directly by NC conventional machine tools were redesigned. 7. While (to combine) several operations NC-programmed machine tools provide great savings in setup time.

### III. Read the text and make up a summary.

If we are to maintain a steady, continuous stream of parts into and out of automatic machines, we must be sure that there is always a fresh part ready when the machine needs it, and that the completed part is taken out of the way and moved to the next machine. The answer lies in the automatic conveyor.

Depending upon the size, shape, and weight of the parts to be handled, the conveyor may be an overhead chain with hooks<sup>1</sup> to carry the work, an under-floor chain to drag the work on small wheeled cars or a series of rollers along which the work can travel by gravity or be propelled by turning the rollers by power. Sometimes combinations of two or more of these methods may be employed, together with automatic elevators to raise or lower the work, as needed. The conveyor may start and stop at timed intervals, as on an automatic assembly line, giving each operator a certain period of time to perform his particular task; or it may run continuously to carry the work from place to place.

In a fully conveyORIZED factory it is quite possible for work to progress from raw stack to finished part without ever being touched by hand. Under such conditions, the question naturally arises as to what happens if a machine breaks down and interrupts the flow of material from one machine to the next. The answer is found in a system of "banks" or by the use of stand-by machines.