

Министерство высшего и среднего специального образования СССР

Московское ордена Ленина, ордена Октябрьской Революции  
и ордена Трудового Красного Знамени  
высшее техническое училище им. Н. Э. Баумана

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**Л. М. СТЕПАНОВА**

**МЕТОДИЧЕСКИЕ УКАЗАНИЯ  
ПО ОБУЧЕНИЮ ЧТЕНИЮ ТЕХНИЧЕСКИХ ТЕКСТОВ  
НА АНГЛИЙСКОМ ЯЗЫКЕ  
ПО СПЕЦИАЛЬНОСТИ АМ-123**

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Утверждены  
редсоветом МВТУ

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involves the material being cut, the tool, the mechanical device and the cutting fluid. 5. A certain cutting fluid should be used and the mechanical equipment for the particular process involved should be chosen properly. 6. There are several factors involved in the machining operation which are closely associated with both the tool and the work.

§ I.

Exercise 1. Translate the noun groups according to the model:

axis - ось; rotation - вращение; workpiece, work, piece - обрабатываемое изделие (деталь, заготовка)

workpiece rotation axis - ось вращения заготовки

cutting - резание; cutter - фреза, резец

metal cutting operation; cutter rotation axis;

feed - подача; feed direction; feed mechanism;

lathe - токарный станок; lathe centre; lathe operation;

removal - снятие, срезание; metal removal; material removal;

stock - материал; stock removal process;

speed, velocity, rate - скорость, stock removal velocity;

tool feed rate; return velocity;

surface - поверхность; finish - чистота (обработанной поверхности), отделка; surface finish; (но принят термин "шероховатость")

tool geometry; tool material; workpiece material; machining operation; machine tool operation; machine tool control (control - управление).

Exercise 2. Fill in the missing forms according to the pattern.

Learn the terms.

to cut - резать; cutting - резание

metal cutting operations

to turn - ...	...	- точение, обточка
to bore - ...	...	- растачивание
to mill - ...	...	- фрезерование
to drill - ...	...	- сверление
to ream - ...	...	- развертывание
to shape - ...	...	- строгание (поперечное)
to slot - ...	...	- долбление
to plane - ...	...	- строгание (продольное)
to grind - ...	...	- шлифование

to lap - ...	...	- доводка
to machine - ...	...	- обработка резанием
to finish - ...	...	- окончательная (чистовая) обработка
to rough - ...	...	- черновая обработка

**Exercise 3.** Translate the following sentences with absolute Participle Constructions.

( to feed, fed, fed - подавать; to rotate, to revolve - вращать(ся); to fix - фиксировать, закреплять; to generate a circular hole - образовать круглое отверстие)

1. In drilling a rotating cutting tool is fed into a fixed workpiece, a circular hole being generated in it. 2. The cutting speed increased sufficiently, the ideal surface finish may be achieved. 3. Tool materials having been improved, the cutting speed of machine tools <sup>has</sup> increased considerably. 4. In shaping operations the tool cuts on the forward stroke only, the workpiece being fed transversely at the end of each stroke. 5. Drilling being a roughing operation, and not a finishing one, the surface finish is generally not of great importance. 6. Drilling is a stock removal process for producing holes in components, with a revolving cutting tool fed into a fixed workpiece. 7. Slotting being similar to shaping, operators frequently call it vertical shaping.

**Exercise 4.** Translate the following nouns and give the corresponding a) verbs: knowledge, operation, removal, production, cutting, cutter, rotation, revolution, action, feed, relation, discussion;

b) adjectives: thickness, circle, periphery, similarity.

**Exercise 5.** a) Look through the text (5min.) and say what operations are described here.

b) Translate the text:

#### BASIC METAL-CUTTING OPERATIONS

Modern manufacture knows quite a number of metal-cutting operations, the basic of them being turning, boring, milling, drilling, shaping, slotting, planing, as well as some abrasive operations and a series of modern machining processes. Turning is the metal-cutting operation that generates an exterior surface, circular in its cross section, on workpieces that rotate about

an axis, the operation being performed with a single-point tool. In turning operations the tool travels parallel to the axis of the revolving workpiece. The tool feed rate is usually very much slower than the workpiece surface speed. The operation that generates an interior surface is called "boring"; that is, boring is internal turning. Either the workpiece or the cutting tool may rotate about an axis to enlarge and size a hole that was originated previously by drilling or some other operation.

Turning and boring operations in which the workpiece rotates about an axis are performed on the lathe and on the boring and turning machine. Boring operations in which the cutting tool rotates about the axis are performed on the horizontal boring, drilling, and milling machine. As to surface finish, generally it appears that the ideal surface finish may be achieved when the cutting speed is increased sufficiently - unfortunately this condition may not always be obtained in practice. The milling operation is a stock removal process using a tool with one or more teeth rotating about a fixed axis, each tooth removing material from workpiece fed past the tool. Milling is therefore an intermittent cutting process, each tool producing a chip of variable thickness. Milling operations may be classified into two types: peripheral milling and face (or end) milling.

In peripheral milling, cutting occurs on the teeth at the periphery of the cutter, the generated surface being a plane parallel to the cutter axis. In face milling, cutting is performed by the edges on the periphery and the face (or end) of the cutter as well. The surface of the work generated is usually at right angles to the cutter rotation axis.

A number of other cutting processes can be directly related to those discussed above. The cutting action of shaping, slitting and planing, for example, are very similar to turning.

Exercise 6. Find all the absolute participle constructions in the text (5)

Exercise 7. Look through the text and find the equivalents for:

цельный ряд (2), скорость подачи инструмента, то есть, что касается, обычно (2), в комплексе, на практике, процесс обработки резанием (2), вращающийся (2), относительно неподвижной оси, перно-

дический процесс резания, стружка изменяющейся толщиной, под прямым углом к..., внутренний (2), скорость (2), действие (2), поверхность (?), обрабатываемая деталь (2), срезать стружку (материал) (2).

Exercise 8. Make up a plan to the text.

Exercise 9. a) Translate the text:

The cut at right angles to the axis of the work (the cross-feed operation) is known as facing. In other words, the lathe operation of finishing the ends of the work, to make the ends flat and smooth and to make the piece the required length is called facing.

The work may be held either on centers or in a chuck. An advantage of holding the work in a chuck lies in the fact that the work does not have to be centered before facing. To generate a flat surface when facing on centers, the lathe centers must be in line and the work should be adjusted between the centres carefully.

b) Put a heading to the text.

c) Compare this process with turning.

d) Compare the two ways of holding the work.

Exercise 10. A text for written translation (time limit 25min.)

In shaping and slotting the tool moves over the workpiece, cutting on the forward stroke only. The workpiece is fed transversely at the end of each stroke. The tool may be driven either by a quick-return mechanism or by a hydraulic ram. In both cases the return velocity is made as high as possible to reduce the overall cutting time. The geometry of the tools used and the cut taken are comparable to turning, although the values of the angles and feeds and speeds are not necessarily the same. The surface finish is known to depend on the tool geometry and cutting conditions as discussed for turning.

Exercise 11. a) translate without a dictionary (time limit 10 min)., b) what can you say about drilling?

Drilling is a metal removal process for producing holes in components. The process involves feeding a revolving cutting tool along its rotation axis into a fixed workpiece. A circular

hole is therefore generated in the workpiece. The feed velocity (or feed rate) is usually small compared to the peripheral tool velocity. The surface finish in drilling is generally not of great importance, since it is usually a roughing operation. If a good finish or high accuracy is required, drilling is followed by some other operation such as reaming.

Exercise I2. Translate the text without using a dictionary (12min.) ( to fail - выйти из строя, cutting fluid - смазочно-охлаждающая жидкость).

To remove a given amount of metal the cutting tool is efficient only when operated at the proper depth of cut and the proper speed and feed. Therefore, the right speed, feed and depth of cut is of extreme importance.

The cutting speed of a milling cutter is the rate at which the chip is cut, i.e. the speed of the cutting edge of a tooth as it cuts off its chip. It is known that cutting involves friction between the cutter and the work, and friction, in its turn, generates heat. When a cutter is overheated, it may fail.

Consequently, the kind of material the cutter is made of is very important in determining the cutting speed. Some other factors besides those mentioned influence the cutting speed of milling cutters. They are: A) the amount of material to be removed, B) the cutting fluid used, C) the relation of depth of cut and feed, and D) the surface finish desired.

In many milling machines the feed mechanism is independent of the number of revolutions of the cutter. However the problem of proper milling machine feeds offers one of the most interesting and at the same time one of the least understood questions in machine tool operation. A great number of factors being involved, one can mention only some of them, e.g. the amount of metal to be removed, the surface finish desired, the diameter of the cutter, the number of teeth in the cutter, the way in which the work is held, etc.

Put a heading to a) each paragraph, b) the whole text;

Make up an abstract.

Exercise I3. Speak on a) turning, b) boring, c) milling, etc..

На уроке ?!

§ 2.

Exercise 1. Translate the following sentences where the Infinitive is used as an Attribute.

(to grind (ground, ground) - шлифовать; honing - хонингование)

1. The components to be ground on this machine are very complex. 2. The processes to be discussed in this text are divided into four groups. 3. It is necessary to choose the proper abrasive process to be used in this particular case. 4. The finishing operation to be performed on this kind of components has not yet been chosen. 5. The amount of metal to be removed by honing may vary in a wide range.

Exercise 2. Translate the text, try to remember the new words.

The abrasive processes<sup>es</sup> to be described in the text are grinding and honing. In grinding the grain (зерно, абразивный порошок) should be as hard and sharp (острый) as the edge of the tool in turning. Lapping (доводка) and superfinishing (сверхточная обработка) are abrasive processes as well. The latter gives the highest accuracy (точность), the most precise (точный) component dimensions (размер). Grinding is the most common (распространенный) abrasive process. The differences between conventional (обычный) cutting and grinding are considerable. As the grains wear (изнашиваться, истираться), they either fracture (трескаться) or go off the abrasive wheel (круг). The worn (wear - wore - worn) grains are not sharp enough. The chips produced are relatively (относительно) long. Finishing operations give fine (тонкий) surface texture (структура).

Exercise 3. Give the corresponding a) adjectives to the nouns: accuracy, importance, difference, precision, relation, convention, consideration. b) nouns to the verbs: apply, vary, produce, utilize, operate, achieve, improve, remove, wear, finish, machine, fracture. c) synonyms to the words: various, precise, common, utilize, manufacture, act, removal, part.

Exercise 4. Translate the text.

**ABRASIVE PROCESSES**

The use of abrasive stones to sharpen tools dates back to the early days of mankind. Abrasive processes are metal cutting operations involving hard and sharp abrasive grains used as cutting

tools. Since these processes give fine surface textures, precise component dimensions and low stock removal rates, they are often considered to be finishing operations.

The abrasive processes in common use are : (I) Grinding, (II) Honing, (III) Lapping, (IV) Superfinishing, listed in order of improved finish. The major difference between these processes is in the relative importance of stock removal, surface finish produced and accuracy achieved. In general, grinding gives the greatest stock removal and the worst surface finish.

Grinding is the best known and most common abrasive process. The abrasives are bonded in the form of wheels. For accurate work, specially designed grinding machines are used. While it is known that grinding removes metal by cutting as do single-point tools, the differences between conventional cutting and grinding are considerable. An important difference is that grinding is a self-sharpening process. As the grains wear during cutting they either fracture or are torn off the wheel bond, exposing new and sharp cutting edges. Grinding has found an important place in manufacture and its application is constantly increasing.

Honing also utilizes bonded abrasives for stock removal and for producing the desired surface finish. Honing may be used after turning, boring and other single-point tool operations. Since honing usually produces a better surface finish than that readily obtained by grinding, the process is not only used for stock removal purposes. The metal to be removed by honing varies in a wide range. Honing is more limited in application, although it is similar to grinding in the way abrasives are used to machine the workpiece, i.e. cutting occurs in the same way as in grinding and other operations. In contrast to grinding the chips produced in honing are relatively long, since the grains are in contact with the work for a major portion of the machine stroke. The stock removal rate, surface finish and cutting forces are considered to depend on the cut depth, the cutting velocity, the abrasive and workpiece properties. The conditions to be used in this process may vary in a wide range.

Exercise 5. Make up a plan to the text.

Exercise 6. Look through the text and find the equivalents

for: для заточки инструмента; обычно применяемые процессы; самый распространенный шлифовальный процесс, обычно используемые процессы р зчия; процесс самозаточки; по мере того как зерна истираются; связанные абразивные материалы; заданная (требуемая) шероховатость ; может сильно меняться (меняется в широком диапазоне); оно схоже с шлифованием в том, как (каким путем); происходит таким же путем (образом); в противоположность шлифованию.

Exercise 7. Look through the text and find a) the sentences (2) where the Infinitive is used as an attribute; b) different cases where Participle II is used as an Attribute (II).

Exercise 8. a) Look through the text (5 min.). What information did you obtain? Put a heading to the text.  
b) Translate the text.

Perfect surface finish is often demanded in industrial production as well as dimensional accuracy. At the same time, manufacturers are faced with a conflicting problem which should be overcome - the problem of manufacturing cost. Lapping offers the best accuracy of all the machining methods, and needs delicate handling because the result is much affected by the selection of lapping conditions. If the set of lapping conditions is properly determined perfect surface finish can be achieved.

Lapping is an abrasive process for producing components with surface finishes and dimensional accuracies superior to those readily obtained by grinding or honing. Lapping usually follows other abrasive processes and its economic success generally depends on the prior operations. Components to be lapped are usually left about .0005 in. oversize.

Lapping may be done manually or on specially designed power-driven machines. In both cases lap wear should be small, or at least uniform so that the lap maintains its form. The workpiece wear (stock removal) should be as high and as uniform as possible to achieve the desired size and shape, and the surface finish required, quickly and accurately. Uniform wear and stock removal will occur when all points on the surfaces are subjected to the same treatment, i.e., same velocity, distance traveled, pressure, etc. A number of machines have been designed for lapping flat and cylindrical components as well as more complex

shapes. High-quality lapped surfaces are used on gauges. In addition, the tool life of cutting tools is increased by lapping the tool faces.

c) Discuss the heading you put before.

Exercise 9. a) Look through the text (3min.) and say what information you could obtain.

Grinding has always been recognised as the metal removal process requiring the highest level of skill. It is only natural, as by the time a component reaches the grinding stage most other operations have been completed and the component already carries substantial added value. For this reason, among others, the human skill element has always been critical and the technology has therefore been slow to adopt the levels of automation long ago used on modern lathes and machining centres, for example.

This situation has changed fundamentally in the recent years following the arrival of computer numerical control (CNC). But the automation of grinding should go much further than simply the machine cycle (the control of the contact between the wheel and the work). At present, grinding is expected to be able to integrate into complete manufacturing systems. One can hope that the machines will be able to run (to operate) for long periods in an unmanned mode. As a result, other functions have to be automated, including work load/unload tasks and wheel changing. As to internal grinding, for example, internal grinding wheels are relatively small in diameter and therefore have shorter working lives than those used for external grinding. Thus, fresh wheels may have to be used several times during an unmanned shift. Nevertheless, wheel changing does not exclude automatic compensation for wear on the wheel to be applied continuously by means of CNC.

b) Translate the text (45 min. for written translation)

c) Make up an abstract.

Exercise 10. a) Look through the text (1a.) . What information could you obtain?

b) Translate without using a dictionary.

Fine grinding can achieve the surface finish values readily obtained by honing, or even lapping, but this may not be economical. These processes have been developed for specific requi-

rements so that the surface finish value is not the only criterion for comparison - the nature of the surface texture may also dictate which process is the most suitable for the particular job. Further comparisons of the above processes show that the abrasive size, cut dimensions, cutting velocities and pressures generally decrease from grinding to superfinishing.

Exercise II. a) Look through the text and say what information you could obtain (2 min.).

b) Translate without using the dictionary (gundrill -  
- пучечное сверло, close tolerance - допуск в узких пределах)

Gundrilling got its name from its first application, the drilling of rifle barrels. But more and more manufacturers are discovering that it is one of the quickest and most economical methods of drilling holes of almost any depth to extremely close tolerances and fine surface finishes, i.e. of extremely high quality. The gundrill looks and functions like a combination drill and reamer, drilling and sizing the hole in one pass.

Precision drilling requires a machine built to extremely close tolerances. That is why some manufacturers have turned to grinding with a diamond wheel in the production of the newest gundrill machine. Before trying a diamond wheel it was impossible to meet the parallelism tolerance of .0002 in. per ft. The diamond used is designed specially for grinding iron and steel. Since the surfaces are first milled, the stock removed by grinding is no more than .006 in.

Exercise I2. Sum up the information you got on a) grinding, b) honing, c) lapping.

§3 Exercise I. a) Translate some words and group of words which you will find in the text: cutting tool, to remove the metal, surface - a finished surface - to generate finished surfaces; single-point tool, multiple-point tool; to move - motion, relation - relative, relative motion.

b) Translate the text without using a dictionary.  
c) Put a heading to the text.

The cutting tool is the part of the machine which removes the metal. Some machine tools generate finished surfaces on workpieces with single-point tools, and others form them with multi-

edged tools. The former are used for turning and planing operations, while the latter are mainly used for drilling, milling and grinding operations. The speed and accuracy of the operation are generally limited by the cutting tools used. With single-point tools, accuracy of shape is generated by the relative motions of the workpieces and cutting tools, while in the second case, it depends on the accuracy of the shape of the cutting edges.

Exercise 2. Translate the text, try to remember the new words as you will find them in the following texts.

Tool life (стойкость инструмента) is a term which is in common use in metal cutting. Tool life means (to mean - meant - meant - значить, означать) the useful life (срок службы, долговечность) of a tool expressed (выражать) in time (or volume of material removed) from the start of a cut to some end-point defined (определять) by a failure (выход из строя) criterion, i.e. before a cutting tool becomes worn out or fractures. Generally, at a high cutting speed tool life is considered to be extremely short. As the cutting speed decreases tool life tends (иметь тенденцию) to increase. Industry generally operates at cutting speeds providing long tool life.

Exercise 3. Translate without using a dictionary trying to guess the meaning of the underlined words.

The tool was extremely sharp but now it has failed. It no longer cuts properly it cannot be used for the particular conditions therefore it should be resharpened.

Extremely high temperatures may cause complete failure of the tool. Complete failure is generally caused by shock loads.

Exercise 4. a) Look through the text (3min.). What problem is discussed in the text?

b) Translate the text.

The cutting tool is expected to perform its function as long as possible under the particular cutting conditions, if machining is to be economical. A tool that no longer performs the desired function is said to have failed and hence reached the end of its useful life. At such an endpoint the tool is not

necessarily unable to cut the workpiece but is only unsatisfactory for the purpose required. The tool may therefore be re-sharpened and used again, it may be used on less restrictive machining operations, or it may be scrapped. *бесполезно?*

Tool life can be readily expressed in physical quantities and hence appears to be a simple concept, yet it is actually based on some definition of tool failure. A tool fails when it no longer performs its function, so the failure criterion will depend on the requirements of the component being produced. For instance, in a roughing operation surface finish and dimensional accuracy will be of little importance while excessive rise in cutting forces and power requirements may be taken as the failure criterion. In finishing operations, however, the surface finish and dimensional accuracy will be of major importance and the tool will fail when the particular conditions can no longer be achieved. All these failures are mainly related to the wear on the edges of a tool.

However, complete failure is known to be usually prevented, because of the possible damage to the component and the total loss of the cutting tool. It is often convenient to remove the tool from service just prior to complete failure. Complete failure (or total destruction) may be caused by high cutting forces or shock loads which produce a fracture. In some cases the cutting edge may be chipped, or fine cracks may develop close to the cutting edge due to mechanical and thermal shock loads. This failure may result in rapid total destruction of the tool.

- c) Put a heading to the text;
- d) Make up a plan;
- e) Make up an abstract.

Exercise 5. Look through the text and find the equivalents for: как можно дольше, при данных особых условиях резания, больше не выполняет требуемых функций, не обязательно не способен резать, может быть поэтому подвергнут перезаточке, операции обработки с менее жесткими требованиями, как раз перед полным выходом из строя, рядом с режущей кромкой, из-за возможного повреждения детали.

Exercise 6. Give the corresponding nouns to the verbs and translate them: to cut, to machine, to fail, to require, to shar-

pen, to express, to define, to depend, to produce, to achieve, to relate, to lose, to remove, to serve, to develop, to result, to force, to cause.

Exercise 7. a) Look through the text (2m.) and say what information you have obtained; b) Make a written translation.

All cutting tools are known to be provided with a cutting edge (or edges) which is the most important part for several reasons. In the first place, it is, strictly speaking, the only portion of the tool that actually cuts. The rest of the tool bit serves as a support for the cutting edge, carries away the heat generated by the cutting action, and aids in the removal of the chip. Thus the cutting efficiency of any tool depends, to a great extent, upon the proper design and location of the cutting edge or edges. A large side cutting-edge angle or a large nose radius, for instance, will give a long tool life. Both in combination, however, will tend to cause chatter, vibration in the workpiece, cutting tool, and machine tool that accelerates wear on the cutting tool and produces a poor finish on the workpiece.

The action of a cutting tool depends mainly on the rigidity of the work, the rigidity of the tool, and the shape of the cutting tool. Thus, cutting tools must combine sufficient strength to maintain a sharp cutting edge, sufficient wear resistance to prevent wearing of the cutting edge, sufficient toughness to prevent chipping of the cutting edge and sufficient hardness to prevent picking up of the chips.

Exercise 8. a) Some hints to make the text easier for understanding:

1. Machinability means the ability to be machined, while to be machined, in turn, means to be cut by means of some cutting tool. 2. Since this text is rather difficult you are given some help. 3. In order to translate the text properly one should understand all the terms. 4. From the point of view of physics it is not easy to explain this phenomenon. 5. As to machinability, it is not easy to give a definition of this term. 6. In roughing operations, for instance, the failure criterion may be expressed in terms of cutting forces and power requirements. The higher the cutting forces, the sooner will the tool fail.

b) Translate the text paying special attention to the underlined words and groups. (—)

### MACHINABILITY.

Machinability is a term that is often used and seldom fully explained. It has been suggested that the word was first used in the 1920's relating speed and tool-life. It was thought machinability was a property of the work material which, in turn, depended on other physical properties, such as the hardness. But a simple and accurate definition of this property has not appeared, and a unit of machinability is not available. It is generally accepted that a material has good machinability if the tool wear is low or tool life is long, the surface finish produced is good and the cutting forces are low. In addition, ease of chip removal and good dimensional accuracy are also considered important. Since these parameters for defining machinability depend on a number of factors such as tool material and geometry, cutting conditions, and so on, it is not surprising that machinability is a difficult concept.

While machinability is known to consist of a number of differing requirements, it is common to express it in terms of the cutting speed for a given tool life in minutes.

In order to compare materials, a common material is taken as a reference or standard. Clearly, a material with a high cutting speed for a 60-minute tool life will be considered to have a high machinability, which is desirable. The higher the relative machinability, the easier is the material to machine from the point of view of tool wear and tool life. Thus the problems and difficulties associated with tool life also apply to machinability. As to metal machining efficiency, the most important parameters influencing it are tool life, forces and power requirements, surface finish, etc.. These are of greatest importance since they relate the machining parameters of a cutting tool to the work material for the particular operation.

Exercise 9. Translate the text putting in a proper link-word(s).

(as to, from the point of view of, in addition, in order to, in terms of, in turn, since, thus, while).

... aerospace components, all types of machining operations

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are employed for their production, ... for the manufacture of gas turbine engines, turning and drilling are of major importance. In airplane production ... face milling and drilling are among the most important machining operations. However, ... cost some materials, e.g. titanium, are not suitable for machining, ... often machining results in as much as 50 to 90 percent loss in chips expressed ... weight. ... low heat conductivity of some materials may increase the temperature at the tool-workpiece interface and this ... results in shorter tool life. ... extremely high temperatures result in higher cost as well. ... some types of machining such materials as titanium often result in considerable stock removal and extremely high temperatures it was necessary to look for new ways. ... lower the cost of machining such materials as titanium new techniques have been developed.

Exercise IO. Translate the sentences paying special attention to the underlined noun-groups:

1. The initial and final size of the chip thickness depends on the width of the work with respect to the cutter diameter. The chip thickness variation will also depend on whether the cutter axis is symmetrically situated on the workpiece. The conventional methods of studying the chip formation mechanics are particularly difficult.

2. The effect of tool wear was also studied by other research workers who showed a new type of surface finish-time curve. The surface finish will depend on the tool bit radius, which is subject to considerable wear and hence may change the surface finish values. However, surface finish equations may be used to decide what variables should be changed to improve the surface finish and to estimate these values.

Exerc.IIa) Look through the text (Ia.) and say what information you have obtained.

b) Translate without using a dictionary.(numerical control (NC) - числовое программное управление (ЧПУ)

There are advantages in the use of numerical control that aid in producing a result of higher quality which in some cases cannot be achieved by any other means. In addition, it is known that there are many cases where accuracy is desired at almost any cost. Numerically controlled equipment makes it possible to achieve extremely high quality, i.e. extremely high accuracies with

very close tolerances in some cases where manual methods are limited because of operator's insufficient reaction speed.

c) Discuss the advantages of NC equipment.

Exercise 12. a) Look through the text and say what information you have obtained.

b) Translate without using a dictionary.

There are two aspects of the machining process which determine the surface finish or surface roughness. The former is the geometric roughness generally determined by the shape of the cutting tool and the feed per revolution or feed per tooth; the latter being the actual roughness. The surface finish in the latter case is generally poorer because of the built-up edge generated by the tool during the chip formation process. Vibration or chatter during the machining process, in turn, may result in still poorer surface finish.

c) Discuss the problem of surface finish.

Exercise 13. Translate the text without using a dictionary.

As to some types of milling, the relative motion between the cutter and the work is a little more complex than would appear at first sight, since the cutter centre moves relative to the work at the same time that it is revolving, and the surface generated by the cutter will obviously depend on the amount of this relative motion. In general, the surface generated is a series of waves, the size of the wave depending on the rotation of cutter and travel of the table.

Exercise 14. Sum up the information you have obtained on tools.

#### Additional texts for translation

##### New Methods Needed

With numerical-control systems the dimensions of the work-piece are determined by numerical information fed to the machine together with the required process information, the position of the moving parts of the machine tool being measured continuously by suitable transducers.

At the same time there is an increasing trend towards the wider use of materials which are tougher and harder than the conventional mild steels and non-ferrous alloys, and which retain their

hardness and toughness at high temperatures. All conventional metal - cutting, grinding, forming, forging, etc. processes rely essentially on plastic deformation of the workpiece material caused by pressure against a harder tool. The harder the workpiece material, the more difficult it becomes to find tools that will behave satisfactorily. These new materials are therefore difficult to machine by conventional methods and it is not possible to cut them at the rates which were possible with the materials that they have replaced. Machining by conventional methods is much slower with harder materials and the high rate of tool wear limits its application.

The search has begun, therefore, for new methods of machining, and particularly for methods that are independent of the hardness or toughness of the workpiece material.

The newer methods of machining that are now being developed avoid this difficulty by relying on quite different processes for shaping the workpiece. Two main processes are involved - chemical processes, in which the material of the workpiece is removed atom by atom by chemical action and thermal processes in which material of the workpiece is melted and vaporised. The main forms in which thermal methods of machining are practised are: plasma torch, electroerosion, electron beams, lasers.

#### NEW MACHINING PROCESSES

The art of removing material by mechanically forcing a cutting edge through a component has been known and used for several thousand years. Quite recently a number of entirely new machining processes have been developed, such as ultrasonic machining, thermal metal removal (electrical discharge machining, machining with electron beams, machining with lasers), electrochemical metal removal. While these have not yet shown signs of displacing conventional machining for most operations, they have superseded it in several specialized applications<sup>1)</sup>.

Although the analysis of the newer machining processes is far from complete, they are being studied by research workers in all parts of the world, and the processes themselves are steadily becoming more efficient. It is almost certain that the industrial use of most, if not all, of the processes will grow in the years to come. This is the general trend.

As to ultrasonic machining, the process is sometimes called ultrasonic grinding. In ultrasonic machining, material is removed under the action of abrasive grains which are driven into the work surface by a tool oscillating normal to the surface at high frequency.

The tool, made of relatively soft material, is oscillated at frequencies between 20,000 and 30,000 cycles per second with an amplitude of about 0.001 in. It is pressed into the workpiece with a load of a few pounds and feeds down as a hole is cut in the work. The tool is shaped to produce a desired hole shape.

Several different types of abrasive have been used for ultrasonic machining. The commonly used abrasives are aluminium oxide, silicon carbide, boron carbide and, somewhat less commonly, diamond dust. The size of abrasive varies between 200 and 2000 grit. Coarse grades are used for roughing, while finer grades (say 600 grit) are used for finishing. The extremely fine grades (1000 to 2000) are only used for a final pass on work of extreme accuracy.

Metal removal by means of an electrical discharge dates back only to the early 1940's, but since that time it has made remarkable strides and is now in common use. Mysterious as it at first appears<sup>2)</sup>, the process is actually not complicated. What happens is that a series of electrical discharges take place between the work and the tool, or electrode, which is formed to the desired shape of the hole. The rate of discharge may vary between 20,000 and several million per second. At each discharge,

minute areas of the work surface becomes so hot that particles of the metal are vaporized and washed away by the coolant.

The process can be applied to cutting the hardest metals and drilling holes in particular. But perhaps its most useful field lies in making dies from hardened steel, thus avoiding the danger of the finished die cracking or distorting during the hardening process.

Notes:

- 1) ... In several specialized applications - в некоторых специальных областях применения
- 2) ... mysterious as it at first appears ... - хотя с первого взгляда все это представляется загадочным...

214547  
ULTRASONIC MACHINING

Ultrasonic vibration that is, vibration at a rate beyond the rate of perception of the human ear, was first applied to metalworking in the early 1950's. Among the first uses was the cleaning of small precision parts, as miniature ball bearings for aircraft instruments, which would be useless unless perfectly clean.

The vibration is obtained by a piezoelectric crystal, that is, a crystal, such as quartz, which has the property of changing its physical dimensions when an electric current is passed through it. If a current of sufficiently high frequency is employed, the crystal will vibrate at ultrasonic speed, and its vibrations can be transmitted mechanically to other objects. The vibratory unit is called a transducer. *hpeodpafobretels*

Perhaps the most interesting application of ultrasonics, however, is the cutting and engraving of hard materials, such as glass, precious stones, and carbides. A tool of the required size and form is made of brass or other soft material and attached to the transducer. The tool is lowered until it just barely touches the work, and current is applied. At the same time, a flow of water and fine abrasive, usually boron carbide, is pumped over the work. The tool does not actually touch the work, but the vibrations literally hammer the particles of abrasive into the surface and chip off tiny fragments. Some wear does take place in the tool, but it is very slight and, as it is equally distributed, it does not change the shape. The method is quite commonly applied to cutting intricately shaped holes in carbide or hardened steel.

Machining with Lasers *MONS*

A laser (light amplification by stimulated electron radiation) is a very highly concentrated beam of light - it can form a spot less than 0.0001 in. diameter. This beam of light has a very high energy density (of the order of  $10^3 \text{ kw/cm}^2$ ) which can cut metal in a similar way to the electron beam. It has the great advantage over the electron beam, of relatively low energy loss in air, so there is no need to place the component in a vacuum.

The tremendous amount of research work being devoted to the development of lasers for a wide variety of purposes seems likely to result in powerful systems for machining.

Laser could be expected to be the tool of the future, as the process of cutting, welding, etc. is usually carried out quickly, with low distortion and minimal loss of material. In addition, laser produces a product which requires little or no further machining or cleaning and it is a process easily incorporated into automated systems. For instance, the combination of a carbon dioxide laser as a cutting source, together with a precision machine tool, allows highly accurate and fast cutting of a wide variety of manufactured components from steel to plastic and inorganic materials. The laser cutting source is linked to a computer numerical control (CNC) system which provides fast, highly accurate machining of components. So accurate is the finish (surface finish) and quality that little or no further processing is required. Laser cutting is a unique thermal process which has the least effect on the material being processed. The laser concentration is so intensively localised that cutting can be achieved on products without any surface diffusion adjacent to the cut. The contact free transfer of energy permits high quality cutting of hard, brittle or soft materials without the need for refinishing or further treatment.

#### Acid Electrolytic Polishing (VI) KP

For many years the process of electrolysis has been used for polishing of metal surface. The material to be polished is made the anode and is immersed in an electrolyte, and a cathode is provided to complete the electric circuit. For some years the process was used mainly for preparation of metallurgical specimens. Since the Second World War, it has come into reasonably wide use for industrial polishing of components.

To produce a good surface finish, careful selection of the electrolyte, the current density and the operating temperature is very important. The mechanism involved in electrolytic polishing shows that the process is dependent on the formation of a thin viscous layer at the surface of the workpiece. The layer tends to make recesses in the surface and cause selective attack on the high spots. Thus, the surface is gradually made smoother.

Electropolishing removes fine surface scratches and gives very high surface finish values with surfaces initially prepared

by grinding. The process is very useful for small components and parts containing recesses which cannot be satisfactorily polished by other means.

The selection of electrolyte depends on the material to be polished. The current densities vary between 0.01 and 7 amps/cm<sup>2</sup> at voltages between 1 and 200. The temperature is in the range of 40 to 200°F. Polishing time seldom exceeds 15 minutes and is often a matter of seconds.

*max*

### Electrochemical Machining

V2

Electrochemical machining uses the same electrochemical principles as in electropolishing but the component (anode) is placed very close to the cathode. Because of this, the rate of material removal from the workpiece can be high and the workpiece can be shaped by the cathode (or tool, as it is usually called).

There are two basic subgroups of electrochemical machining. One, known as electrochemical or electrolytic grinding, uses a metal-bonded diamond or aluminum oxide grinding wheel as the cathode. Material removal takes place both by electrolytic action and by mechanical grinding. The other process, called simply electrochemical machining or electrochemical milling, uses a shaped metal cathode which is fed into the workpiece to produce a desired cavity shape. In electrolytic grinding the workpiece is separated from the metal wheel by the abrasive particles. The electrolyte is fed into the gap between work and wheel as a continuous flow. Nonmetallic elements and reaction products are removed by the mechanical action of the abrasive grains. 75 amps or less is the usual current for electrolytic grinding.

## ACTIVE VOCABULARY

A	abrasive	- абразивный; абразивный порошок
	accelerate	- ускорять
	accept	- принимать
	accuracy	✓ точность; accurate - точный
	action	- действие
	actually	- фактически
	aid	- помогать; помощь
	amount	- количество
	angle	- угол; at right a. - под прямым углом
	application	- применение
	approach	- подход (к проблеме)
	axis (axes)	- ось (оси)
B	beam	- луч
	bit	- вставной резец
	bond -	- связь, связующее вещество
	boring	- расточка; bore - растачивать
C	case	- случай
	cause	- быть причиной, вызывать
	center	- центр, центровое отверстие; центрировать, устанавливать между центрами.
	chatter	- дрожание, вибрация
	chip	- стружка; выкраивать, выламывать; chipping - выкраивание
	chuck	- патрон
	circle	- круг; circular - круглая
	close (to)	- близко (к)
	common	- широко распространенный, общепринятый, обычный
	complex	- сложный
	component	- деталь
	condition	- условие
	considerable	- значительный
	control	- управление
	conventional	- общепринятый, традиционный, обычный
	crack	- трещина; треснуть
	cross-section	- поперечное сечение
	curve	- кривая (линия)
	cost	- стоимость

- cut - проход (режущего инструмента);  
 резать, обрабатывать режущим инстру-  
 ментом; cutter - фреза, cutting -  
 - резание
- D damage - повреждение, повредить  
 define - определить; definition - определение  
 demand - требовать  
 depend - зависеть  
 depth - глубина  
 desire - желать, требовать  
 destruction - разрушение  
 determine - определить  
 developments - достижения  
 diamond - алмаз  
 dimension - размер; dimensional - размерный  
 discharge - (эл.) разряд; electrical d.machining -  
 электроимпульсная обработка  
 drill - сверло, сверлить; drilling - сверление
- E easy (easier) - легкий  
 edge - режущая кромка; side cutting e. - вспо-  
 могательная режущая кромка  
 efficiency - производительность, к.п.д., effici-  
 ent - эффективный, производительный  
 enlarge - увеличить  
 equation - уравнение  
 example - пример; for example - например  
 excessive - избыточный  
 extent - степень; to a great extent - в значи-  
 тельной степени  
 exterior - внешний
- F face - торцовая поверхность; facing - обточка  
 торца  
 fail - выходить из строя, failure - выход из  
 строя, разрушение  
 feed - подача; cross feed - поперечная подача,  
 feed (fed, fed) - подавать (инструмент  
 или заготовку)

	fine	-	мелкий, тонкий
	finish	-	чистота обра- ботки; finishing - чистовая обработ- ка, доводка; surface finish - шерохова- тость
	fix	-	фиксировать, закреплять
	flat	-	плоский
	fluid	-	жидкость; раствор; газ; cutting f. - охлаждающая смесь
	force	-	сила
	fracture	-	разрыв, трещина; давать трещину
	frequency	-	частота
	friction	-	трение
G	gauge	-	измерительный прибор, датчик
	generally	-	обычно
	generate	-	получать (поверхность на детали) обработкой (на станке)
	grain	-	зерно, абразивный порошок
	grind (ground, ground)	-	шлифовать; grinding - шлифование, заточка
	gundrill	-	пушечное сверло; gundrilling - свер- ление ствола оружия
H	handling	-	манипулирование (установка, снятие, передвижение, обработка детали)
	hard	-	твердый, hardness - твердость
	heat	-	тепло
	hole	-	отверстие
	hone	-	хон; хонинговать; honing - хонинго- вание
I	improve	-	улучшить, усовершенствовать; improvement - улучшение
	increase	-	увеличение; увеличивать; increasingly - все более
	influence	-	влияние; влиять
	interior	-	внутренний
	intermittent	-	прерывистый
	internal	-	внутренний
	introduce	-	вводить, внедрять; introduction - введение, внедрение

- involve - включать (в себя), затрагивать, вм-  
зывать, повлечь за собой
- iron - железо, чугун
- L lap - притир; притирать, доводить;  
lapping - притирка, доводка
- lathe - токарный станок
- length - длина
- life - срок службы; tool life -  
стойкость инструмента
- load - груз; загружать, закладывать (заго-  
товку для обработки на станке)  
unload - снимать (обработанное изде-  
лие на станке)
- location - расположение, установка (детали на  
станке)
- long - длинный; no longer - больше не
- loss - потеря
- M machinability - обрабатываемость
- machine - станок; обрабатывать на станке;  
machine-tool - станок  
machining - механическая обработка,  
обработка резанием
- main - основной, главный; mainly - главным  
образом, в основном
- maintain - поддерживать, сохранять
- major - значительный, главный
- manually - вручную
- manufacture - производство; производить;  
manufacturer - предприниматель, проми-  
ленник, поставщик
- mill - фрезеровать; milling - фрезерование,  
face m. - торцевое фрезерование,  
peripheral m. - фрезерование плоскости  
параллельно оси фрезы
- motion - движение
- N nose - вершина резца
- O obtain - получать
- operate - работать, действовать; управлять

	operation	-	работа, действие
	oscillate	-	вибрировать
	overheat	-	перегреть
	oversize	-	больше максимального допус- каемого размера
P	particular	-	особый, именно данный
	pass	-	проход (резцом)
	perform	-	выполнять
	periphery	-	окружность; peripheral - окру- жный
	pick up	-	налипать
	piece	-	обрабатываемое изделие (заготовка, деталь)
	plane	-	плоскость
	plane -	-	строгать; planing - строгание (продольное)
	point	-	рабочий конец (резца)
	poor	-	плохой (по качеству)
	portion	-	часть
	precise	-	точный; precision - точность
	prevent	-	предотвратить, помешать
	property	-	свойство
	provide	-	обеспечить, снабжать
Q	quality	-	качество
R	range	-	круг, область; колебаться в определенных пределах
	recess	-	углубление, врезка
	rate	-	скорость, темп
	readily	-	легко
	ream	-	развертывать; reamer - развер- тка, reaming - развертывание
	reduce	-	уменьшать; reduction - уменьше- ние, понижение
	relate	-	иметь отношение, связь; relative - касающийся, связанный
	removal	-	снятие, удаление; stock r. - снятие стружки
	remove	-	удалять, снимать, срезать

require	-	требовать; requirement - требова- ние
resistance	↓	сопротивление; wear г. - износоус- тойчивость
result in...	-	привести (в результате) к...; result from - являться результа- том
revolution	-	оборот; вращение; revolve - враща- ться
rigidity	-	жесткость; rigid - жесткий
rise (rose, risen)	-	возрастать; повышение
rotate	-	вращать(ся), поворачивать(ся); rotation - вращение
rough	-	грубый, шероховатый; крупнозернис- тый (о шлифовальном круге); обра- батывать начерно, roughing - черно- вая обработка, roughness - шерохо- ватость
S		
scrap	-	неисправный брак; браковать, выб- расывать
serve	-	обслуживать; service - обслуживать; производить осмотр и текущий ре- монт; обслуживание, эксплуатация (машины)
shape	-	строгать (на шепинге); shaping - - строгание (поперечное)
sharp	-	острый; sharpen - затачивать; resharpen - перезатачивать (инстру- мент); self-sharpening - самозаточ- ка
shift	-	смена (рабочая)
shock	-	удар
similar	-	подобный
size	-	размер; доводить до точного раз- мера
skill	-	умение, квалификация
slot	-	долбить; slotting - долбление
slow	-	медленный

smooth	-	ровный, гладкий
speed	-	скорость; surface v. - окружная скорость, скорость резания
stock	-	материал
strength	-	прочность
sufficient	-	достаточный
superfinishing	-	суперфиниширование, сверхтонкая обработка
superior	=	более высокого качества
support	-	опора, подставка; поддерживать
surface	-	поверхность
T		
tend	-	иметь тенденцию
texture	-	структура
thick	-	толстый; thickness - толщина
tolerance	-	допуск
tool	-	инструмент; single point t. - однолезвийный инструмент; multipoint, multi(ple) - edged t. - многолезвийный инструмент
tooth (teeth)	-	зуб (зубья)
tough	-	вязкий; toughness - вязкость; жесткость, прочность
transducer	-	преобразователь, датчик
transverse	-	поперечный
turn	-	точить, обтачивать; вращаться; turning - точение, токарная обработка; отточка; turn out - выпускать (продукцию)
U		
ultrasonic	-	ультразвуковой
undergo	-	подвергаться; претерпевать
unfortunately	-	к сожалению
unit	-	единица; деталь, узел
unmanned (mode)	-	безлюдный (режим), работающий без обслуживающего персонала
useful	-	полезный; эффективный
utilize	-	использовать
V		
value	-	величина, значение; стоимость; ценность

vaporize	- испарять(ся)
vary	- меняться; variable - переменный; variety - разнообразие; various - различный, разнообразный
velocity	- скорость
W wear	- износ; изнашиваться, истираться
wheel	- круг (шлифовальный)
work	- обрабатываемая заготовка, деталь; обработка, обрабатывать
workpiece	- обработ. заготовка, деталь

#### SOME USEFUL COMBINATIONS

in addition	- кроме того
as to	- что касается
due to	- вследствие, из-за
either... or...	- или... или...
at least	- по крайней мере
by means of	- при помощи, посредством
a number of	- несколько, ряд
in order to	- для того чтобы
from the point of view	- с точки зрения
the rest of	- остальные
a series of	- несколько, ряд, серия
in terms of	- на основании, через
in turn	- в свою очередь