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МЕТОДИЧЕСКИЕ УКАЗАНИЯ  
ПО ОБУЧЕНИЮ ЧТЕНИЮ ТЕХНИЧЕСКОЙ ЛИТЕРАТУРЫ  
НА АНГЛИЙСКОМ ЯЗЫКЕ ПО СПЕЦИАЛЬНОСТИ АМ-3

IV к.

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§ 1.

Exercises

1. Compare the meaning of separate words and their combinations:

to bring - to bring about; to turn - to turn out; to look - to look for - to look up; to step - to step up; to mak - to make up; to keep - to keep pace with

2. Read the text: a) without using a dictionary; explain in Russian what the text is about; b) look up the words in the dictionary and translate the text.

AUTOMATION

Part I HISTORICAL BACKGROUND

After World War II new cutting materials, and new concepts of cutting speeds, had brought about a condition in which the machine was capable of turning out the work faster than a man could load and unload it. This meant that machines were not being used to their maximum capacity, and handling time was out of all proportion to machining time. What was needed was some completely automatic system of handling that could keep pace with the machine. Out of this need was born the modern concept of automation.

As to the term "automation", it is considered to denote the use of mechanical devices and mechanisms operated pneumatically, hydraulically or electrically in order to perform work which was earlier done manually.

One of the first applications of this kind was the handling of steel sheets into and out of large presses. The process continued until the final part was discharged to another conveyor without once being touched by the machine operators. Only one man was required to supervise the operation of the entire unit.

The advantages of this mechanized handling were so apparent that engineers began to look for other opportunities to apply the principle. Lathes, for example, offered a real challenge. If work could be brought to <sup>the</sup> machine, loaded, turned, and unloaded, tremendous savings would be possible. So, too, with millers, drills, broaches, grinders, and all the varied machines required for quantity production. Designers in many countries were devising loaders, feeders, and unloaders to convert stan-

standard machines for automatic operation. And machine tool builders were modifying machines so that the various devices could be readily attached.

Meanwhile, machine tool designers began work on completely new machines in which the automation devices were built-in as a part of the machine itself. Gone were the limiting factors of human operation; speeds and feeds could be stepped up to unheard-of rates; and the working areas could be completely enclosed.

3. What does the word "handling" mean in the text?
4. Find the above combinations (see ex.1) in the text.
5. Make up an abstract of the text.

## §2

### Exercises

1. Read and translate the following word groups  
to discharge - разгрузать, выгружать  
to charge, to load - to discharge, to unload;  
e.g. the discharge side of the machine; for loading automatically into the machine;  
scrap - металлический лом, отходы; браковать  
e.g. the workpiece will have to be scrapped or reworked  
fresh work - new work;  
e.g. they are not receiving fresh work  
means - способ, средство  
BUT: to mean - значить, означать  
DON'T MIX UP! e.g. This means that all the machines that handle the work...  
as long as - пока  
e.g. as long as work remains within accepted limits...;  
as soon as - как только  
e.g. but as soon as the piece begins to reach the limits...  
bank - бункер, накопитель

2. Read the text.

## AUTOMATION

### Part II

But now a new problem arose. With fully automatic operation, it was essential that parts leaving one machine be exactly the

right size for loading automatically into the next machine. But suppose the roughing tool wears very rapidly, or even breaks, and a part leaves the first machine with a wrong diameter.

To avoid this, an automatic gage<sup>1</sup> can be installed on the discharge side of the first machine to inspect the one or more dimensions involved. If the work passes this inspection, it can move on to the next machine; if it will not pass, the gage will hold the work, stop the machine, and signal the operator, who must then locate the cause of the trouble and make the necessary corrections to the tools.

Size control by this method is fairly simple and reasonably satisfactory, but it still leaves something to be desired. One workpiece, the one held by the gage, will have to be scrapped or reworked, and the machine has to be stopped while the tools are being adjusted. This means that all the machines that handle the work after this one must also stop, because they are not receiving fresh work; and preceding machines must also be stopped to prevent their piling up work that has no place to go, unless, as will be described later, suitable "banks" have been provided.

The next step, therefore, in automatic control, is to let the gage actually control the machine. As long as work remains within the accepted limits, the gage will pass it, but as soon as a piece begins to reach the limits the automatic correction mechanism goes into action to adjust the tool.

The gaging equipment may be operated by air, or may be electric or electronic.

<sup>1</sup> gage - the American spelling of the English "gauge".

3. What does the word "handle" mean in this text? Compare it with the meaning it had in the previous text.
4. Find sentences which contain the main idea of the text.
5. Put a heading to the text
6. Say some words about the gage mentioned here and its functions.

### § 3

#### Exercises

1. Read and translate the following word groups:

self-resetting - автоматическая переналадка  
e.g. the self-resetting lathe; self-resetting, is not confined to lathes.

too - также; (но перед определениями) слишком  
e.g. too worn for further use; too badly worn to be of use.

oversize - превышение размера, больше макс. допускаемого размера  
e.g. the work is approaching oversize.

undersize - меньше заданного размера

e.g. a part being turned undersize; an undersized piece.

to call - звать, называть - BUT: to call for - требовать

e.g. so the next time (when) an advance is called for ...

there is not much likelihood - it is unlikely

e.g. there is not much likelihood of a part being turned undersize.

case - случай

e.g. in the case of grinders... - as to grinders...

to make provision - to provide

e.g. provision is made to advance the wheel

## 2. Translate the text.

### AUTOMATION

#### Part III SELF-RESETTING

This principle is employed on the self-resetting lathe, which not only adjusts the tools to compensate for wear, but actually changes them when they become too worn for further use. Instead of a conventional toolpost, this machine has a drum in which eight or ten identical tools are mounted and carefully adjusted. The first tool operates until the gage signals that the work is approaching oversize. Then that tool is advanced 0.0005 inch and continues to work until the next signal is received. After it has been advanced six times, it will be too badly worn to be of further use, so the next time an advance is called for, instead of advancing, it withdraws all the way to the starting point and the drum indexes to bring the second tool into cutting position. This continues until the last tool in the drum has made its last advance. Then, instead of bringing the worn No. 1 tool into position, the machine stops and flashes a warning signal to the operator. Changing the tool takes only a few minutes. The operator removes one nut, lifts off the used drum, replaces

it with another drum of sharpened tools, and tightens up the nut. Then he presses the start button and the machine continues as before.

On machines of this type, gaging is not confined to the work; the tool itself is also gaged. Thus, if a tool should break, the machine does not wait for a bad piece to be produced, but automatically indexes the drum to bring a new tool into place.

In a lathe operation, there is not much likelihood of a part being turned undersize unless a tool has been improperly adjusted in the first place. Consequently, if the gage should find an undersized piece, it will automatically stop the machine.

Self-resetting is not confined to lathes, but can equally well be applied to grinders and other machines. In the case of grinders, provision is made to advance the wheel to compensate for wear. At the same time, the speed of the wheel-driving motor is adjusted to compensate for the change in wheel diameter so as to maintain constant surface speed.

3. Make up a plan to the text.

4. Describe the process of changing tools on the self-resetting lathe.

5. Explain in what case the work approaches oversize.

6. Translate without using a dictionary.

#### Feed-Back ( Обратная связь )

The word feed-back is frequently encountered in description of new, automatic machines, and an understanding of the term is highly important. It may be defined as using an instrument to measure a quantity and, as limits are reached, feeding this information back into some form of control mechanism that will correct the error found in the measurement. The self-resetting lathe is an example of this.

#### § 4

##### Exercises

1. Read the terms and translate the word groups:

punch - пробойник      to punch - ..робивать (отверстие)

e.g. the tape is plastic, with punched holes; each tool movement is recorded by a small punch which punches holes in the tape;

punched tape - перфолента

e.g. the control of machine tools by means of a punched tape;  
the punched tape has long been used to operate piano keys  
(клавиатура);

(player-piano - пианино; warp thread - нить основы (ткани))

Jacquard loom - жаккардов ткацкий станок

tape control - программное управление посредством перфоленты

e.g. the first step in applying tape control.

controls - рычаги управления

e.g. to use regular manual controls;

controller - контроллер, регулятор

increment - приращение

e.g. the increments of movement of the tool slides;

multiplier - "дубликатор", координатное приспособление (для станков)

2. Look through the text (time limit - 5 min) and say what  
problem is discussed here.

## AUTOMATION

### Part IV TAPE CONTROL

The control of machine tools by means of a punched tape has been one of the outstanding developments of modern times. The basic principle is not new; the punched tape has long been used *before* to operate piano keys - in the case of the old player-piano - or to control the movement of the warp threads in the Jacquard loom, but it was not until about 1950 that it was introduced as a means of controlling the movements of a machine tool.

The tape may be paper or plastic, with punched holes, or it may be magnetic and quite similar to those used in sound recorders.

The first step in applying tape control is to prepare the tape. This may be done in several ways. With one system, the machine operator machines the first workpiece, using regular manual controls and working slowly to be sure that every operation is exactly correct. As he does this, the tape is being fed through the machine controller and each tool movement recorded by a small punch which punches holes in the tape. After the operation is complete, a fresh workpiece is loaded into the machine and the tape played back at full speed to machine it automatically.

With another system, the engineering department prepares the tape. First of all, the dimensions on the drawing are reduced to units corresponding to the increments of movement of the tool slides. These are written on a chart which is then translated into punched holes on a machine similar to a typewriter. The machine operator then receives a tape rather than<sup>1</sup> a drawing of the new part he is to produce. If the parts are to be produced in quantity, the tape may be in the form of a loop which will continue to feed through the controller and produce parts, twenty-four hours a day if necessary, until the order is completed.

If production requires a second or third machine to be employed, exact copies of the tape are quickly made on a duplicator and, provided the machines are all in top condition, parts produced by one machine will be absolutely identical with those from another machine. The tremendous advantages of this system are obvious, as identical parts can be produced by different machines and even different plants.

<sup>1</sup> rather than - а не

3. Translate the text. Do the translation of the second half in writing (it should take you not more than an hour).

4. Describe and compare the ways the punched tape can be prepared.

5. What are the functions of a) the controller; b) the duplicator?

6. Make up an abstract of the text.

## §5

### Exercises

1. Read and try to remember the new terms. Translate the word-groups:

Ltd. (limited, limited company, limited corporation) - компания с ограниченной ответственностью (обычно ставится в конце названий английских компаний)

feature - черта, особенность; деталь, устройство

e.g. one of the main features of the part; one of the features of the seminar; a special feature was incorporated in the system; the design features of a shaft;

bearing - опора, опорная поверхность  
e.g. distance between bearing centres; load between bearings;  
mild steel - мягкая (низкоуглеродистая) сталь  
post-processor - пост-процессор (часть системы подготовки  
управляющих программ для станков с ПУ)

2. Translate the text without using a dictionary.

#### FROM DESIGN TO MANUFACTURE IN ONE DAY

The numerical control tape preparation service provided by International Computing Services, Ltd, has been used to demonstrate how computers and numerically controlled machine tools can help to convert ideas into finished products in a relatively short time. The demonstration, in which a shaft was manufactured in one day from basic design details, was one of the main features of a seminar entitled 'From Design to Manufacture' held recently at the North Staffordshire Polytechnic, Stafford.

At the beginning of the seminar, delegates were invited to specify the design features of a shaft, including horse power, speed, distance between bearing centres, load between bearings, and length of load. The required shaft dimensions were then evaluated on the Polytechnic's ICL System 4-50 computer, using a shaft design program written at the Polytechnic. These dimensions were combined with details of the blank piece of mild steel from which the shaft was to be machined, to prepare a part-program.

The part-program was punched on to paper tape. The programming system performed calculations, a special feature being incorporated in the system which automatically selects all feeds, speeds, and depth of cut to be used. A post-processor determined the cutter location data for the particular machine to be used.

Various automatic data validation checks were carried out by the KDF9 computer before the necessary control tape was produced and returned to the Polytechnic.

The shaft was machined automatically, under tape control, on a Wickman Lang Numericon centre lathe, which was installed in the machine laboratory at the Polytechnic for the duration of the seminar. The shaft was completed and presented to the seminar delegates for inspection during the afternoon session.

3. Find the key-sentence in the text.

§ 6 TWO-SPINDLE AUTOMATIC GRINDER

Exercises

1. Read the new terms and translate the word groups:

grinder - grinding machine-tool, grinding machine;

rotary - вращающийся; (о станке) с вращающимся рабочим столом

e.g. a new rotary dial-type 2-spindle vertical chuck grinder.

gage = gauge - датчик, измерительный прибор

e.g. an electronic in-process gaging and machine control system;

bore - a bore is made by boring;

e.g. to automatically finish-grind the bore diameter of a transmission shaft;

tolerance - допуск (на размер)

e.g. all parts are finish-ground to within required tolerances;

sensing finger - щуп

e.g. diamond-tipped sensing fingers of the gage

readout - считывание данных,

e.g. to provide visual readouts of part size on two dials.

ID - inside diameter;

preset - заранее установленный, заданный

e.g. when the ground ID reaches a preset point;

floor-to-floor time - полное штучное время (обработки), время пребывания изделия на станке

2. Translate the text (time limit about an hour)

TWO-SPINDLE AUTOMATIC GRINDER

Major auto manufacturers are now using a new rotary dial-type 2-spindle vertical chuck grinder with an electronic in-process gaging and machine control system to automatically finish-grind the bore diameter of a transmission shaft. Use of the new high-speed machine with automatic gaging and control equipment completely automates the grinding operation assuring that all parts are finish-ground to within required tolerances, thus reducing scrap and improving productivity.

Each of the work stations is equipped with electronic gaging equipment. During grinding, diamond-tipped sensing fingers of the gage move in and out of the bore in synchronization with the grinding wheel, and contact the ID of the surface being

ground. As grinding proceeds and the wheel feeds into the workpiece by means of a special motor, movement of the sensing fingers as a result of changes in the ground ID are converted into electrical signals. These signals are fed back to the system to provide visual readouts of part size on two dials, and to provide automatic machine cycle control signals to the grinder.

When the ground ID reaches a preset point, the gaging system signals the machine to stop feed, when final desired size is reached, both readouts on the dials (one reading in .0005-inch increments) reach zero, and the system signals the machine to retract the wheel. When both workpieces reach final size, the machine automatically retracts the wheel bringing the next unground workpiece into position. Floor-to-floor cycle time for the operation is 40 seconds per cycle, with two parts finished per cycle.

4. Explain why the machine is called "two-spindle automatic grinder".

5. Explain the term "dial-type".

6. Try to guess what is the abbreviation for "ВНЕШНИЙ ДИАМЕТР".

## § 7

### Exercises

1. Read and try to remember the new terms. Translate the word-groups:

cam - кулачок

CNC - Computer Numerical Control - ЧПУ с применением компьютера

e.g. CNC cam milling machine;

Keyboard - панель управления (с клавиатурой)

e.g. a keyboard incorporated in a small desk top computer;

to store - запасать, закладывать

core memory - запоминающее устройство компьютера, память

e.g. the programme is stored in a core memory;

bell-type cam - конусный кулачок

(flat) plate-type cam - плоский (дисковый) кулачок

workhead - headstock;

e.g. rotary movement of the workhead spindle; the workhead is swivelled through 90°;

cutter head slide - салазки фрезерной головки

waste material - отходы, (здесь) стружка

to fall clear - свободно падать, сбрасываться

e.g. remainder of the waste material can fall clear;

so far - до сих пор

e.g. the waste material that has been produced so far...

## 2. Read the text.

### CNC CAM MILLING MACHINE

The new Swiss-built CNC machine enables a flat- or bell-type cam for a cam-operated automatic to be prepared at one operation by milling, and it avoids the need for multiple stages including marking-out, sawing, filing and polishing that are normally associated with this work. A programme for controlling a milling sequence can be prepared in a few minutes by means of a keyboard incorporated in a small desk top computer that is connected to the machine by cables. Programming is carried out in conversational language from basic data relating to angular positions and heights of cam rises that are normally required for cam making.

After a programme has been prepared, it is stored in a core memory for transmission to the machine.

For producing a bell-type cam, cutting is carried out for the full wall thickness of the blank at one pass, and to obtain the required shape, rotary movement of the workhead spindle is combined with linear motion of the cutter head slide in a direction parallel to the milling spindle, under the control of the computer programme. After the blank has been rotated through  $180^{\circ}$ , the workhead spindle is stopped, and the cutter head slide is traversed. At the end of this travel, the waste material that has been produced so far can fall clear. The cutter head slide is then returned to its original position, and cam milling is resumed. The remainder of the waste material can fall clear at the end of the cam milling operation.

When the procedure here described has been completed, a light cut can be taken on the cam under the control of the same computer programme, mainly with the aim of improving surface finish. For setting up the machine for cutting a flat

plate-type cam, the workhead is swivelled through  $90^\circ$  on the base to bring the work spindle parallel with the milling spindle.

3. Speak about the advantages of the new machine.
4. Make up an abstract of the text.

## § 8

### Exercises

1. Read and try to remember the new terms:

sample - образец

cross-slide - поперечные салазки суппорта

stepping motor - шаговый двигатель

end-working unit - устройство для торцевой обработки

run - работа (машины)

production run - производственная работа, цикл

batch - партия, серия (изделий)

2. Translate the text without using a dictionary.

### CNC SLIDING-HEADSTOCK AUTOMATIC

(a post-exhibition report)

With the aim of demonstrating the high versatility of the Traminer 16 CNC sliding headstock automatic for small-batch work, visitors to the exhibition were invited to provide details of components that they wished to produce. In most instances, details were submitted in the form of rough sketches, and with visitors in attendance, the method of programming the machine was demonstrated with the aid of a keyboard mounted on a drawer-type unit in the base, and sample components were produced.

As will be seen from Fig.7, many components produced during these demonstrations are of types with high length/diameter ratios that can be produced most effectively on sliding headstock automatics, and are of forms for which considerable periods would normally be required for making cams. With the Traminer 16 machine, movements are applied to the sliding-type headstock and to a total of six cross-slides by stepping motor drives under the control of a programme stored within a mini-computer, and with this arrangement, the need for cams is avoided. In addition, there is an end-working unit incorporating three drilling spindles and a threading spindle. Since

programmes can be quickly prepared with the aid of the keyboard unit, the machine can be brought into operation for producing a fresh part in the shortest possible time, to suit requirements for small-batch production. At the end of a production run, the programme can be stored on a magnetic tape cassette.

3. What are the advantages of the above machine?

## § 9

### Exercises

1. Read and try to remember the new terms. Translate the word-groups:

output - производительность, продукция

e.g. alternative methods of increasing output, instead of the conventional solution; the output of three skilled men;

capstan lathe - токарно-револьверный станок

turnover - оборот (капитала)

scale - масштаб; шкала; весы; окалина

e.g. this factor tipped the scale

2. Look through the text (time limit - 5 minutes). Say some words on the problem the text deals with (in Russian).

### SMALL FIRMS ALSO USE NC

In 1976 S.J.Cliffors & Co Ltd investigated alternative methods of increasing output, instead of the conventional solution of expanding the area occupied and the number of machines installed.

Investigations up to that time had led them to believe that one NC lathe might reasonably be expected to give about the same output of turned parts as three conventional capstan lathes, each with its own operator.

Disposing of three ordinary capstan lathes would release more than enough floor space to house one NC lathe. Thus, one operator on one NC lathe could at least approach the output of three skilled men with capstan lathes.

There was already an acute shortage labour in the area, and no indication that this constraint would ease in the future. Here, then, was the factor which ultimately tipped the scale.

Some 15 months ago, the company installed a Niles NC lathe. Now it already has a library of more than 100 tapes, many of them for components for long standing customers who order in batches of anything from 50 to 200 on a regularly repeating basis.

The Niles lathe alone is estimated to have increased the company's turnover by some 60 per cent. In fact, since it was installed it has been necessary to introduce a night-shift, and the number employed by the company has actually risen.

Now the company is planning to purchase a second NC lathe which will have the same type of controller in order to avoid the problems of programming and maintaining two different types of system. The managing director of the company prefers to see the operator using his skills and effort to speed up changeover of the machine from one component to another, changing chuck jaws, tooling, etc, rather than have him interfering with the machine cycle and programme through the CNC controller.

Thus, as one can see, it is not only the larger type of company who can benefit from the production advantages of numerical control.

3. Translate the text using a dictionary.
4. Make up a detailed plan to the text.
5. What are your impressions of the firm's activities?
6. Make up an abstract of the text.

## § 10

### Exercises

1. Read the terms and translate the word-groups:

copying - копирование

e.g. to combine NC with copying; NC plus copying; this enables copy turning to be carried out in opposite directions;

cycle time - оперативное время

lead time - период освоения

e.g. very short cycle times normally associated with high-volume output; lead times have been reduced to a few hours instead of weeks;

set-up (setup) - наладка; режим

sequence of operations - цикл (операции)

e.g. a full sequence of operations can be completed at one set-up.

copying slide - копировальные слайзки  
e.g. the copying slides enable contouring to be performed; simultaneous application of the NC slide and one of the copying slides;

driver - поводок; поводковый патрон

2. Look through the text (time limit 5 min.) and say a few words on the subject it deals with.

#### NC PLUS COPYING

One of the latest development twists on the small-batch, turning front is to combine NC with copying.

The MC 200 Multi-Tool lathe built by the Drummond, Division of Staveley Machine Tools Ltd is designed to bring to small batch production the advantages of very short cycle times normally associated with high-volume output.

Special arrangements enable a total of 10 tools to be applied to the work during a machining cycle, and in most instances a full sequence of operations can be completed at one set-up.

Numerical control enables set-ups to be changed over quickly to suit requirements for small-batch production. Whereas there is a total of six axes of movement on the lathe, control is applied by a 2-axis system, which avoids complexities in programming normally associated with multi-tool NC turning.

The lathe is principally intended for turning stepped shafts up to 240 mm diameter by 1500 mm long. Whereas the NC system covers requirements for straight-line working only, the copying slides enable contouring to be performed. These slides enable copy turning to be carried out in opposite directions simultaneously if required.

By simultaneous application of the NC slide and one of the copying slides, cuts of considerable depths can be taken on the work for rough machining.

The sequence starts with the work-piece blank being rotated by the driver while 3-pass roughing and semi-finishing cuts are taken on a portion at the left-hand end with the NC slide.

After the driver has been retracted, the semi-finished end is gripped by the chuck, and machining is completed on the re-

remainder of the part by the combined application of the copying and NC slides. The slides operate simultaneously for copy turning in directions towards and away from the headstock.

Movements of the driver and operation of the chuck are included in the NC program, and they take place automatically as part of the overall machining cycle.

Experience gained with this machine so far, has indicated that various component parts for machine tools can be produced in one-tenth the times formerly required for machining with center-type and copying lathes. Moreover, lead times have been reduced to a few hours instead of weeks in most instances because all turning operations can be completed at one set-up.

With the NC system and qualified tooling, the set-up on the machine can be changed over in a few minutes when a different part is to be produced.

3. Translate the text using a dictionary. Do the translation of paragraphs 6,7,8 in writing.

4. Make up a detailed plan to the text in the form of questions to each paragraph.

5. Make up a summary of the text.

## § 11

### Exercises

1. Look through the text (time-limit 3 min.) What information do you get from it?

When a fresh workpiece blank is loaded on to the lathe it is held between the tailstock centre and a combined cone centre and face driver housed within the bore of the headstock spindle. At this point, the blank is passed between the jaws of a spindle-mounted chuck, but it is not gripped by them. The face driver is then moved axially by a hydraulic cylinder in opposition to the thrust exerted by the tailstock, to bring the left-hand end of the blank clear of the chuck jaws.

Single- or multi-pass turning for machining can then be carried out for a short distance at the left-hand end of the blank either by the overhead copying slide or the NC slide. Afterwards, the driver is retracted and the chuck jaws are then

closed to grip the rough-turned end of the work.

A sequence of rough- and finish-turning cuts can then be taken on the work for the remainder of its length with the copying and NC slides. At the end of this sequence, the part can again be brought clear of the chuck by outward movement of the driver, to enable finish turning to be completed at the left-hand end.

2. Translate the text without using a dictionary.

3. Put a heading to the text.

## § 12

### Exercises

1. Read the terms and translate the word-groups:

programmed instruction - запрограммированная команда, программа

e.g. tool changing in accordance with programmed instructions;

tape control - ЧПУ с использованием перфоленты

machining sequence - цикл обработки

e.g. the most advanced unit has tape control of the complete machining sequence;

cutter head - резцовая головка

e.g. movements of the cutter head vertically and transversely;

engagement - включение, зацепление

e.g. selection and engagement of feed rates;

to present - повернуть, подавать

provision (for) - обеспечение

e.g. provisions for automatic tool changing; provision for presenting two faces of the work to the cutters.

2. Form adverbs from the adjectives and translate them:

current, substantial, basic, full, transverse, vertical.

3. Look through the text (time limit 3 min). What new trends are discussed here? Which of the trends is discussed in detail?

### NEW TRENDS IN METAL-CUTTING EQUIPMENT

The most important developments in metal-cutting equipment during the past three decades have been the widespread introduction of numerical control and provisions for automatic tool changing. These two trends have led to the development of the

"machining centre", and equipment of this type currently represents the peak of machine-tool design.

Such machines are built by an increasing number of manufacturers, and their use is likely to grow substantially. They offer particular advantages for the production of complex components in small batches, and they can substantially reduce the lead time before a new product can be placed on the market.

The term "machining centre" has been applied to the more complex multioperation machine tools, and machining centres are now being built by various makers in a number of countries. Basically, the term relates to a machine designed to perform multiple operations on a fully automatic cycle including tool changing in accordance with programmed instructions, with provision for presenting two or more faces of the work to the cutters without moving the work on its support. The most advanced unit of this type has tape control of the complete machining sequence including movements of the cutter head vertically and transversely, and the work towards and away from the cutter spindle; rotation of the work table through 360 degrees and inclination of the table from the horizontal to the vertical; automatic tool changing; and selection and engagement of the spindle speeds and feed rates.

Machining centres are made in a number of sizes and of various degrees of complexity.

4. Translate the text without using a dictionary.
5. Explain the term "machining centre".

## § 13

### Exercises

1. Read the terms and translate the word-groups:

crankcase - картер

e.g. a 20-cylinder diesel engine crankcase;

rigid - жесткий, негибкий

e.g. rigid requirements; a very rigid machining setup;

storage - хранение на складе

e.g. storage costs;

saving - экономия e.g. considerable production cost savings;

clamping - закрепление

e.g. repeated clamping; clamping in different machines;

fixture - зажимное приспособление

the high cost of fixtures; fixture for accurate tool location;  
surface finish; shape accuracy; time loss; workpiece periphery;

radial drill - радиально-сверлильный станок

boring mill - горизонтально-расточной станок

2. Translate the text.

### MACHINING CENTRE

#### Part I. Why a Machining Centre?

MTU, Motoren- und Turbinen-Union, Friedrichshafen, W. Germany<sup>1</sup> had a complex machining problem: carrying out no less than 1500 operations in 500 different positions on one workpiece. The workpiece: a 20-cylinder diesel engine crankcase, one of a family of components for diesel engines with 6 to 20 cylinders.

Because of the wide range of diesel engines, crankcase machining involves workpieces with varying numbers of cylinders, V angles, drilling patterns and materials; hence an unusually flexible production setup was necessary.

In addition, rigid requirements were placed on dimensional and shape accuracy and surface finish.

Since the value of the workpiece increases substantially as machining progresses, this, combined with significant storage costs, meant that reducing total production time could lead to considerable production cost savings.

Thus, since production time for this component largely determines the lead time for the complete engine, minimum time was an important criterion in selecting the best machining setup.

As the V shape of the crankcase called for 12 different tool cutting angles for the workpiece periphery and 2 for the two ends, the machining setup was to have 4 axes of motion. In addition, size, weight and geometrical shape of the workpiece together with the high cutting forces involved made it necessary to use a very rigid machining setup.

According to experts, the conventional solution would have been one or two special-purpose machines and at least two universal machines, e.g. a radial drill and a boring mill. But such a solution has several drawbacks. One is significant time losses

when passing through several machine tools, the second is the loss of accuracy because of repeated clamping in different machines, and, a major factor, the high cost of fixtures for accurate tool location on the workpiece. In addition, expensive multi-spindle drilling heads would have been required for hole patterns.

These factors led to the choice of a numerically controlled machining centre. Replacing 4 conventional machines, the machining centre significantly reduced total production time for diesel-engine crankcases, for it carried out up to 1500 operations in 500 positions on one workpiece.

<sup>1</sup>MTU is a German company, therefore its name is written in German; Friedrichshafen is a town in West Germany where MTU's enterprises are situated

3. Make up a detailed plan of the text.

4. What factors led to the choice of a machining centre?

5. Find all the sentences with because of, since, as, for, introducing adverbial modifiers of reason.

#### § 14

##### Exercises

1. Read the terms and translate the word-groups:

column - стойка                      to traverse - перемещаться

bed - станина

e.g. a column traverses along an 8 m. long bed;

positioning time - время базирования

e.g. this speed ensures minimum positioning time;

head - головка

e.g. the head can be angularly positioned; large boring and milling heads; a corresponding precision head; multi-spindle heads; head slide; head changing system; head changing time;

downtime - простой

e.g. downtime of the machine;

to damage - повреждать, разрушать

e.g. when a spindle is damaged during heavy machining operations;

to pivot - свободно поворачиваться

e.g. a pivoting workpiece holding head;

magazine - магазин, бункер

e.g. a chain-type magazine; an angle-type magazine;

2. Look through the text (time-limit 5 min.). What kind of information does the text contain?

## MACHINING CENTRE

### Part II

Having analysed all the factors MTU came to the conclusion that only a machining centre could solve their problems.

After studying the machines available on the market, the company chose a Burr model TC2-30 machine. This machine, developed by Ludwigsburger Maschinenbau, W.Germany, has a column which traverses in the X-axis along an 8 m long bed. Hence workpieces of varying length can be easily accommodated. A fast traverse speed of 10 m/min in all 3 main axes (X, Y and Z simultaneously) ensures minimum positioning time. Main spindle drive is rated at 30 kW.

A special feature of the machine is the provision of a strong, pivoting workpiece holding head which can be angularly positioned (A-axis) under numerical control.

Rotation of the workpiece holding head forms the fourth axis of the machine.

As to tools they can be automatically changed in 10 s from a chain-type magazine with a capacity of 50 tools. Tool coding is used for identifying the tools, so the tools up to 160 mm in diameter and weighing up to 25 kg can be taken and replaced in any position in the magazine.

Another special feature of the machining centre is the provision of a changing device for large boring and milling heads. This means that for roughing operations a head running in robust bearings can be used, while for accurate machining or finishing a corresponding precision head can be fitted to the machine. In addition, this changing device can be used for multi-spindle drilling heads. In this case the changing system would be extended to hold 9 heads. Head changing time is approx. 50 s.

Another advantage of this head changing system is that downtime of the machine is reduced when a spindle is damaged during heavy machining operations.

Changing is simple: The column is traversed to the changing device; the head slide is moved out of the machine and into the vacant position of the changer; the angle-type magazine is swivelled through 90° so that a new head slide comes into position; and the new head is then slid into the guide-ways on the machine column.

3. Translate the text. Do the translation of the second part in writing (Another special feature ... )

4. Put a heading to the text.

5. Make up a summary of the text.

## § 15

### Exercises

1. Look through the text (time limit 5 min.) What information could you get from the text?

#### NC AND ROBOTS. THE LATEST TRENDS

*answer 142*

Automation is playing an increasingly important role in modern manufacture. And such powerful aids as NC and robots are designed to play a much larger part than they do today.

The 3rd International NC Robot Automation exhibition and conference was held in Milan in March 1978 on the initiative of the Italian Machine Tool Manufacturers' Association (UCIMU). The aim of the exhibition and conference was to show the latest developments and trends in the automation field. The products displayed included NC equipment, industrial robots, transducers, process control equipment, NC measuring machines, tool presetting equipment and digital read-out systems. The papers presented at the conference dealt with various aspects of NC machining and measurement and with the broader subject of automation in production.

Special prominence was given to industrial robots.

The MAPOR concern, one of the exhibitors of industrial robots showed a Swedish-built Robot unit. This free-standing robot is intended for operation in connection with forging, its hydraulic equipment for obtaining the various movements, as well as its electrical system for programming, being totally enclosed within the base. A horizontal arm carrying jaws for work-

piece gripping can be extended and retracted through distances up to 1100 mm (or 1500 mm if required) and it can be swivelled through angles up to  $190^{\circ}$  on an arc up to 2590 mm maximum radius. In addition, the arm can be tilted above and below the horizontal position, to give gripping heights from 762 to 1778 mm above floor level. Wrist action provided for the gripper head includes a  $90^{\circ}$  swivel movement and  $30^{\circ}$  tilt.

Programming for point-to-point movements is carried out by means of a stepping switch and interchangeable cam drums in conjunction with limit switches and stops, and there is provision for two speeds of operation to be obtained at each cycle. The rating for workpiece load may be 25 or 45 kp.

2. Translate the text using a dictionary. Here are some terms: transducer - преобразователь      digital readout system - цифровая система считывания

### 3. PTP ROBOT

The field of application of the type PTP robot introduced by Utita SpA, includes spot-welding, work-loading and unloading on machine tools, assembly and inspection. Two forms are available which provide freedom of movement on five and six axes, and will handle workpiece loads weighing up to 40 and 35 kg respectively. The arm carrying the gripper head is situated at a height of 1050 mm above floor level. It can be swivelled in the horizontal plane through angles up to  $280^{\circ}$  and reach from the pivot point ranges from 1350 to 2150 mm. In addition, the arm can be tilted through angles up to  $30^{\circ}$  above and below the horizontal position.

Movements are applied by a combination of hydraulic cylinders and vane motors operating on a closed-loop system, with resolver feedback for position, speed and acceleration. Control is provided by a microprocessor with capacity for storing 10 programmes with a maximum of 1000 steps. For programming, the robot can be operated in a teaching mode in which it is guided through various movements manually, and data are stored within the memory for application automatically during a working sequence. Provision is made for stored data to be recorded on to magnetic tape for reference purposes.

Translate the text. Here are some terms you will need:

spot-welding - точечная сварка

vane motor - лопастной двигатель

closed-loop system - система замкнутой цепи

resolver - решающее устройство

4. Make up plans to the texts.
5. Make up an abstract to both texts.
6. Compare the two robots described above.

Translate the following text without using a dictionary:

перев(2)  
SAVINGS OBTAINED

We were given some details of the savings which the company hopes to achieve, on the basis of data taken during the progress of operations in the production of crankcases and cylinder heads. With one of the crankcases, the previous methods involved nine separate operations on conventional machines, and the total set-up time was 488 min, and the total floor-to-floor time 440 min. On the NC machine, the part will be produced at one set-up, and it is expected the setting time will be 165 min, and floor-to-floor time 306 min. There will be a saving of 323 min setting time per batch, and a saving of 134 min floor-to-floor time per part, or 31 per cent it is anticipated.

Another crankcase required six conventional operations, and the total setting-up time was 351 min, and the overall floor-to-floor time, 234 min. These times will be reduced to 90 min for setting-up, and 195 min floor-to-floor, it is hoped. For two further crankcases, the preliminary results obtained indicate that setting-up time will be reduced from 210 to 90 min in one instance, and from 210 to 75 min in the other.

set-up time - установочное время

Calculate what per cent saving will be obtained for the second crankcase.