Tomsk Polytechnic University

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TECHNOLOGY of MECHANICAL ENGINEERING

Part 2

Workbook

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This workbook is devoted to technological opportunities of machine tools and designing of technological processes.

This workbook is prepared at the TPU Department of Mechanical Engineering.

It is recommended for foreign students following the Bachelor Degree Program in Mechanical Engineering at the Tomsk Polytechnic University.

Reviewed by: V.F. Skvorsov, the head of the department “Technology of Mechanical Engineering, Cutting and Tools”

TO THE STUDENT

The discipline "Technology of mechanical engineering" is studied on the senior rate for the bachelor level in 7 and 8 semesters and is divided into two parts. The parts "Fixing of accuracy in mechanical engineering and bases of the theory of cutting action" are studied in the seventh semester (3 credits). The part second "Technological opportunities of machine tools and designing of technological processes" is studied in the eighth semester (3 credits). At the end of each semester the examination by the appropriate parts is stipulated.

This workbook is written in according with the textbook "Technology of Mechanical Engineering", part 2. The material in the Workbook is presented in the same order and with the same section division as in the textbook. The Workbook contains exercises which must fulfill. This workbook covers the topics to be studied in 5 terms:

1. Measurements and measuring tools.
2. Inspection of surface form, disposition of surfaces and surface finish.
3. Tolerances and fits.
4. Cutting tools.
5. Bases of the cutting action.

6. Drills and Drilling Machine Operations

6.1. Identify each lettered part of the drill press by matching it with its correct name.

_____ 1. Column
_____ 2. Table lift crank
_____ 3. Guard
_____4. Base
_____ 5. Power feed
_____ 6. Switch
_____ 7. Table lock
_____ 8. Motor
_____ 9. Variable speed control
_____10. Head
_____11. Spindle
_____12. Table
_____13. Quill lock handle

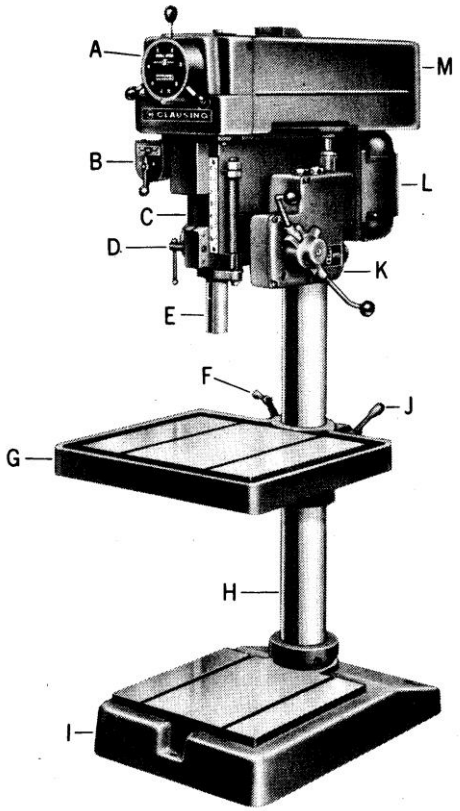


Fig.6-1. Parts of the drill press.

6.2. Identify each of the illustrated hole machining operations by matching it with its correct name listed below.

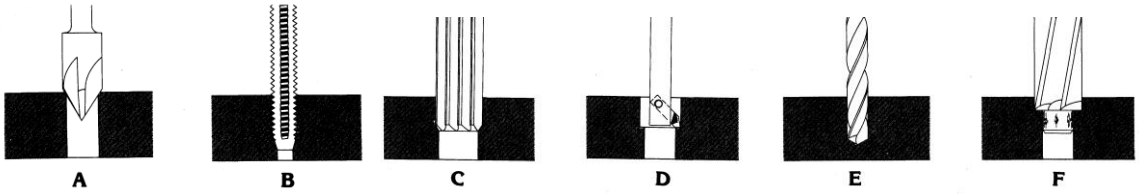


Fig.6-2. Hole machining operations.

_____14. Drilling
_____15. Reaming
_____16. Boring
_____17. Countersinking
_____18. Counterboring
_____19. Tapping

6.3. Identify each illustrated drilling machine by matching it with its correct name.

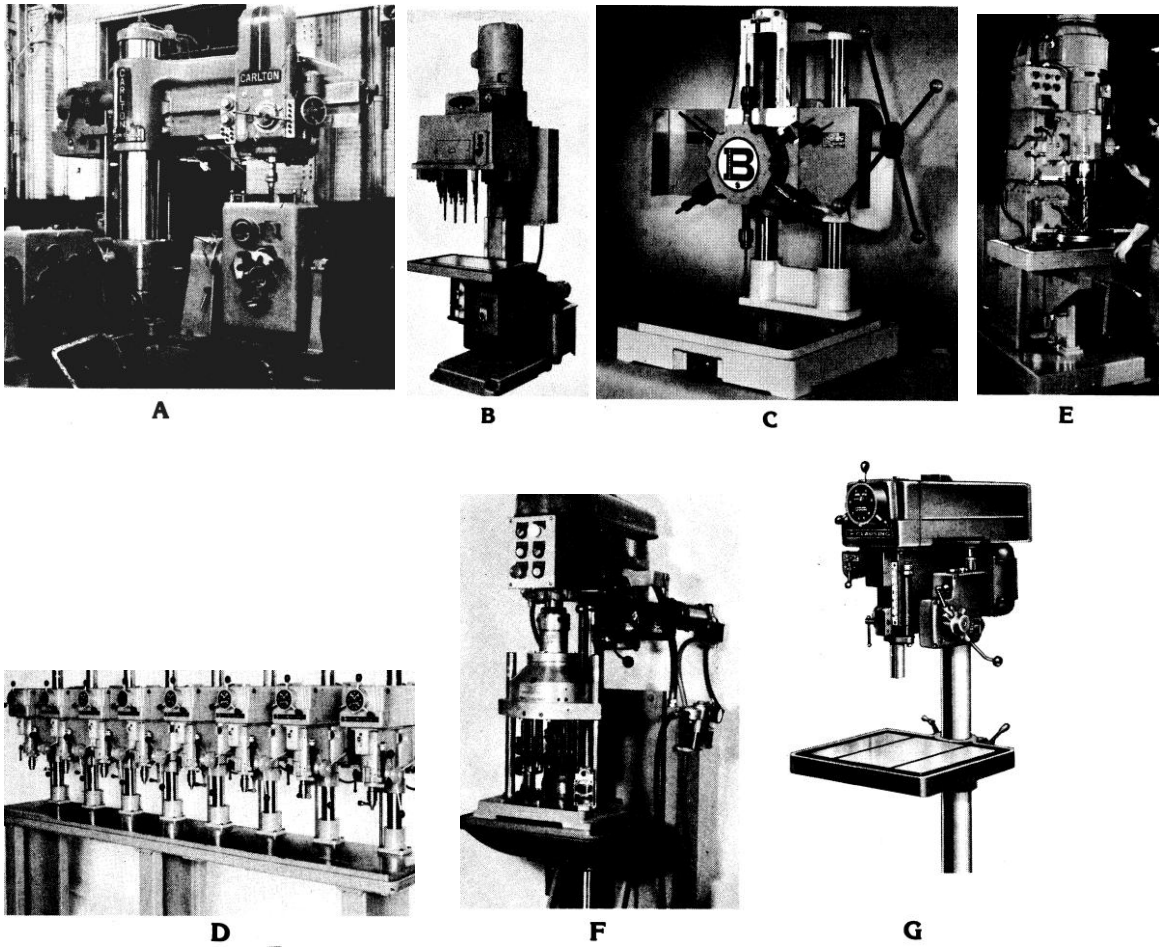


Fig.6-3. Drilling machines.

____20. Multiple spindle drilling machine
____21. Gang drilling machine
____22. Upright drilling machine
____23. Turret drilling machine
____24. Radial drilling machine
____25. Multiple spindle drill attachment
____26. Sensitive drilling machine

6.4. Identify each lettered part of the twist drill by matching it with its correct name.

____27. Lip (cutting edge)
____28. Flute
____29. Tang
____30. Web
____31. Shank
____32. Land

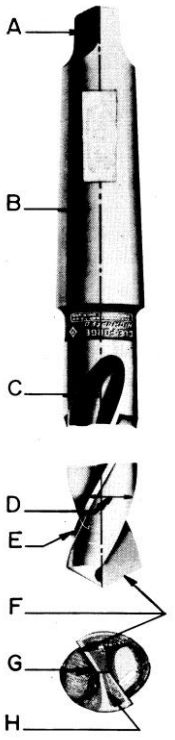


Fig.6-4. Parts of the twist drill.

____33. Margin
____34. Lip clearance

6.5. Identify the best use of each style of drill by matching it with its drilling application listed below.

____35. High production drilling on screw machines.
____36. Drilling in die steels with a HRC 48-65 hardness range.
____37. Hand and drill press operation.
____38. For enlarging cored holes in castings.
____39. Step drilling operations.
____40. Production drilling of cast iron, cast steel, and non-ferrous metals.

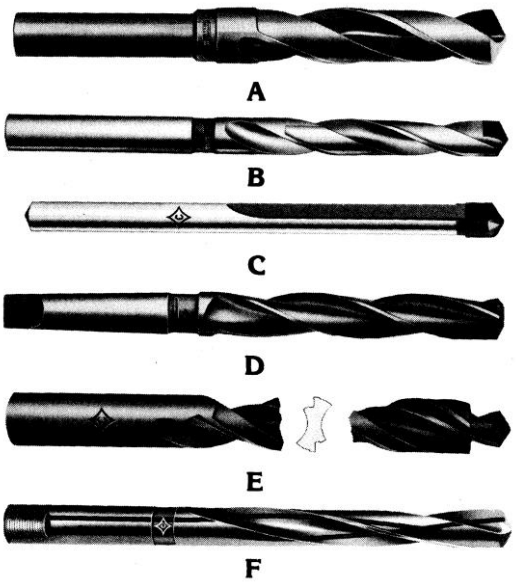


Fig.6-5. Styles of drills.

6.6. Write the letter of the best answer to complete the following statements.

6.6.1. For general-purpose drilling in metals, the included angle of the drill point should be
A. 12°.
B. 59°.
C. 118°.
D. 130°.

6.6.2. Recommended clearance angles for twist drills are
A. 5-8°.
B. 8-12°.
C. 12-15°.
D. 120-130°.

6.6.3. To make a drill with a №1 taper shank fit a drill press spindle with a №2 or №3 tapered hole, you should use an adapter called a (an)
A. reducer.
B. enlarger.
C. drill adapter.
D. sleeve.

6.6.4. The name of the standard taper used on taper shanked drills, reamers, etc. is
A. Brown and Sharpe.

B. Jarno.
C. Morse.
D. American Standard.

6.6.5. The removal of a taper-shanked drill from a drill spindle requires using a tool called a (an)
A. drift.
B. wedge.
C. drill remover.
D. ejector.

6.6.6. A size system **not used** to make twist drills is
A. number.
B. metric.
C. letter.
D. decimal.
E. fractional.

6.6.7. To produce a 25.4 mm hole with the greatest degree of straightness and accuracy, the operation(s) you would perform is (are)
A. drilling.
B. drilling and boring.
C. drilling and reaming.
D. drilling, reaming, and boring.

6.6.8. For holes 12.7 mm diameter and larger, machine reaming allowance for one-step reaming should be
A. 0.4 mm.
B. 0.8 mm.
C. 1.5mm.
D. 3.0 mm.

6.6.9. Allowance for hand reaming should never be greater than
A. 0.05 mm.
B. 0.13 mm.
C. 0.25 mm.
D. 0.51mm.

6.6.10. Machine reaming is generally done at what fraction of the speed used for drilling?
A. 1/4-1/3.
B. 1/3-1/2.
C. 1/2-2/3.
D. 2/3-3/4.

6.6.11. The feed for a drill refers to the rate of
A. surface speed per minute.
B. surface speed per revolution.
C. advancement into the work per minute.
D. advancement into the work per revolution.

6.6.12. Generally, as drill diameters increase, feed rate
A. increases.
B. decreases.
C. remains the same.

6.6.13. The cutting speed of a drill is expressed in terms of
A. meters per minute a point on the outside diameter of the drill travels.
B. the distance the drill advances in one revolution.
C. revolutions per minute.
D. the distance the drill advances in one minute.

6.6.14. The correct rpm for a 6.35 mm diameter high-speed steel drill for drilling low carbon steel at 30.5 mpm is
A. 900.
B. 1 200.
C. 1 500.
D. 1 800.

7. Metalworking Lathes, Methods of Holding Workpieces

7.1. Identify each lettered lathe part by matching it with its correct name.

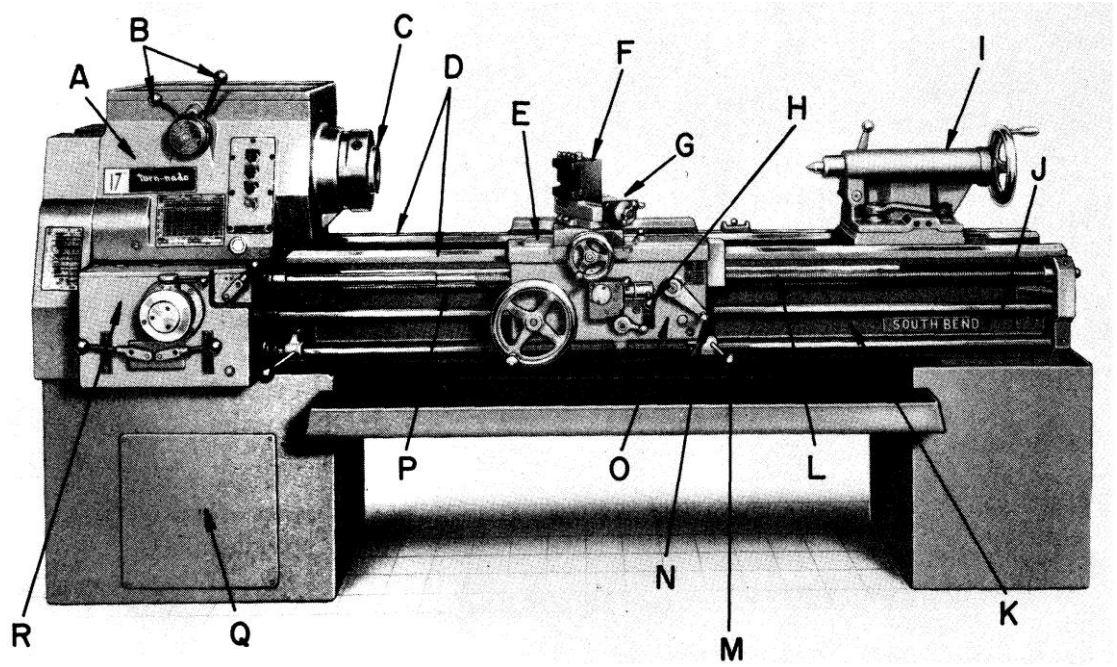


Fig.7-1. Lathe parts.

_____1. Tool post
_____2. Tailstock
_____3. Apron
_____4. Headstock
_____5. Motor drive
_____6. Lead screw
_____7. Compound rest
_____8. Bed
_____9. Speed change levers
_____ 10. Saddle
_____ 11. Half-nut lever
_____ 12. Gearbox
_____ 13. Brake-clutch control
_____ 14. Rack
_____ 15. Bed ways
_____ 16. Feed rod
_____ 17. Power feed clutch
_____ 18. Spindlenose

7.2. Write the letter of the correct answer to complete the following statements.

7.2.1. The size of a lathe is given in terms of its maximum swing
A. over the ways and length between centers.
B. over the ways and length of bed.
C. over the cross slide and length of bed.
D. over the cross slide and length between centers.

7.2.2. The type of drive system for which speed changes should be made with the machine running is
A. cone pulley, flat belt drive.
B. cone pulley, v-belt drive.
C. geared head drive.
D. variable speed belt drive.

7.2.3. When the tool travels along the work parallel to the lathe bed, it is referred to as what kind of feed?
A. Cross.
B. Longitudinal.
C. Taper.
D. Straight.

7.2.4. The part of a lathe feeding and threading mechanism that determines how fast the carriage or cross slide will move is the
A. lead screw or feed rod.
B. end gear train.
C. quick change gear box.
D. feed clutch.

7.2.5. The part of the carriage assembly that may be set at any angle for cutting short tapers is the
A. tool post.

B. cross slide.
C. compound rest.
D. saddle.

7.2.6. The feed change lever on the apron **cannot** be used to
A. select longitudinal feed.
B. reverse feed direction.
C. select cross feed.
D. disable the feed clutch.

7.2.7. The rate of feed shown on the quick-change gear box chart tells how much the tool moves per
A. second.
B. minute.
C. revolution of the workpiece.
D. 100 revolutions of the workpiece.

7.2.8. Center holes required for supporting workpieces between centers must have an angle of
A. 30°.
B. 45°.
C. 60°.
D. 82°.

7.2.9. The type of manually operated turret lathe that is usually the largest is the
A. hand screw machine.
B. saddle type machine.
C. ram type machine.
D. none of the above.

7.2.10. Which of the following is least efficient for high volume production?
A. Single-spindle automatic lathes.
B. Horizontal multiple-spindle automatic lathes.
C. Numerically controlled turret lathes.
D. Vertical multiple-spindle automatic lathes.

7.2.11. Automatic centering of round, square, or hexagonal workpieces is possible with which type of chuck?
A. Universal.
B. Independent.
C. Spindle.
D. Collet.

7.2.12. The most versatile type of lathe chuck is the

A. universal.
B. independent.
C. spindle.
D. step.

7.2.13. The type of chuck that requires a second set of jaws for holding larger diameter workpieces is the

A. universal.
B. independent.
C. spindle.
D. step.

7.3. Identify each toolholder by matching it with its correct name.

_____1. Left-hand turning.
_____2. Knurling.
_____3. 16,5° straight turning.
_____4. Boring.
_____5. Right-hand turning.
_____6. Straight cutoff.
_____7. 0° straight turning.
_____8. Threading.
_____9. Throwaway insert.
____10. Right-hand cutoff.

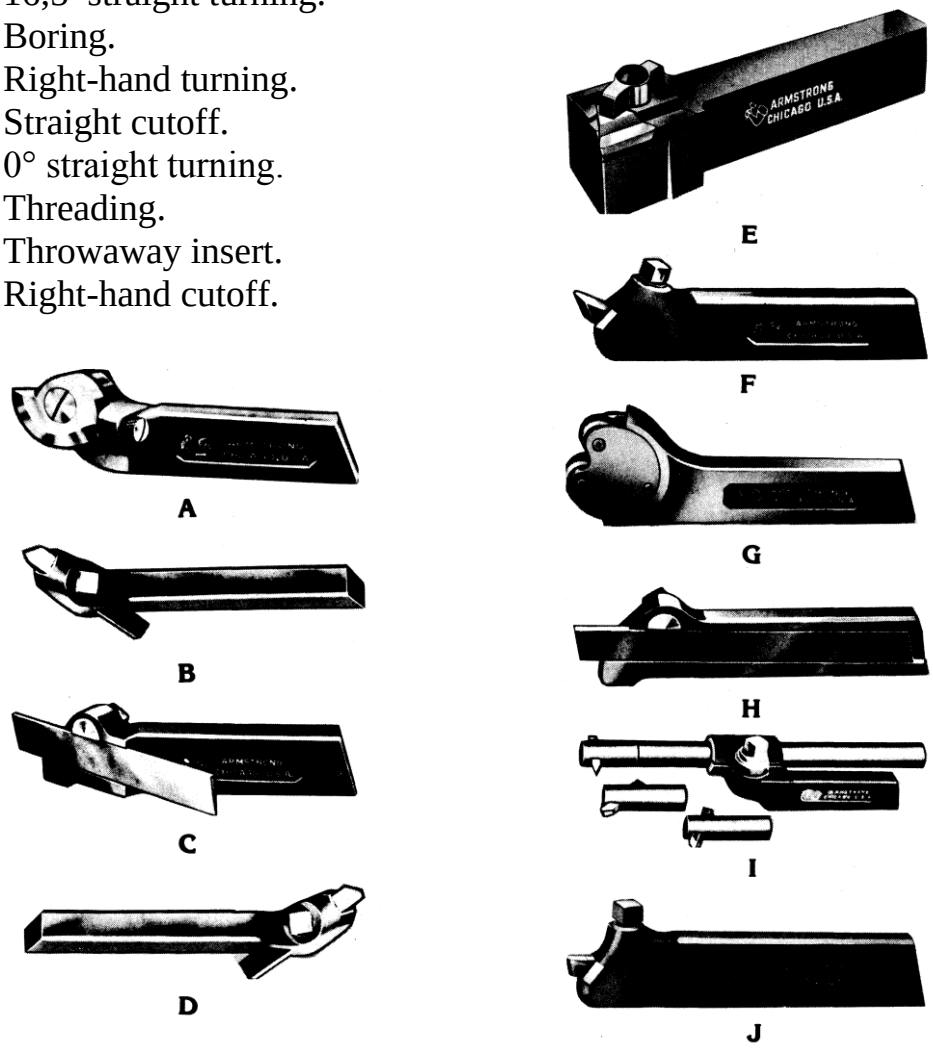


Fig.7-2. Toolholders.

7.4. Identify the cutting tool part or angle by matching it with its correct name.

_____1. Side relief angle.
_____2. Cutting edge.
_____3. End relief angle.
_____4. Flank.
_____5. Back rake angle.
_____6. End cutting edge angle.
_____7. Mose radius.
_____8. Side cutting edge angle.
_____9. Face.
____10. Heel.
____11. Side rake angle.
____12. Shank.
____13. Nose angle.

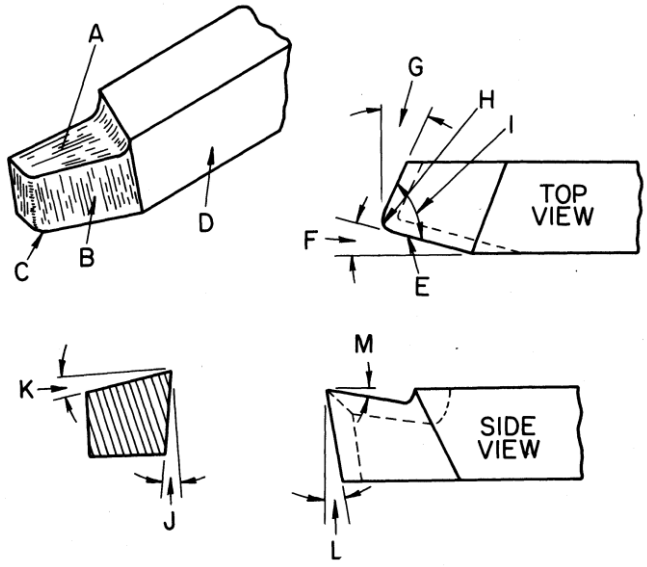


Fig.7-2. Cutting tool parts and angles.

7.5. Write the letter of the correct response to the following questions and statements.

7.5.1. Working end and side relief angles of 8-10° are commonly used for turning many metals, using what kind of cutting tools?

A. High-speed steel.
B. Cast alloy.
C. Carbide.
D. Ceramic.

7.5.2. For lathe work with the use of high-speed steel tools, a tool-holder with a back rake of what angle should be used?

A. 0°
B. 6,5°
C. 10°
D. $16,5^0$

7.5.3. For shaper work with the use of high-speed steel tools, a tool-holder with a back rake of what angle should be used?

A. 0°
B. 6,5°
C. 10°
D. $16,5^0$

7.5.4. For lathe work with the use of cemented carbide tools, a tool-holder with a back rake of what angle should be used?

A. 0°
B. 6,2°
C. 10°
D. $16,5^0$

7.5.5. A shape provided on the face of the tool bit which causes short, coiled chips is called a chip

A. coiler.
B. breaker.
C. generator.
D. maker.

7.5.6. The recommended nose radius for a general-purpose turning tool is

A. 0.4 mm.
B. 0.8mm.
C. 1.1 mm.
D. 1.5mm.

7.5.7. An increased back rake angle

A. increases shear angle at the chip.
B. reduces the power required to form the chip.
C. *A* only.
D. Both *A* and *B*.

7.5.8. The side rake angle

A. determines the type of chip produced.
B. enables the tool to cut more freely.
C. determines the direction that the chip leaves the tool face.
D. all of the above.

7.5.9. Aluminum oxide wheels should be used for grinding which of the following tool materials?

A. High-speed steel.
B. Cemented carbide.
C. Cast alloy.
D. Both *A* and *C*.

7.5.10. Carbide tools should be sharpened on wheels made of

A. aluminum oxide.
B. silicon carbide.
C. diamond.
D. either *B* or *C*.

7.5.11. Lathe tools for chasing threads should have a working back rake of what angle?

A. 0°
B. 8-10°
C. 15°
D. 60°

7.5.12. For straight turning, the height of the lathe tool bit point

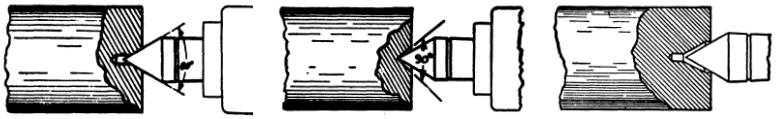
A. must always be on center.
B. may be 0-5° above center for all metals.
C. may be 0-5° above center for most metals.
D. may be 0-5° below center for some metals.

7.5.13. Ordinarily, the point of a lathe tool bit should project how far out of the toolholder?

A. 6mm.
B. 13mm.
C. 19mm.
D. 25mm

7.6. Identify the illustration of the center drilled hole by matching it with its description listed below.

_____1. Too deep.
_____2. Wrong angle.
_____3. Correctly done.



A B C

Fig.7-3. Center drilled holes.

7.7. Write the letter of the correct response to the following statements and questions.

7.7.1. To provide a good bearing surface, about how deep should the tapered part of the center drill penetrate the workpiece?

A. One-quarter of the way.
B. . Halfway.
C. Three-quarters of the way.
D. All the way.

7.7.2. When work is mounted between centers, the tailstock handwheel is adjusted until

A. firmly locked.
B. a slight resistance is felt.
C. the handwheel slips.
D. the lathe groans when under power.

7.7.3. A live tailstock center

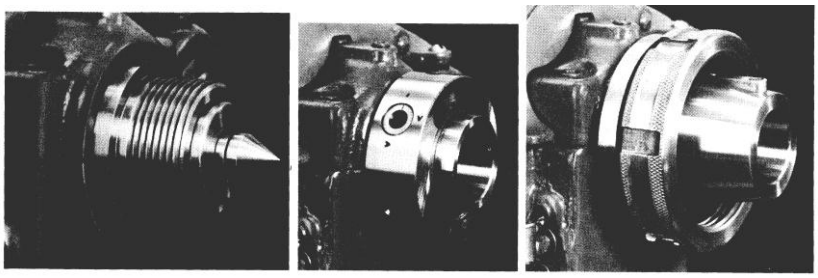
A. is spring-loaded to provide correct pressure on the workpiece.
B. has bearings to let it revolve freely with the workpiece.
C. requires a center hole lubricant.
D. requires no center hole.

7.7.4. When a workpiece is mounted between centers and a standard tailstock center used, lubrication is required

A. at the headstock end only.
B. at both ends.
C. at the tailstock end only when machining steel.
D. at the tailstock end only.

7.8. Identify each illustrated lathe spindle nose by matching it with its correct name.

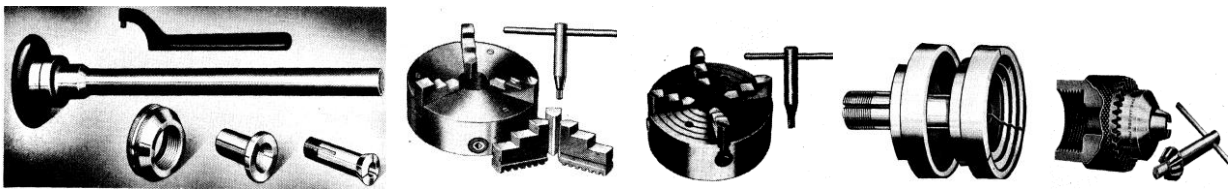
_____1. Cam-lock.
_____2. Threaded.
_____3. Taper keyed.



A B C

Fig.7-4. Lathe spindle nose.

7.9. Match each of the illustrated chucks with its correct name.



A B C D E

Fig.7-5. Chucks.

_____1. Independent.
_____2. Step.
_____3. Spindle.
_____4. Collet.
_____5. Universal.

7.10. Write the letter of the correct response to the following statements and questions.

7.10.1. The figure at the right illustrates a setup of a rectangular block in an independent chuck. What are the coarse adjustments needed to locate X on the block on center?

A. Away ¼ ring; up ¼ ring.
B. Away ¼ ring; up ½ ring.
C. Toward ½ ring; down ¼ ring.
D. Toward ¼ ring; down ½ ring.

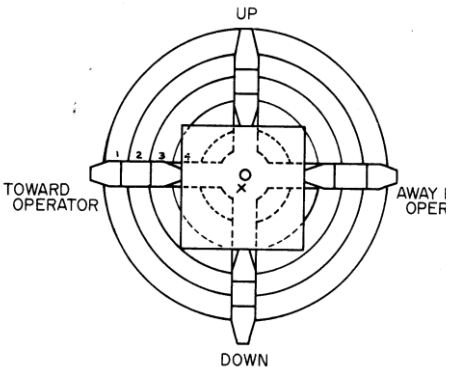


Fig.7-6. A setup of a rectangular block

7.10.2. The most versatile and accurate chuck is the

A. step.
B. collet.
C. independent.
D. universal.

7.10.3. Universal chucks in good condition will center work accurately to within

A. 0.005-0.008 mm.
B. 0.05-0.08 mm.
C. 0.24-0.38 mm.
D. 0.51-0.76 mm.

7.10.4. What is the maximum and minimum variation in stock size that collet chucks can accept before there is danger of springing the collet?

A. 0.03 mm.
B. 0.05 mm.
C. 0.08 mm.
D. 0.10mm.

7.10.5. The chuck which permits the most rapid and most accurate centering of cylindrical stock is the

A. universal.
B. independent.
C. spindle.
D. collet.

7.10.6. The illustration at the right shows a setup procedure for centering work in an independent chuck. What is the device being used to aid centering?

A. Surface gage.
B. Snap gage.
C. Center gage.
D. Dial indicator.

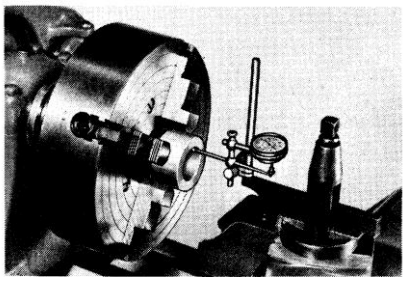
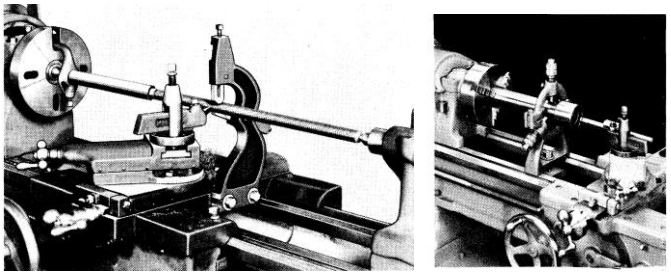


Fig.7-7. Setup procedure for centering work.

7.11. Match each type of lathe rest illustrated with its correct name.

_____1. Steady rest.
_____2. Follower rest.



A B

Fig.7-8. Types of lathe rest.

7.12. Write the letter of the correct response to the following statements and questions.

7.12.1. When drilling and reaming with taper shank tools on the lathe, the tool is generally mounted in

A. the headstock spindle.
B. the tailstock spindle.
C. a drill chuck in the headstock spindle.
D. a drill chuck in the tailstock spindle.

7.12.2. In lathe work, the first step for accurate drilling or reaming is to

A. install the tool.
B. mount the workpiece.
C. check tool sharpness.
D. check lathe center alignment.

7.12.3. The device being employed in the drilling operation shown at point *A* at the right figure is a

A. drill pad.
B. pad center.
C. crotch center.
D. V-block.

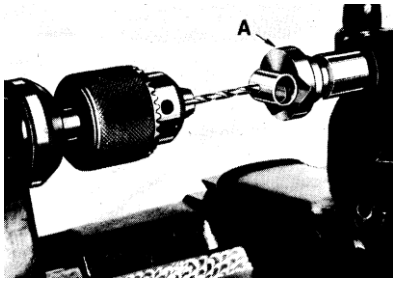


Fig.7-9. Drilling operation.

7.12.4. When taper-shanked tools are installed, they should be seated firmly by tapping with a

A. ball peen hammer.
B. tool post wrench.
C. lead hammer.
D. Any of the above.

7.12.5. The boring of small holes usually requires the use of what kind of boring tool?

A. Inserted tool-bit boring bar.
B. Forged boring bar.
C. Tool bit.
D. Counterbore.

7.12.6. The best method of producing accurately sized, round, straight, and smooth holes is by

A. drilling.
B. reaming.
C. boring.
D. counterboring.

7.12.7. The tool that should be used to accurately measure a bored hole of 50.8 mm diameter is

A. inside caliper.
B. inside micrometer.
C. telescoping gage.
D. small hole gage.

7.12.8. Commercially made mandrels are usually made of

A. aluminum.
B. brass.
C. soft steel.
D. hardened steel.

7.12.9. Mandrels should be oiled before being installed so that they

A. revolve better.
B. will not rust.
C. can be installed easier.
D. can be removed easier.

7.12.10. Which method of taper turning is capable of turning steep tapers?

A. Compound rest.
B. Tailstocksetover.
C. Taper attachment.
D. Automatic feed.

7.12.11. For turning a Morse taper on workpieces of different lengths, which method of taper turning would be the most practical to use?

A. Compound rest.
B. Tailstocksetover.
C. Taper attachment.
D. Automatic feed.

7.12.12. What type of taper attachment is pictured at the right figure?

A. External.
B. Internal.
C. Plain.
D. Telescoping.

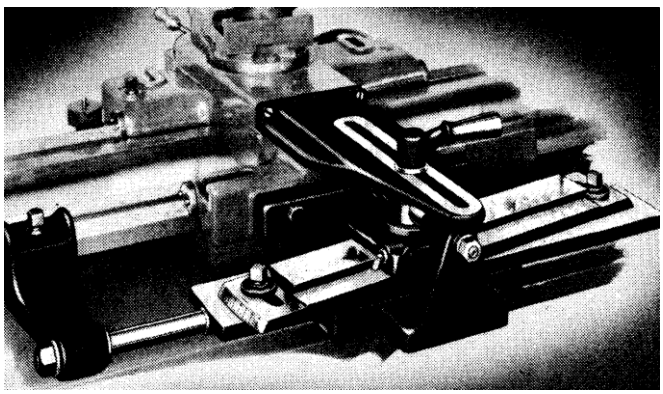


Fig.7-10. Taper attachment.

7.13. Solve the following problems.

7.13.1. Calculate the angle to set the compound rest for turning the taper in the right figure.

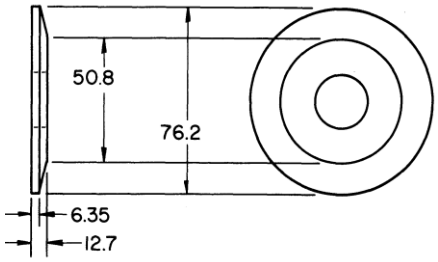
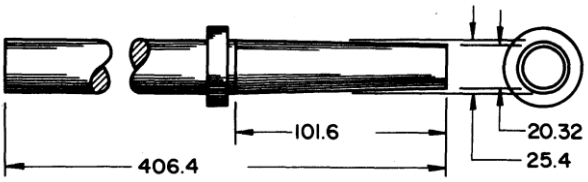


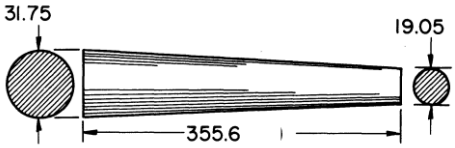
Fig.7-11. Tapering workpiece.

_____.

7.13.2. Determine the amount of setover for turning tapers in the figure below.



A



B

Fig.7-12. Tapering workpieces.

_____A.
_____B.

7.14. Arrange the following steps for chasing a 60° external thread by listing them by letter in their correct order.

_____1.
_____2.
_____3.
_____4.
_____5.
_____6.
_____7.
_____8.
_____9.
_____10.
_____11.
_____12.
_____13.

A. Return carriage to the starting point and advance compound rest screw for the next cut.
B. Set micrometer collar on cross feed screw to zero.
C. Withdraw threading tool at the end of the cut by turning cross feed screw one turn to the left and disengaging half-nut.
D. Adjust gearbox for desired thread pitch.
E. Check that the point of the tool is on center.
F. Mount threading tool in toolholder for maximum rigidity.
G. Make repeated cuts until desired depth of thread is reached.
H. Advance the threading tool until the point touches the workpiece.
I. Set compound rest to 29°.
J. Move the tool past the right end of the workpiece, and advance compound rest screw about 0.08 mm.
K. Return the cross feed screw to the zero setting, and engage the half-nut at the appropriate point.
L. With center gage, set tool square with the workpiece.
M. Start the lathe and engage the half-nut when the appropriate number and/or line is even with the line on the rim of the indicator.

7.15. Write the letter of the correct response to each statement or question.

7.15.1. Lathe hydraulic tracer attachments are capable of turning
A. straight cylinders, cones, concave, and convex surfaces.
B. and boring straight cylinders, cones, concave and convex surfaces.
C. and boring straight cylinders, cones, and concave surfaces.
D. and boring straight cylinders, cones, and convex surfaces.

7.15.2. Templates or models for use with lathe hydraulic tracers must be
A. the actual size of the workpiece.
B. half the actual size of the workpiece.
C. twice the size of the actual workpiece.
D. size varies according to the make of the tracer.

7.15.3. When the initial tracer setup is made, the tracing stylus should touch the highest point on the template. How far from the workpiece should the tool be positioned?
A. 0.8 mm.
B. 1.6mm.
C. 2.36 mm.
D. 3.0 mm.

7.15.4. For finishing cuts on a lathe hydraulic tracer, the tool is made to advance by
A. advancing the cross slide.
B. advancing the tracing stylus.
C. backing away the cross slide.
D. backing away the tracing stylus.

7.15.5. Identify each illustrated turret toolholder (Fig.7-13) by matching it with its name.

_____1. Multiple toolholder.
_____2. Slide tool.
_____3. Knee tool.
_____4. Self-opening die head.
_____5. Roller turner.
_____6. Knurling tool.
_____7. Adjustable toolholder for drills, reamers, etc.

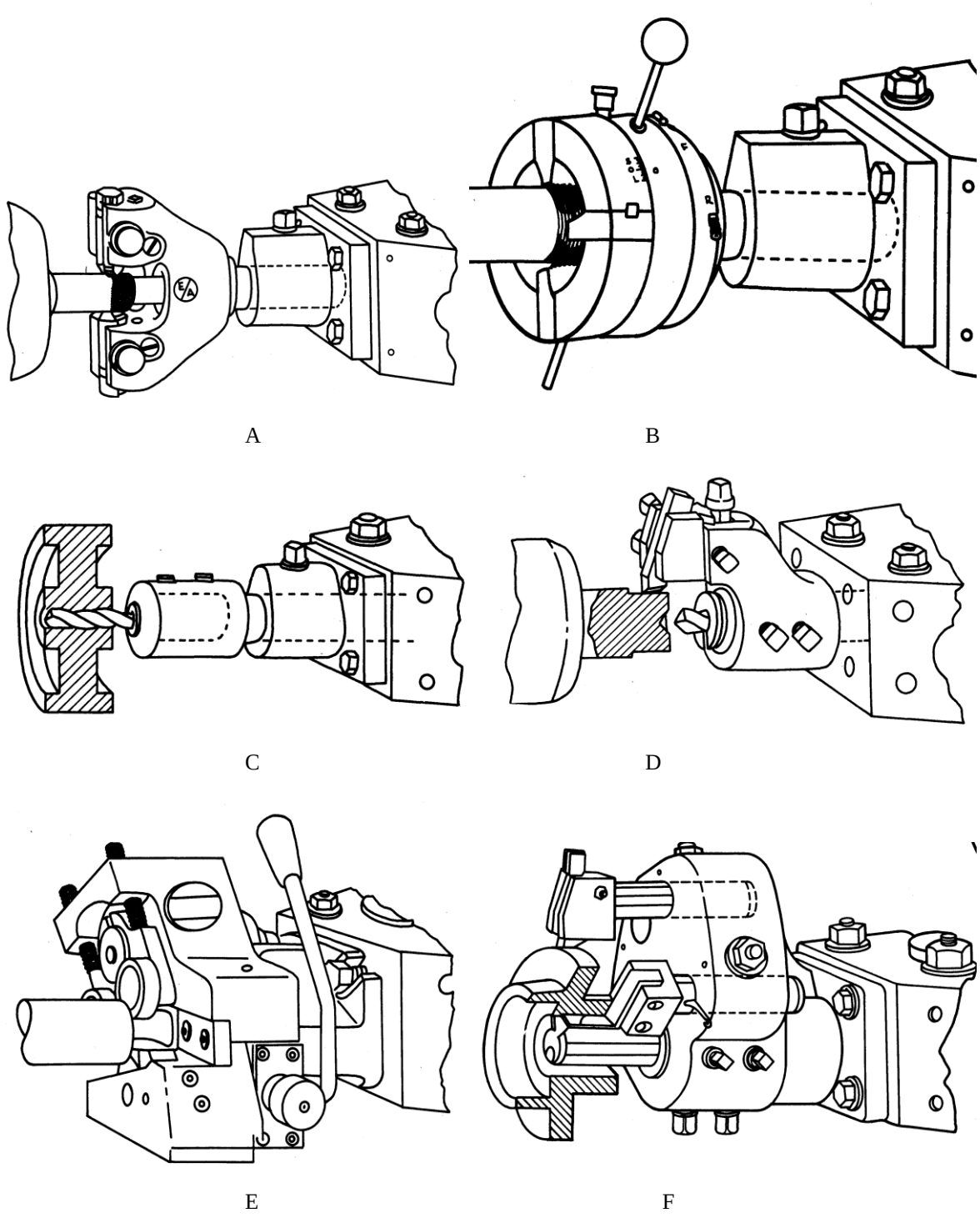


Fig.7-13. Turret toolholders.

7.15.6. A tooling technique recommended for turret lathes to sharply reduce job changeover time is one that uses

A. quick change tooling.
B. permanent setups of universal tooling.
C. packaged tooling for each job.
D. preset tooling.

7.15.7. The rear tool post on a turret-lathe cross slide normally is used for

A. boring.
B. facing.
C. turning.
D. stock cutoff.

7.15.8. In order to prevent flailing of long bars projecting from the outboard side of the turret lathe spindle, they should be

A. run at a slower rpm.
B. cut off short.
C. supported with a stock stand.
D. *A* or *C*.

7.15.9. The turret tool post mounted on the front of the cross slide usually mounts how many tools?

A. 2.
B. 4.
C. 6.
D. 8.

8. The Milling Machine

8.1. Identify the parts of the vertical milling machine shown at the right by writing the part letter in the space next to the part name.

_____1. Spindle.
_____2. Vertical traverse hand crank.
_____3. Quill feed handwheel for fine feed.
_____4. Cross traverse lock.
_____5. Adjusting bolt for swiveling the head.
_____6. Quill.
_____7. Longitudinal traverse hand crank.
_____8. Vertical traverse lock.
_____9. Quill feed lever for coarse feed.
_____10. Ram positioning lever.
_____11. Cross traverse hand crank.
_____12. Quill depth stop.
_____13. Longitudinal traverse lock.
_____14. Motor.

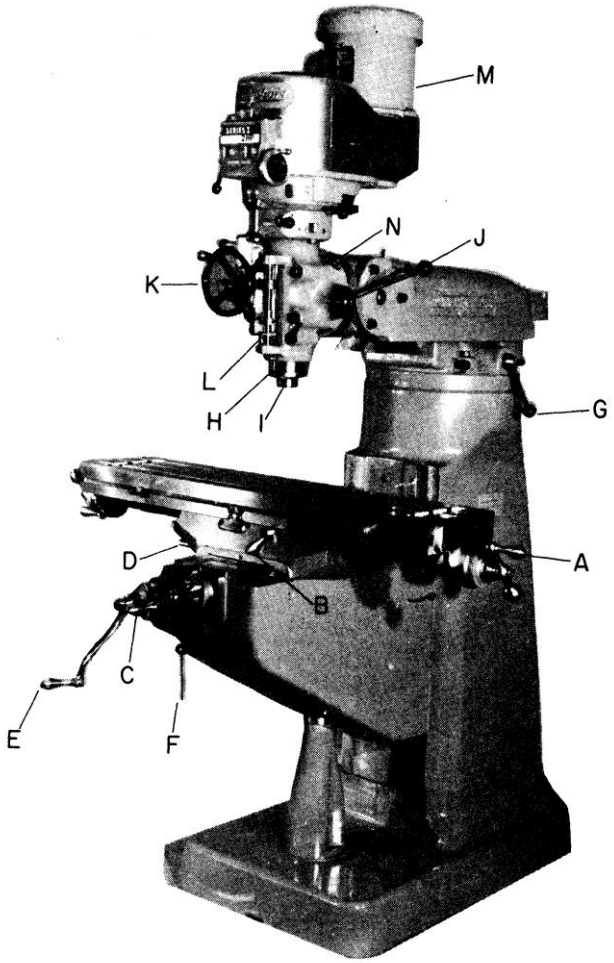


Fig.8-1. The milling machine.

7.15.10. Turret lathe bed turrets usually have how many tool-mounting faces?

A. 4 - 6.
B. 6 - 8.
C. 8 - 10.
D. 10 - 12.

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Fig.7-3. Center drilled holes.

1. For what purposes are the following cutting tools used?

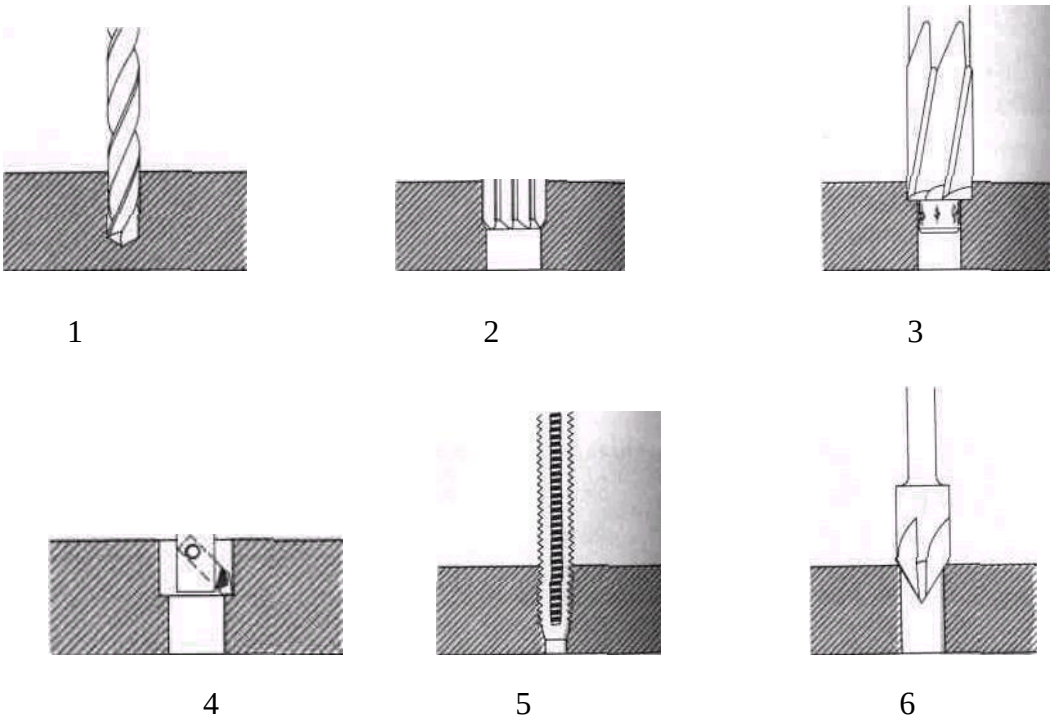

Fig. 1. Cutting tools that can be used on a drill press and a lathe.

1._____
_____
2._____
_____
3._____
_____
4._____
_____
5._____
_____
6._____
_____

Contents

V.V. Konev