DOCUMENT RESUME

ED 098 398 CE 002 502

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TITLE Drilling Machines: Vocational Machine Shop.
INSTITUTION Kentucky Univ., Lexington. Vocational Education Curriculum Development Center.
PUB DATE Feb 74
NOTE 71p.
AVAILABLE FROM Curriculum Development Center, Room 151, Taylor Education Building, University of Kentucky, Lexington, Kentucky 40506 (Single copies only, $2.50)

EDRS PRICE MF-$0.75 HC-$3.15 PLUS POSTAGE
DESCRIPTORS Audiovisual Aids; *Curriculum Guides; Industrial Arts; Instructional Materials; Job Training; Lesson Plans; Machine Tool Operators; *Machine Tools; *Metal Working Occupations; Secondary Education; *Shop Curriculum; Skill Development; *Trade and Industrial Education; Vocational Education
IDENTIFIERS Drilling; Kentucky

ABSTRACT

The lessons and supportive information in this field tested instructional block provide a guide for teachers in developing a machine shop course of study in drilling. The document is comprised of operation sheets, information sheets, and transparency masters for 23 lessons. Each lesson plan includes a performance objective, material and tools, teaching aids, suggested references and an information outline. Student performance objectives include: (1) drill holes in different types of metals, using correct feeds and speeds, (2) make set-ups for drilling flat stock, round stock, sheet metal, and irregular shapes, using the proper work holding devices, (3) change the holding capacity of the drill press spindle, using sockets, sleeves, and chucks, (4) drill holes of predetermined depths, using the drill press stops, (5) countersink, counterbore, and spot face drilled holes, using the proper tool, (6) drill undersize holes and enlarge them, using reamers, (7) tap holes, using taps and tapping attachment, and (8) lap holes, using lap tools. A list of manufacturers of drills and reamers and a bibliography conclude the curriculum guide. (MW)

VOCATIONAL MACHINE SHOP

DRILLING MACHINES

1974

PREPARED AND DISTRIBUTED BY
THE CURRICULUM DEVELOPMENT CENTER
FOR KENTUCKY
151 TAYLOR EDUCATION BUILDING
UNIVERSITY OF KENTUCKY
LEXINGTON, KENTUCKY 40506

MACHINE SHOP

ORIENTATION

BENCHWORK

DRILLING 

LATHES

MILLING MACHINES

GRINDING

SHAPER AND PLANERS

POWER-SAWS

TOOL ROOM PRACTICE

METALS & ALLOYS

RELATED

VOCATIONAL MACHINE SHOP

DRILLING MACHINES

1974

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PREFACE

Vocational educators in Kentucky are vitally concerned with the development of an effective and efficient program of vocational education.

Vocational teachers are certainly concerned with up-to-date instructional methods and procedures.

Curriculum materials are being developed according to varied formats across the country. Materials in this document reflect some of these changes being made in Kentucky.

Vocational personnel at the local level have been involved with curriculum and instructional methods in conjunction with the accreditation visits, craft advisory committee meetings, and other evaluational visits.

It is expected that machine shop teachers will have to add, delete, change and otherwise fit these materials to their own situation.

INTRODUCTION

The course of study in Machine Shop is concerned with eleven major blocks. Traditionally, each course of study was developed, printed, and disseminated as a complete package. The Machine Shop course of study will be printed and disseminated to teachers and other appropriate individuals by block

The blocks are comprised of operation sheets, information sheets, and transparency masters.

These materials were developed as a result of the Trade and Industrial Curriculum Development Institute in 1972.

These materials were field tested at selected sites during the 1973 school year and a Field Test Review Workshop was held to review input collected from the various field test sites.

The lessons and supportive information in this block are designed to provide a guide for teachers in their efforts to develop an instructional system.

In using this guide, the teacher may find it necessary to restate objectives, rewrite lessons, adjust instructional format, and make other changes to fit specific local needs.

This block represents one of eleven blocks that make up the Machine Shop course of study.

ACKNOWLEDGEMENTS

A philosophy proposed by many learning strategists states that curriculum materials developed and produced to support the teaching effort will be more meaningful and find wider application if incumbent teachers have an equalized access to, and a direct influence on, the design and content of such material.

Many machine shop teachers in Kentucky have contributed to the preparation of this document.

Appreciation is especially extended to the following individuals for their efforts in the institute:

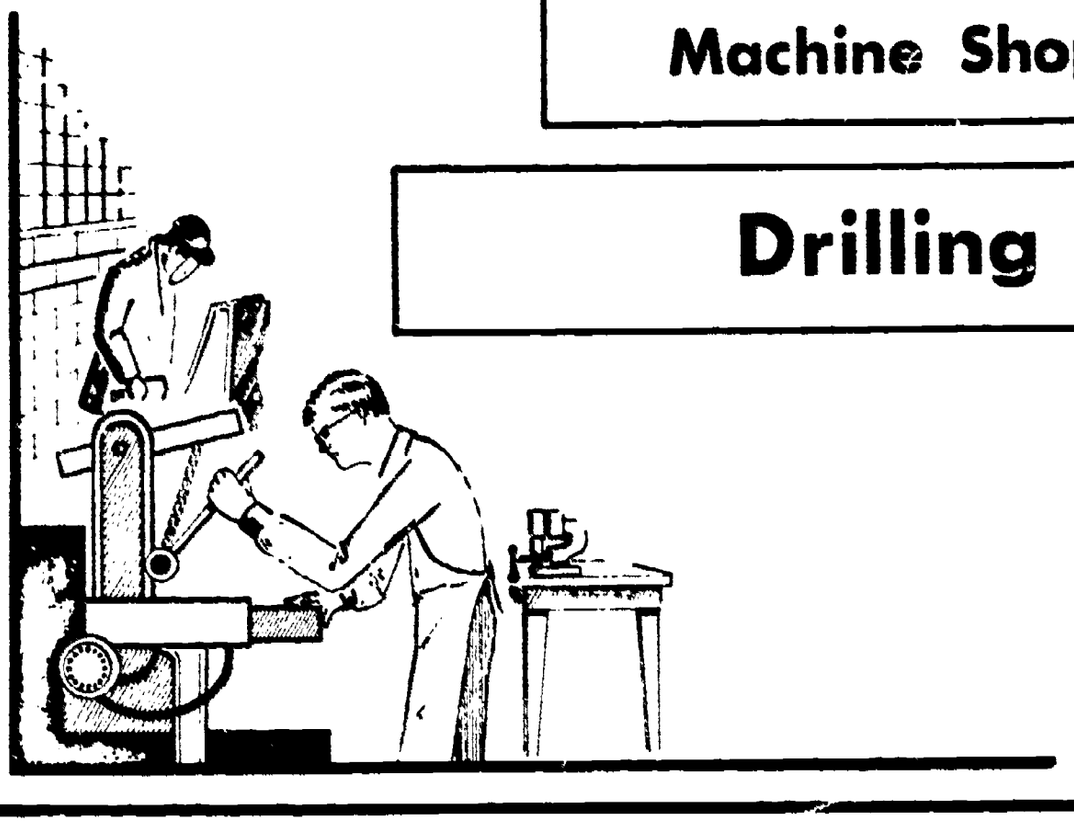
Mr. Larry Young	Ashland State Vocational Technical School
Mr. Noble Stuart	Bowling Green State Vocational Technical School
Mr. Marion Baldwin	Harrison County Area Vocation Education Center
Mr. Paul Combs	Hazard State Vocational Technical School
Mr. William Lewis	Northern Kentucky State Vocational Technical School
Mr. Caudie Redmond	Somerset State Vocational Technical School
Mr. Jerry White	Paducah Area Vocation Education Center

Appreciation is also extended to the following individuals for their efforts in field testing materials and contributing to the Field Test Revision Workshop:

Mr. Larry Young	Ashland State Vocational Technical School
Mr. Noble Stuart	Bowling Green State Vocational Technical School
Mr. Marion Baldwin	Harrison County Area Vocation Education Center
Mr. William Lewis	Northern Kentucky State Vocational Technical School
Mr. Paul Ashley	Breathitt County Area Vocation Education Center
Mr. Bob Saylor	Central Kentucky State Vocational Technical School
Mr. Emmert Behr	Jefferson State Vocational Technical School

We are also grateful to Mr. Fred Martin, Director, Trade and Industrial Unit, Kentucky Bureau of Vocational Education, and to the regional directors and the local vocational administrators for making it possible to conduct developmental workshops.

Appreciation is extended to the Curriculum Development Center personnel as follows: Mr. Raymond Gilmore, Mr. Steve Statzer and Mrs. Donna Phipps Stout for their excellent artwork, Mrs. Pat Schrader for editorial assistance, Mr. Tom VanTreese for assistance with media, Dr. Herbert Bruce for advice and assistance, and Mr. Ralph O'Brien (former curriculum specialist) who planned and participated in much of this effort.



Machine Shop

Drilling

STUDENT PERFORMANCE OBJECTIVES

Upon completion of the twenty lessons in this block, the student will be able to:

1. Drill holes in different types of metals, using the correct feeds and speeds.
2. Make set-ups for drilling flat stock, round stock, sheet metal, and irregular shapes, using the proper work holding devices.
3. Change the holding capacity of the drill press spindle, using sockets, sleeves, and chucks.
4. Drill holes to predetermined depths, using the drill press stops.
5. Countersink, counterbore, and spot face drilled holes, using the proper tool.
6. Drill undersize holes and enlarge them, using reamers.
7. Tap holes, using taps and tapping attachment.
8. Lap holes, using lapping tools.

INFORMATION

Block: Drilling Machines

Lesson: Drilling Machine Types and Sizes

Block ____
Job ____
Lesson ____

Performance Objectives Upon completion of this lesson, the student will be able to describe the types, sizes, special uses, and characteristics of each drilling machine.

References: Machine Tool Operation. Burghardt, Axelrod, Anderson, Part #1, Chapter 8.

Outline of Information:

A. Types

1. Heavy duty--heavy work
2. Standard floor--general purpose use
3. Standard bench--used for light drilling work
4. Gang--used in progressive production work
5. Radial--used for large work, spinkle àocated over work
6. Sensitive--used for light drilling operations
7. Numerically controlled--extreme precision production work

B. Determination of Drilling Machine Size

1. The size of a drilling machine can be determined by the largest diameter workpiece that can be drilled on center (from the column to the center of the spindle).

INFORMATION

Block: Drilling Machines — Block ____ Job ____

Lesson: Drills in the Machine Tool World — Lesson ____

Performance Objective: Upon completion of this lesson, the student will be able to state one trend concerning drills.

References: Drilling Today's Materials. Metal Cutting Institute in New York
The Use and Care of Twist Drills. Cleveland Twist Drill Co.
The Use and Care of Reamers. Cleveland Twist Drill Co.

Outline of Information:

A. History

The twist bit was invented by Stephen A. Morse in 1864.

B. Metrication

Manufacturers agree that it is only a matter of time before the United States adopts the metric system. Dual specification--English and metric measurements side by side--are increasingly common among drill manufacturers and users.

C. Developments in Drills

Cobalt--meets the demand for increasingly high speed drills
Carbide tipped--for abrasive materials (less expensive than solid carbide)
Solid carbide--heavy duty drilling in abrasive materials
Split point--for deep holes
High-helix drills with wide flutes--deep holes in low tensile strength materials including certain plastics and stacked aluminum sheets
Cast drills--research stage in the United States

D. Development in Cutting Fluids

The development of pressurized lubrication has broadened the usefulness of spade drills and gun drills.

INFORMATION

Block: Drilling Machines

Lesson: Safety Precautions

Block ____
Job ____
Lesson ____

Performance Objective: Upon completion of this lesson, the student will be able to describe the safety precautions necessary for operating drilling machines.

Teaching Aids: Film: "Don't Drop Your Guard." (16mm Sound Color, Aetna Life and Casualty)

References: Shop Theory. Anderson, Tatro, pp. 9-12.
Machine Tool Operation. Burghardt, Axelrod, Anderson, Chapter 8.
Technology of Machine Tools. Krar, Oswald, St. Amand, p. 131.
"Safety in the Seventies," School Shop. April, 1972 .

Outline of Information:

A. Essential Safety Practices

1. Remove chuck keys, drill drifts, before starting drill spindle to prevent injury to operator.
2. Use drills that are properly sharpened and are running true.
3. Never attempt to hold the work by hand; a vise stop or clamp should be used to prevent the work from spinning.
4. As the drill begins to break through the work, ease up on the drilling pressure and allow the drill to break through gradually.
5. Always remove burrs from a drilled hole with a file or scraper.
6. Good housekeeping is part of drilling work.
7. Stop power when machine is not in operation.
8. Always wear safety glasses.
9. Remove jewelry from wrists.
10. Long hair must be covered with cap or industrial hair net.
11. Long sleeves must be rolled up to above the elbow.

OPERATION

Block: Drilling Machine — Block ____

Job ____

Lesson: Drilling a Hole (Using Manual Feed) — Operation ____

Performance Objective: Upon completion of this lesson, the student will be able to drill a hole that is true and straight using manual feed.

Tools: Drill press, chuck key, vise, drill bit, safety shield, center punch

Materials: Mild steel, 1/2" thick

Teaching Aids: Charts of drill sizes

References: Machining Fundamentals. Walker p. 95-120.
Metalwork Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.

Steps:

1. Select drill bit (check point and angle).
2. Lock in chuck.
3. Calculate proper speed.
4. Check drill for run out.
5. Clamp work in vise making sure it is flat and square.
6. Adjust drill to center punch marked with the help of a wiggler.
7. Start the drill and slowly feed bit into the work with the point of the drill starting in the indentation made by the center punch. Apply coolant or cutting oil.
8. Raise drill from hole occasionally to release chips.
9. Release some pressure when drill begins to break through.

CAUTION: Do not remove chips with hands or air hose.

OPERATION

Block: Drilling Machine

Lesson: Drilling a Hole (Using Automatic Feed)

Block _____
Job _____
Operation _____

Performance Objective: Upon completion of this lesson, the student will be able to drill a hole that is true and straight using automatic feed.

Tools: Drill press, chuck key, vise, drill bit, safety shield, center punch

Materials: Mild steel, 1/2" thick

Teaching Aids: Charts of drill sizes. Transparency Master: "Drilling," p.3-8.

References: Machining Fundamentals. Walker, p. 95-120.
Metalwork Technology and Practice, Ludwig, Unit 25,30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.

Steps:

1. Secure workpiece in drill vise.
2. Secure vise to machine.
3. Select proper drill bit.
4. Select proper size center drill.
5. Secure center drill in chuck.
6. Adjust machine table to proper height.
7. Adjust machine to proper speed and feed.
8. Position workpiece to center drill.
9. Start machine; center drill to desired depth.
10. Stop machine; remove center drill.
11. Secure drill bit in chuck.
12. Start machine; check drill bit for trueness.
13. Set drill for desired depth.
14. Lubricate drill bit; use hole for oil reservoir.
15. Move drill bit point into center drill hole; engage automatic down feed, and drill until feed disengages at desired depth.

CAUTION: Disengage down feed, raise drill from hole occasionally to clean chips from hole, and lubricate.

OPERATION

Block: Drilling Machine

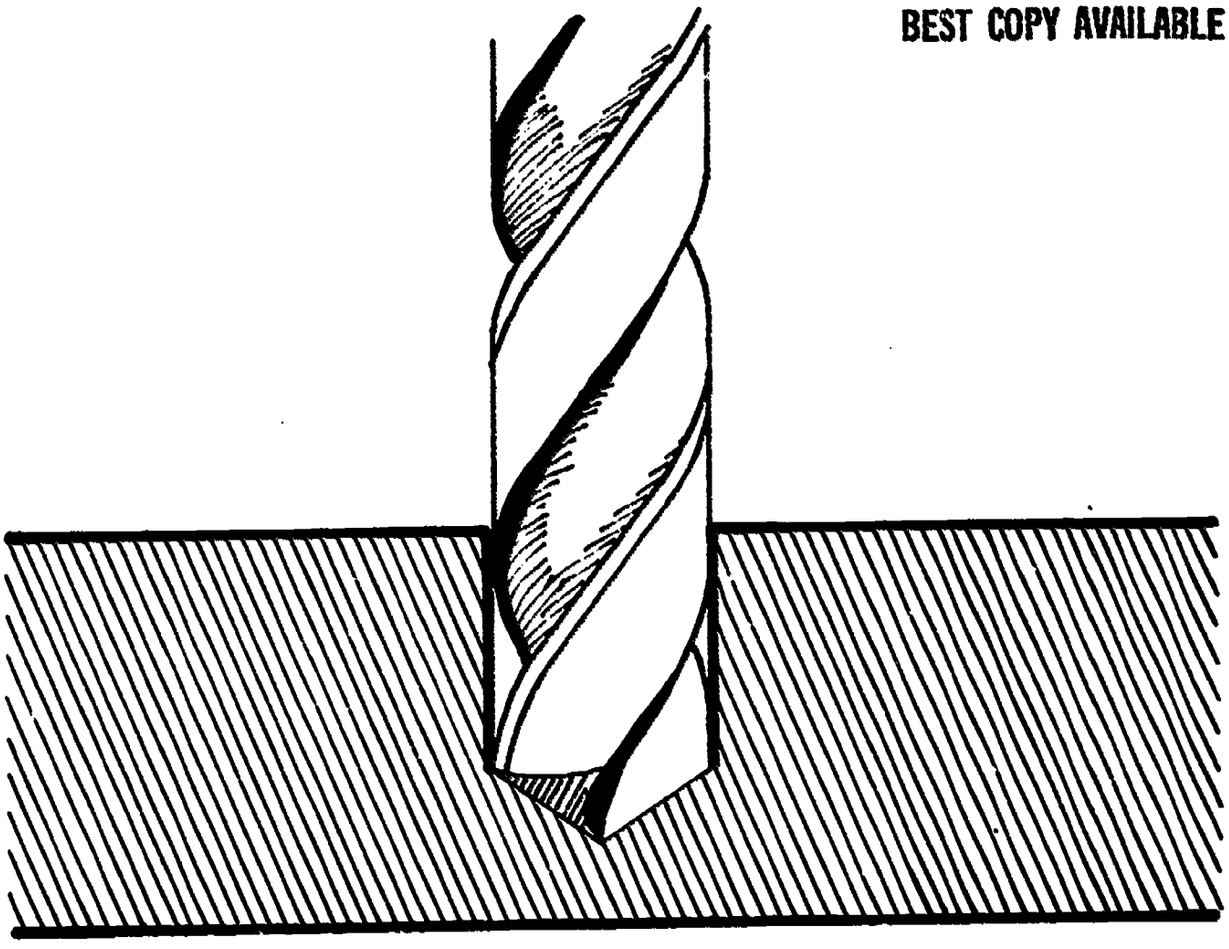
Lesson: Drilling a Hole (Using Automatic Feed)

Block ____
Job ____
Operation ____

Steps: (Continued)

16. After hole is drilled, disengage down feed and remove drill bit from hole.

CAUTION: Do not remove chips by hand.



DRILLING

PHIPPS, CURR. DEV. CNTR., U.K. 884-6

INFORMATION

Block: Drilling Machine

Lesson: Drill Holding Devices

Block ____
Job ____
Lesson ____

Performance Objective: Upon completion of this lesson, students will be able to select the proper drill-holding device for a specific job.

Teaching Aids: Transparency Masters:

"Drill Chuck," p. 3-10.
"Sleeve for Tapered Shank," p. 3-11.
"Drill Drift," p. 3-12.
"Removing the Drill from the Spindle of a Drill Press," p. 3-13.

References:

Machining Fundamentals. Walker, p. 95-120.
Metalwork Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.

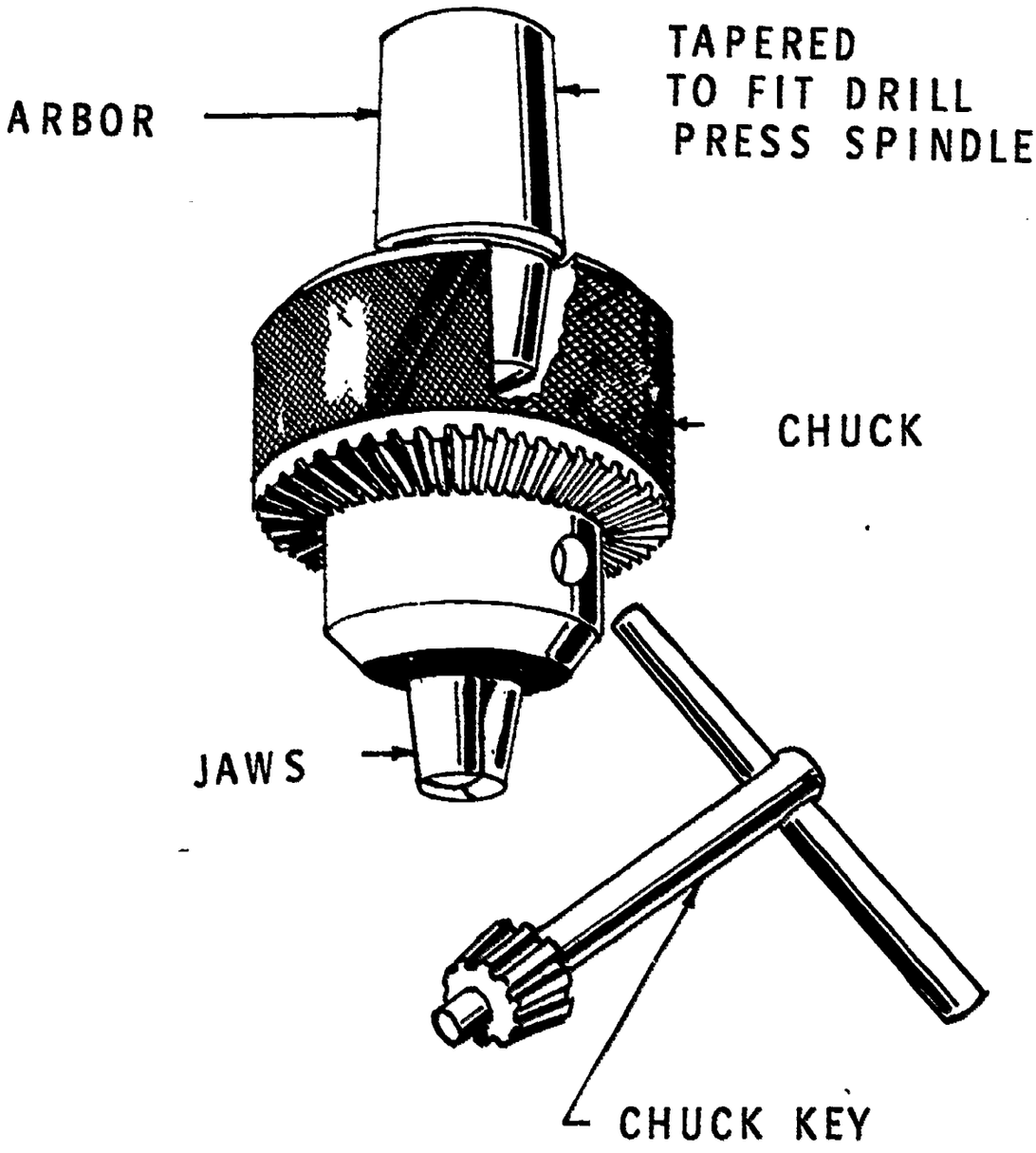
Outline of Information:

A. Chucks: (used to hold straight-shank drills)

   1. Jacobs key-type chuck (3-jaws)
   2. Keyless type chuck (quick change)

B. Drill Sleeves: (used to hold taper-shank drills and straight-shank drills with a tang)

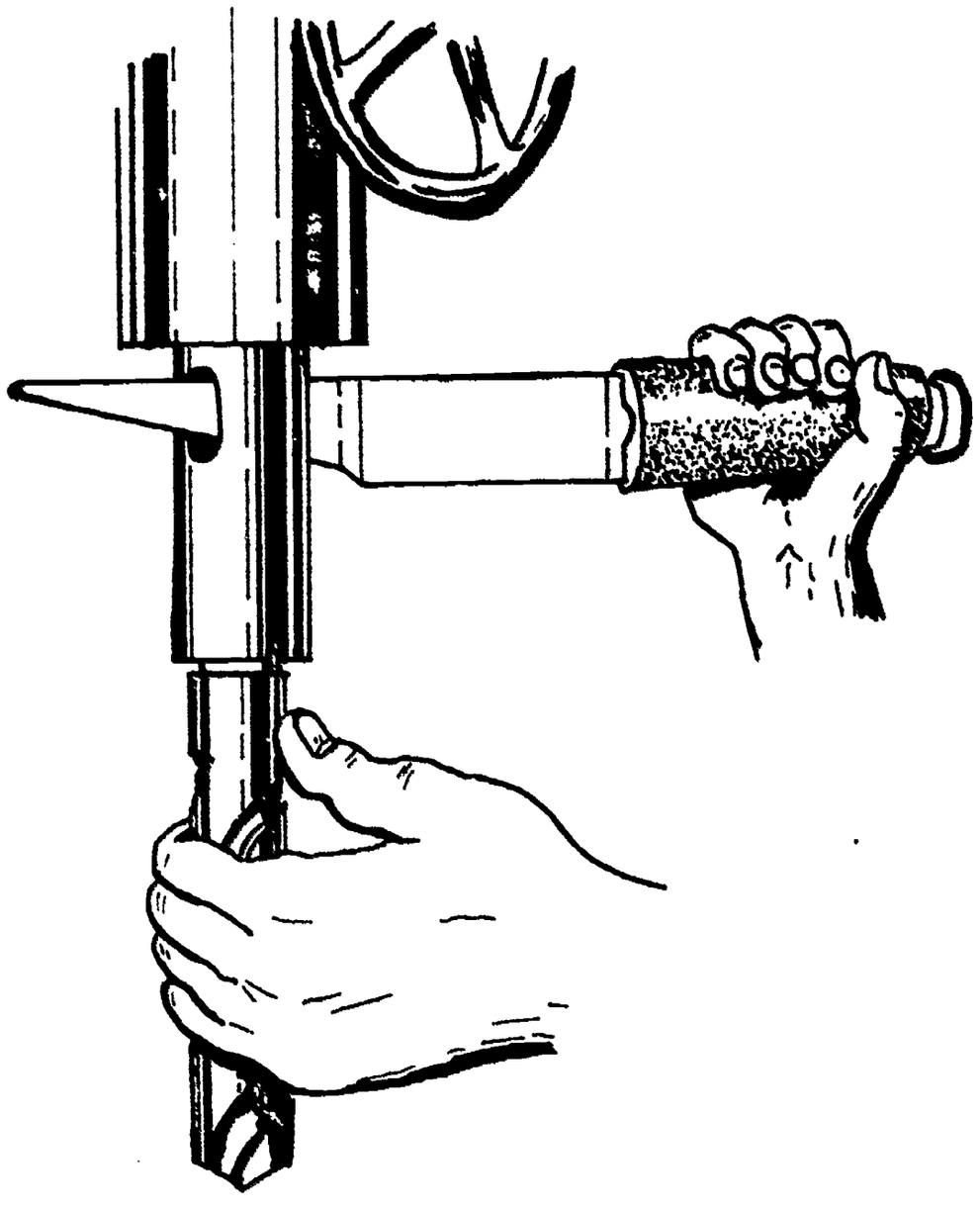
C. Drill Sockets: (used to hold drills that are larger than the spindle opening)


ARBOR
TAPERED
TO FIT DRILL
PRESS SPINDLE
CHUCK
JAWS
CHUCK KEY

DRILL CHUCK

SLEEVE FOR TAPERED SHANKS

DRILL DRIFT



REMOVING THE DRILL FROM THE SPINDLE OF A DRILL PRESS

INFORMATION

Block: Drilling Machine — Block ____

Job ____

Lesson: Work-Holding Devices and Accessories — Lesson ____

Performance Objective: Upon completion of this lesson, the student will be able to identify the various types of work-holding devices.

Teaching Aids: Transparency Masters:

"Clamps," p. 3-16.
"V-Block," p. 3-17.
"Angle Plate," p. 3-18.
"Drill Jig," p. 3-19.

References: Machining Fundamentals. Walker, p. 95-120.
Metalwork Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.

Outline of Information:

A. Vises

1. Drill-press vise--used to hold and locate work for drilling

2. Universal vise--allows the operator to drill holes at an angle without tilting the table

3. Swivel vise--can be rotated through 180 degrees

B. Blocks

1. V-block--used to hold round work

2. Step block--used for blocking back end of clamp

C. Clamps

1. Strap clamps (finger, gooseneck, "U" strap, straight)--used for clamping work to table of drilling machine
   a. Step block
   b. T-Slot bolts-used with strap clamps

2. C-clamp--used to clamp work to the table

3. Parallel clamp (toolmaker's clamp, machinist's clamp)--used to clamp work in place for drilling.

D. Angle Plates--used when work must be clamped to a support

Block: Drilling Machine — Block ____

Job ____

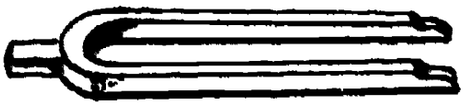
Lesson: Work-Holding Devices and Accessories — Lesson ____

Outline of Information: (Cont'd)

E. Drill Jig

1. Locates the workpiece in proper position and holds it securely
2. Jig bushing guides the drill

PLAIN CLAMP



U-CLAMP

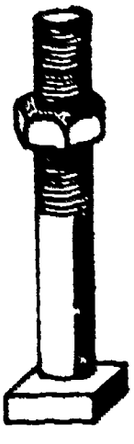
GOOSE-NECK CLAMP

SCEW-HEEL CLAMP

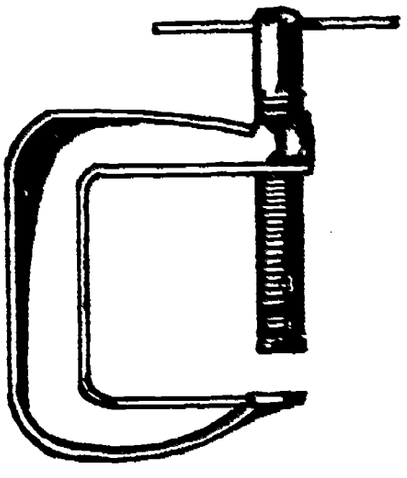
FINGER CLAMP

DOUBLE FINGER CLAMP

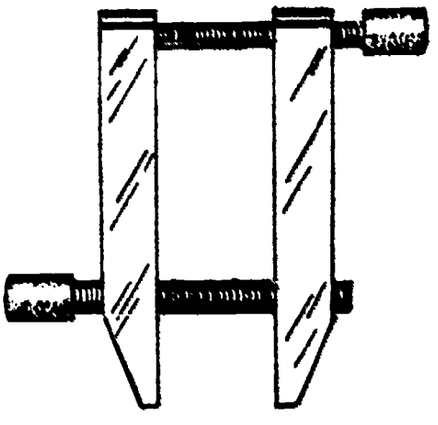
STRAP CLAMPS



T-SLOT BOLT



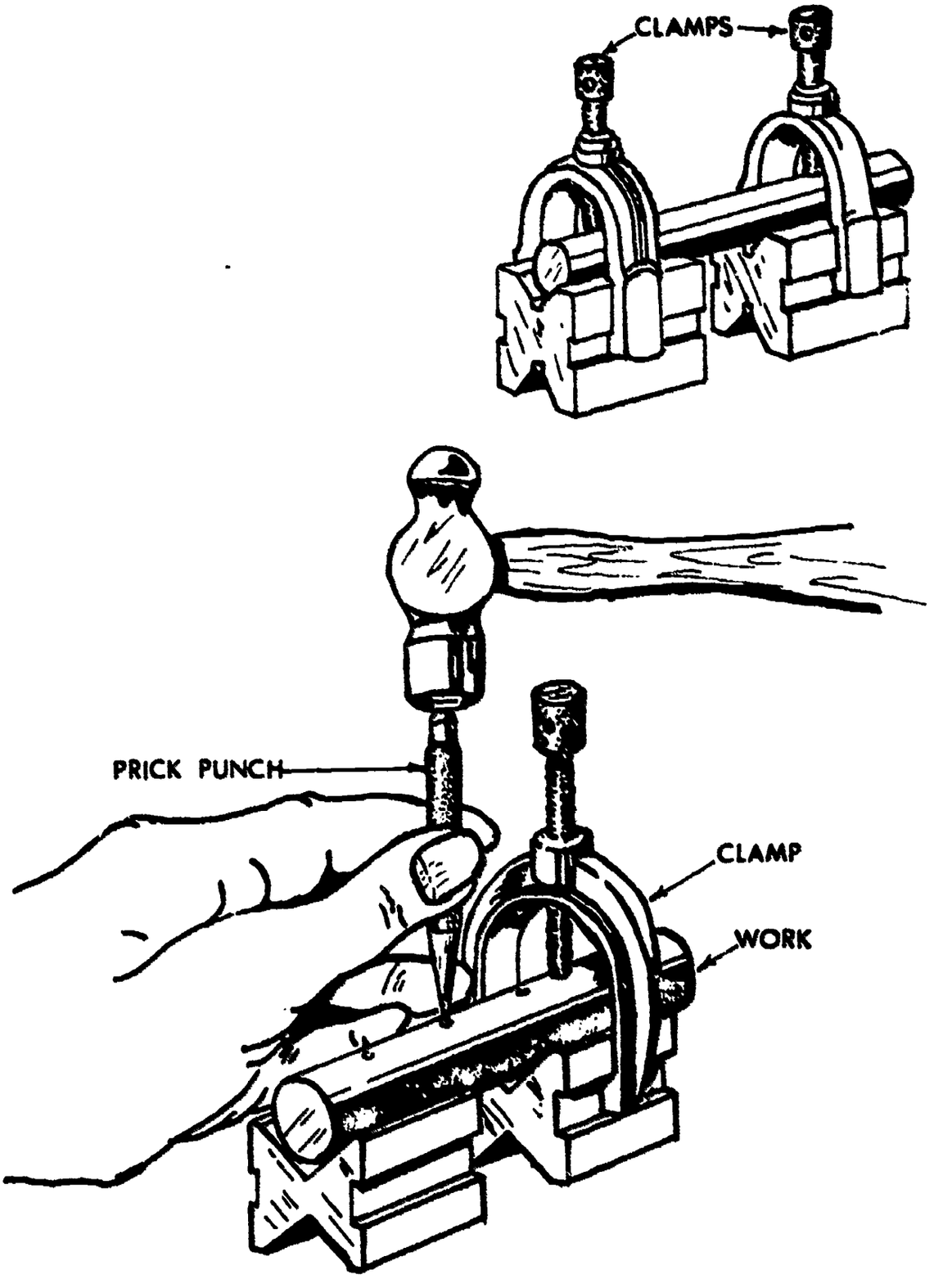
C-CLAMP



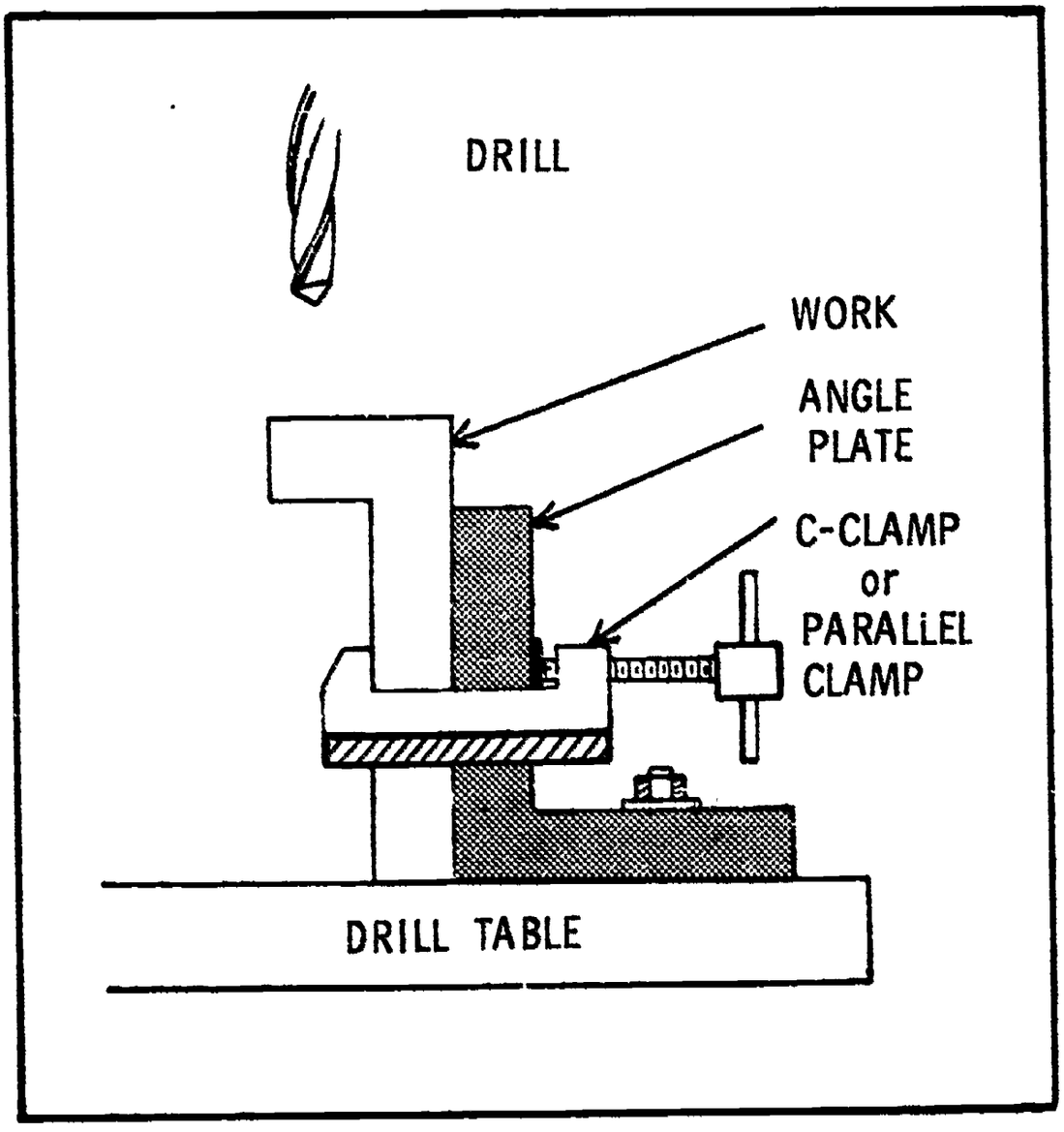
PARALLEL CLAMP

CLAMPS

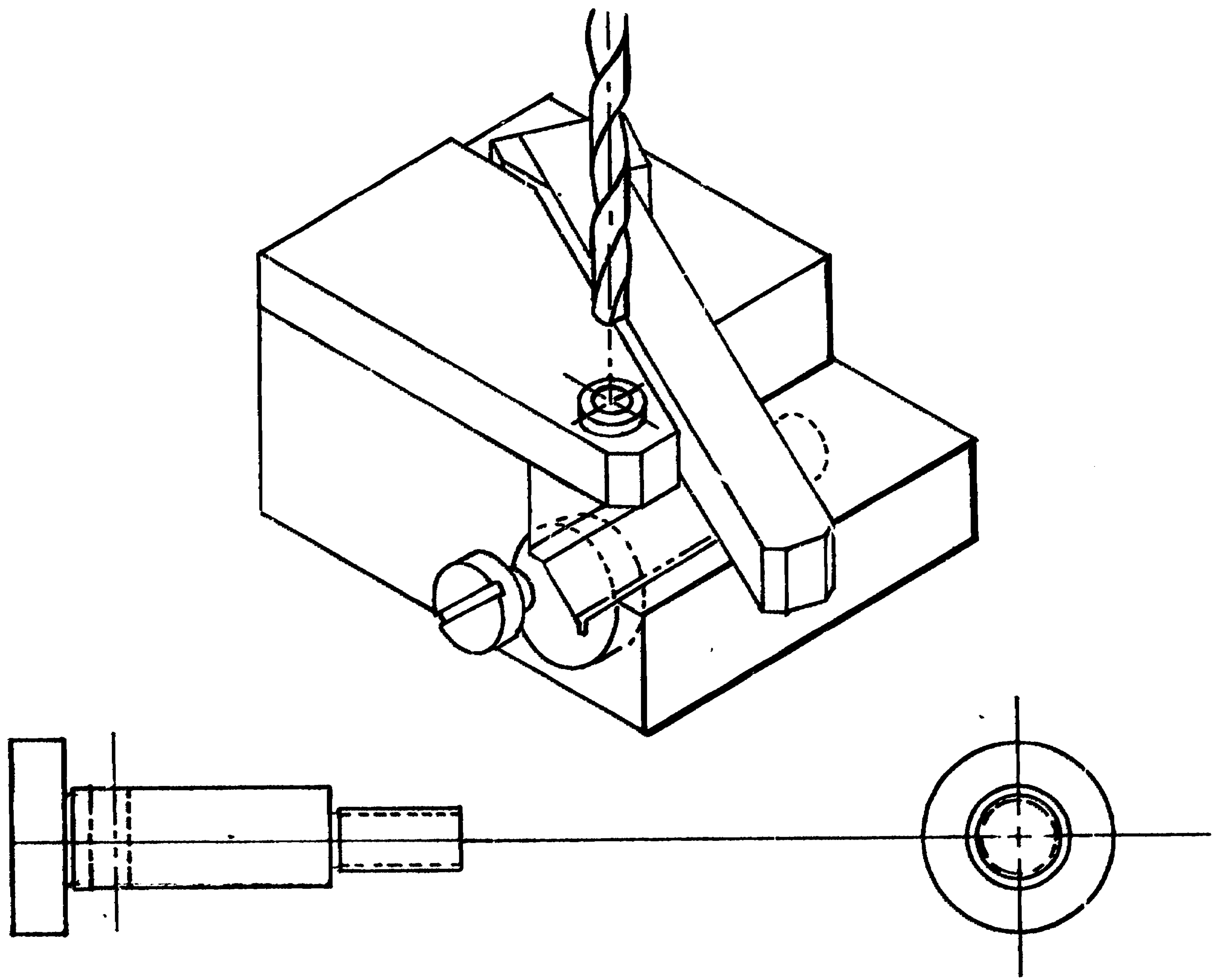
V-BLOCK



ANGLE PLATE


DRILL
WORK
ANGLE PLATE
C-CLAMP or PARALLEL CLAMP
DRILL TABLE

DRILL JIG



OPERATION

Block: Drilling Machine

Lesson: Clamping Work

Block _____
Job _____
Operation _____

Performance Objective: Upon completion of this lesson, students will be able to select and use the proper holding device while drilling a hole.

Tools: Drill press, drill vise, clamping bolts, parallels, V-blocks, step-blocks, and soft-faced hammer.

Materials: C.R.S. 1/2" x 2" x 3 3/4"

References: Machining Fundamentals. Walker, p. 95-120.
Metalwork Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-?78.
Technology of Machine Tools. Krar, Chapter 6.

Steps:

1. Check and remove dirt, oil, grease, and chips from the table of the drill press.
2. Select the correct holding device, or devices.
3. Grip the work in the holding device and level by tapping the work with a soft-faced hammer.
4. Line up center punch mark with the point of the drill bit, and clamp or bolt work to the table.

CAUTION: Check to make sure the work is not moving or springing.

Note: Set the depth gauge on your drill press before drilling to avoid damage to the table.

INFORMATION

Block: Drilling Machine

Lesson: How to Calculate Speeds and Feeds

Block _____
Job _____
Lesson _____

Performance Objective: Upon completion of this lesson, the student will be able to calculate speeds and feeds.

Teaching Aids:

References:

Outline of Information:

A. Cutting Speed of Drill

1. Most important factor in determining the life of a drill

   a. Drill speed too fast dulls cutting edges rapidly as a result of overheating

   b. Drill feeds too fast resulting in a broken or dull drill bit.

2. Factors contributing to most economical drilling speed.

   a. Type and hardness of material

   b. Diameter and material of the drill

   c. Depth of hole

   d. Type and condition of the drill press

   e. Cutting fluid efficiency

   f. Accuracy and quality of hole requirement

   g. Rigidity of work set-up

3. Cutting speed in surface feet per minute

   a. The rate at which the outside or periphery of the tool moves in relation to work being drilled

   b. Measured in surface feet per minute (SFM)

   c. Formula: SFM = .26 x RPM x drill diameter in inches

Block: Drilling Machine

Lesson: How to Calculate Speeds and Feeds

Block _____
Job _____
Lesson _____

Outline of Information: (Cont'd)

4. Drill speed in revolution per minute

   a. Formula when cutting speed is known

      $$RPM = 3.8 \times \frac{S \quad F \quad M}{\text{drill diameter in inches}}$$

   b. Factors to consider in calculating the number of revolutions per minute

      (1) Type of material to be drilled
      (2) Drill characteristics

B. Cutting Feeds

1. The distance that the drill advances into the work for each revolution

2. Factors governing the rate of feed

   a. Material being drilled

   b. Diameter of the drill

   c. Cutting fluid

   d. Condition of the drilling machine (rigidity)

   e. Type of drill

      (1) Carbon
      (2) High speed steel
      (3) Carbide

INFORMATION

Block: Drilling Machine

Lesson: Cutting Fluids

Block _____
Job _____
Lesson _____

Performance Objective: Upon completion of this lesson, the students will be able to select the proper cutting fluid for a specific job.

Teaching Aids: Transparency Master:

"Recommended Cutting Fluids," p. 3-25

References: Technology of Machine Tools. Krar, Oswald, St Amand, McGraw-Hill p. 125.

Outline of Information:

A. Types of Cutting Fluids

1. Emulsifying or soluble oils

a. A mixture of saponified oil (mineral oil base) and a portion of water

2. Straight cutting oils

a. Straight mineral oils

b. Straight fatty oils

3. Mineral lard oil

a. Mixture of mineral oil and lard oil

b. Much lower cost when compared to straight lard oil

B. Purpose of Cutting Fluids

1. Lubrication

a. Lubricating the contact surfaces between the tool and work reduces friction and consequently heat.

b. Lubrication reduces friction between the separate parts of the chip.

2. Cooling

a. Cutting fluids have the ability to carry away heat at the same rate it is generated.

Block: Drilling Machine

Lesson: Cutting Fluids

Block _____
Job _____
Lesson _____

Outline of Information (Cont'd)

3. Chip Disposal

   a. Fluid will help wash chips back through the flutes.

   b. Pressures of 500 pounds per square inch are common for this purpose.

RECOMMENDED CUTTING FLUIDS

	ALUMINUM	BRASS	BRONZE	CAST IRON	COPPER	MALLABLE IRON	MONEL METAL	STEEL ALLOYS	MACHINE STEEL	TOOL STEEL
AIR JET				X						
DRY		X	X	X	X	X				
MINERAL SPIRITS	X				X					
SOLUBLE OIL	X	X	X	X	X		X	X	X	X
SYN. COOLANT	X	X	X	X	X	X	X	X	X	X

INFORMATION

Block: Drilling Machine

Lesson: Parts of a Twist Drill

Block ____
Job ____
Lesson ____

Performance Objective: Upon completion of this lesson, the student will be able to list the parts of a twist drill.

Teaching Aids: Transparency Masters:

"Twist Drill," p. 3-28.
"Drill Point," p. 3-29.
"Web," p. 3-30.

References: Machine Fundamentals. Walter, Goodheart-Willcox, p. 100.
Technical Metals. Johnson, Harold.Charles Bennett Co., p. 370.
The Use and Care of Twist Drills. Cleveland Twist Drill Co.

Outline of Information:

A. Twist Drill Nomenclature

1. Shank

a. Straight

b. Taper

2. Body

a. Flutes

(1) Two or more helical grooves that form the cutting edges, admit cutting fluid, and allow chips to escape from the hole

b. Margin

(1) A narrow raised section on the body of the drill

c. Body clearance

(1) The undercut portion of the body between the margin and the flutes

d. Web

(1) The thin partition in the center of the drill which extends the full length of the flutes

(2) Increases in thickness from point to the shank

Block: Drilling Machine

Lesson: Parts of a Twist Drill

Block ____
Job ____
Lesson ____

Outline of Information: (Cont'd)

e. Tang

(1) Located at the chucking end of the drill

(2) Helps drive the drill and prevents slipping

(3) Provides a means of removing drill from spindle

3. Point

a. Dead center

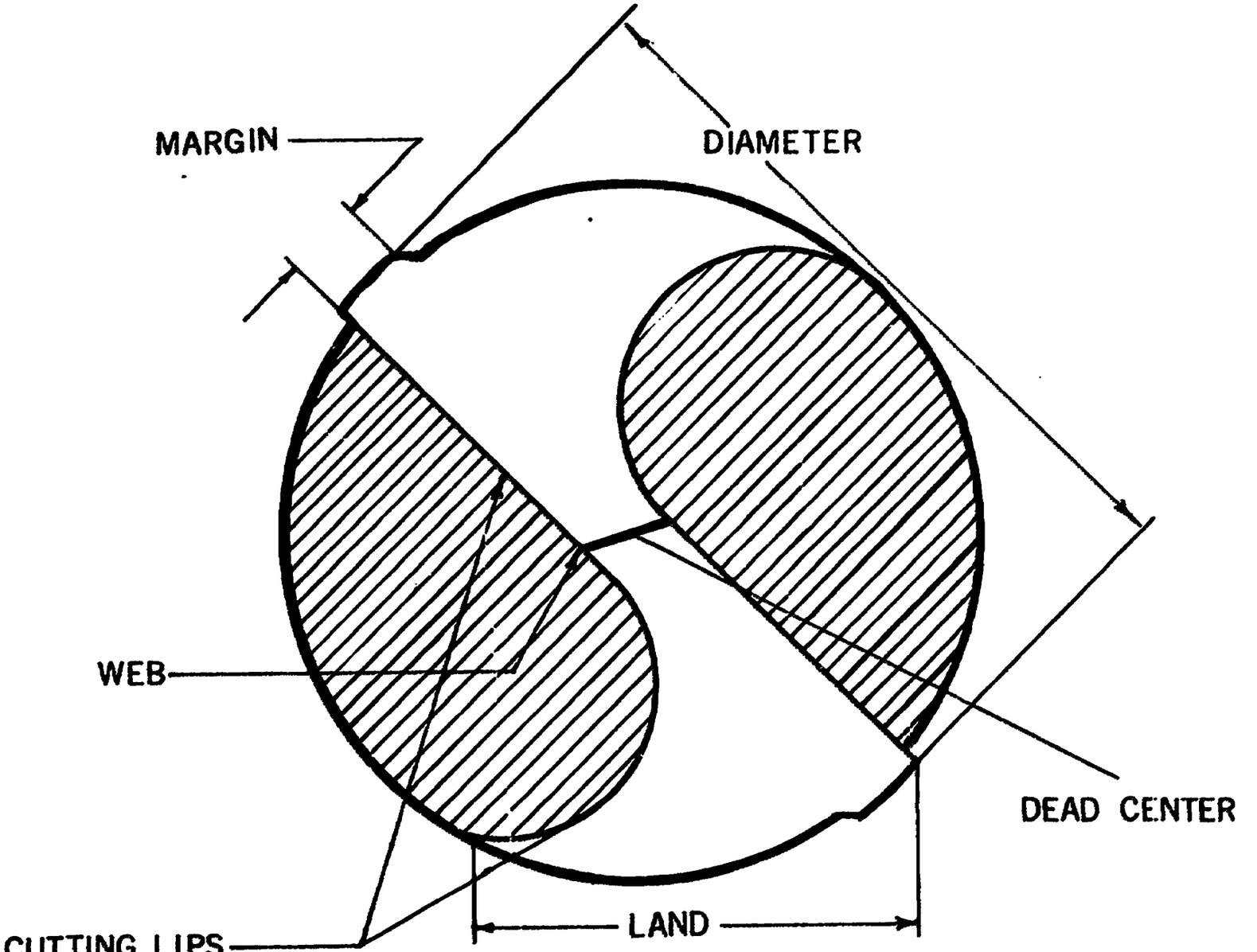
b. Lips or cutting edge

c. Heel

d. Lip clearance

TWIST DRILL

DRILL POINT



WEB
SEC A
WEB
FLUTE
SEC B
CUTTING LIP
MARGIN
HEEL
DEAD CENTER
A
WEB IS THICK
B
WEB IS THIN

INFORMATION

Block: Drilling Machine

Block ____
Job ____
Lesson ____

Lesson: Proper Lip Clearance, Length and Angle of Lips, and Dead Center

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Performance Objective: Upon completion of this lesson the student will be able to calculate the correct lip clearance, length and angle of lips, and the dead center.

References: Machining Fundamentals, Walker, p. 107-108.
Technology of Machine Tools, Krar, p. 125-128.
Shop Theory, Anderson, p. 112-115.

Outline of Information:

A. Lip Clearance

1. The cutting edges of a drill are comparable to chisels.

2. The heel (that part of the point back of the cutting edge) must be relieved.

3. The clearance or relief of the cutting edge should be 8 to 12 degrees.

4. Clearance of less than 8 degrees will result in the drill merely rubbing without penetration.

5. Clearance of more than 12 degrees will result in the cutting edges being weakened.

B. Length and Angle of Lips

1. The lip angle of a drill should be ground at 59 degrees for general work. (118° included)

   a. Lips ground in excess of 118° will not cut easily into the metal.

   b. Lips ground less than 118° weakens the cutting edge.

2. The length of the cutting lips should be equal.

   a. Difference in lip length will result in an over-size hole or a broken drill.

C. Dead Center

1. Equal angles and equal lip lengths are required for the proper dead center.

2. A combination of different angles and unequal lip lengths can result in a broken drill.

OPERATION

Block: Drilling Machines — Block _____

Job _____

Lesson: Grinding Drill Bits — Lesson _____

Performance Objective: Upon completion of this lesson, the student will be able to properly grind a drill bit.

Tools: Drill grinding gauge, bench or floor grinder, and drill bit

Teaching Aids: Charts for lip clearance and proper angles

Transparency Masters:

"Angles and Lips," 3-33.
"Drill Points," 3-34.
"Drill Points," 3-35.
"Grinding Drill Points," 3-36.
"Drill Point Gage," 3- 37.

References:
Machining Fundamentals. Walker, p. 95-120.
Metalwork Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.
Technology of Machine Tools. Krar, Chapter 6.

Steps:

1. Dress and true the grinding wheel.

2. Check the angle of the drill bit.

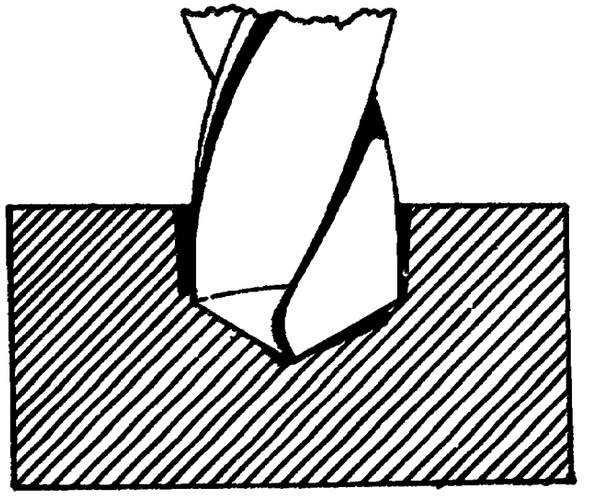
3. Place the body of the drill in the left hand and shank in the right hand at approximately 59 degrees, and begin to grind turning drill clockwise withe the left hand.

   CAUTION: Do not apply too much pressure.

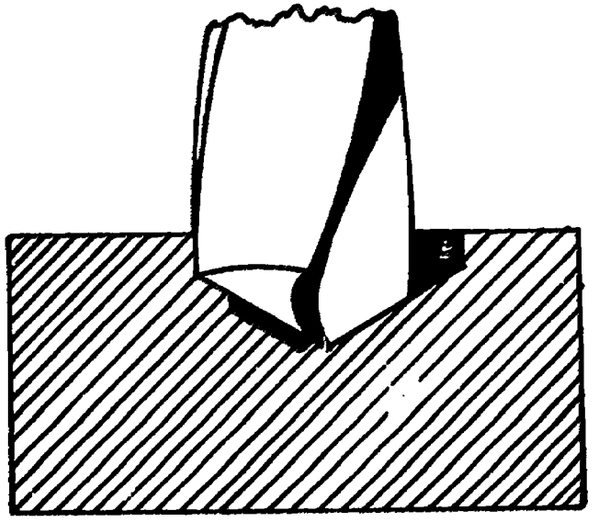
4. After both sides have been ground, gauge the drill for correct angles and length of the lip.

5. Dress up the drill, if necessary.

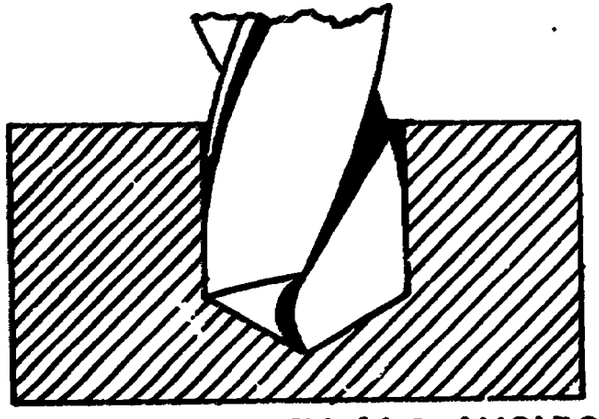
   NOTE: Do not quench high-speed drills in water too cool. Let them cool in the air.



ANGLES OF CUTTING EDGES ARE UNEQUAL



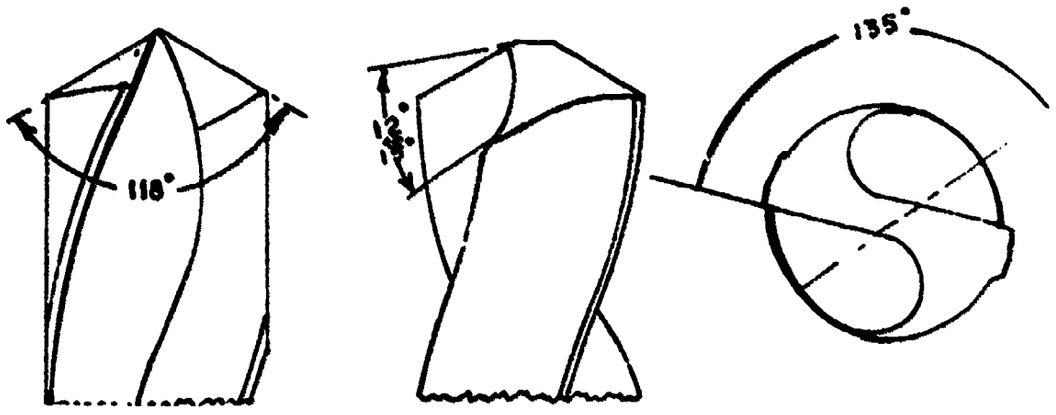
LIPS OF UNEQUAL LENGTH



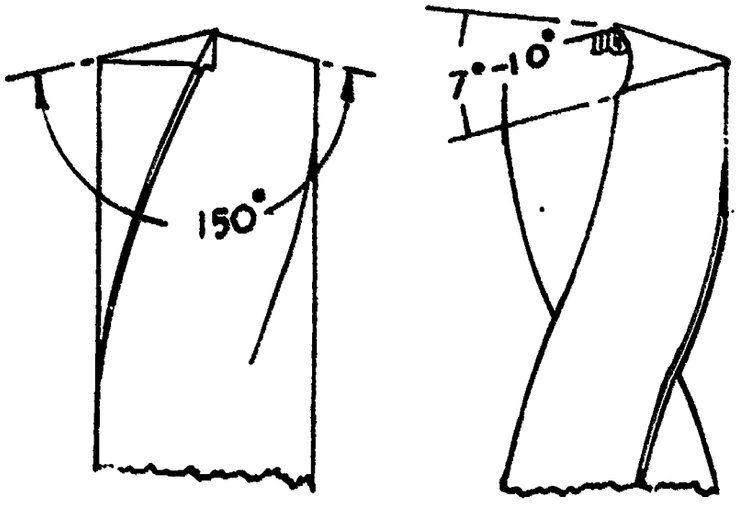
EQUAL LENGTH AND ANGLES

ANGLES AND LIPS

DRILL POINTS

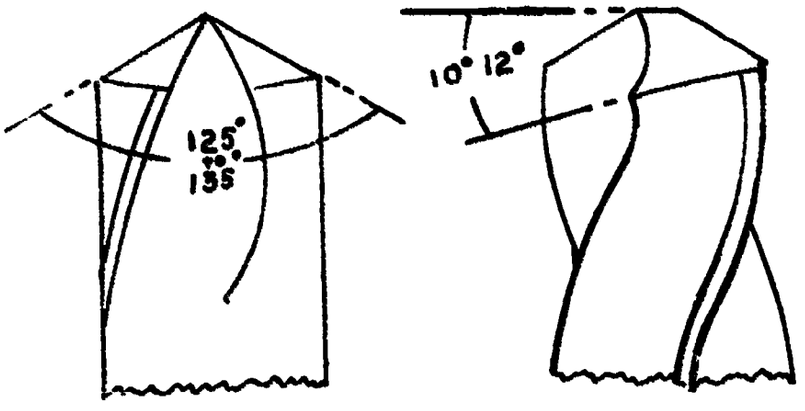


GENERAL CLASS OF WORK

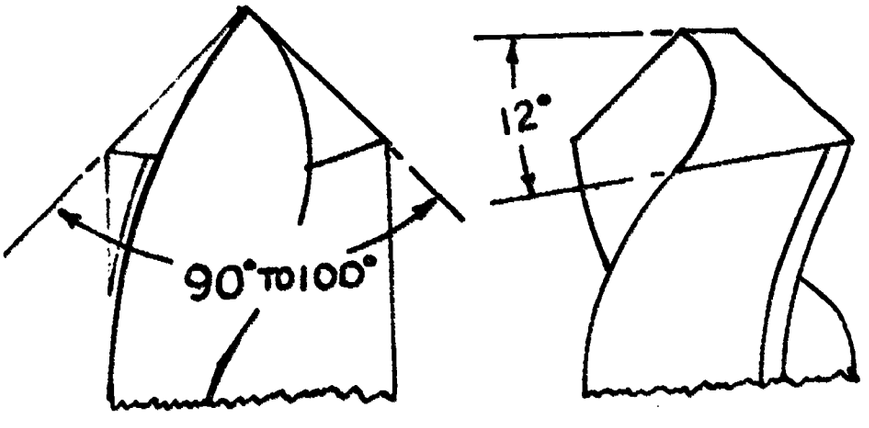


STEEL RAILS - 7° TO 13° MANGANESE
TOUGH ALLOY STEELS - ARMOR PLATE

DRILL POINTS

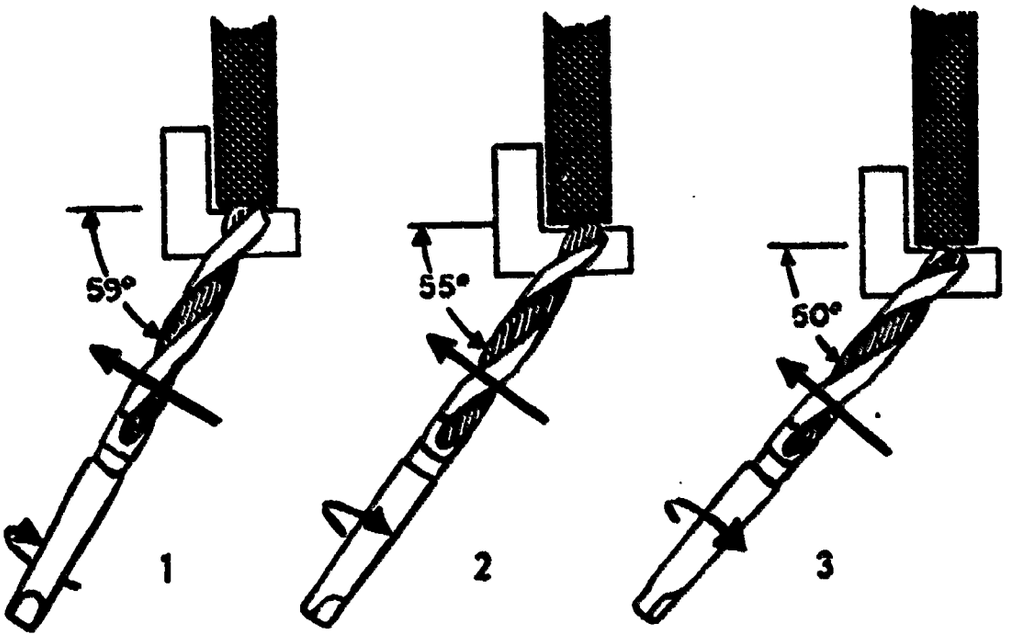


HEAT TREATED STEELS.
ALLOY STEELS. MONEL - METAL
STAINLESS STEEL



SOFT & MEDIUM CAST IRON

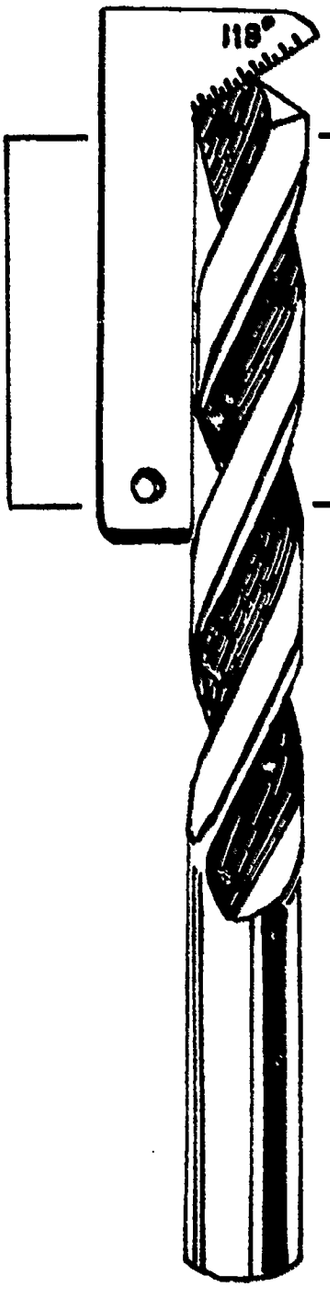
GRINDING DRILL POINTS



Grinding drill points consists of three definite motions:

1. to the left
2. clockwise rotation
3. downward

DRILL POINT GAGE



The drill point gage is frequently used to check the drill point during the sharpening operation.

. PHIPPS, CURR. DEV. CNTR., UK. 886-18

INFORMATION

Block: Drilling Machine

Lesson: How to Select the Proper Reamer

Block ____
Job ____
Lesson ____

Performance Objective: Upon completion of this lesson, the student will be able to identify different types of reamers and select the proper reamer for a specific job.

Teaching Aids: Transparency Masters:

"Reaming," p. 3-41.
"Hand Reamer," p. 3-42.
"Chucking Reamers," p. 3-43.

References:
Machining Fundamentals. Walker, p. 95-120.
Metalworking Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.

Outline of Information:

A. Reamer Nomenclature

1. Shank

a. Straight

b. Tapered

2. Body

a. Flutes
(1) Straight
(2) Helical

b. Margin

B. The reamer is used, after a hole has been drilled, to produce a hole which is round, smooth, straight and accurate to size.

C. A reamer will always ream oversize depending on material and condition of the reamer. About .0005 up to .0002.

D. Types of Reamers

1. Hand reamers

a. Straight-fluted

b. Helical-fluted

c. Expansion, straight

d. Expansion, helical fluted

Block: Drilling Machines

Lesson: How to Select the Proper Reamer

Block _____
Job _____
Lesson _____

Outline of Information: (Cont'd)

e. Adjustable

f. Taper pin

CAUTION: Never operate hand reamers by power.

Note: Never attempt to ream more than .005 with a hand reamer.

2. Chucking reamers

a. Rose (straight or tapered shank)
   (1) Cuts on the end only
   (2) Rough cuts

b. Shell (helical-fluted)
   (1) Economical for large holes
   (2) Can discard shell
   (3) Can retain arbor

c. Adjustable
   (1) Inserted blades
   (2) Adjusts to .015 over or under nominal size

d. Carbide-tipped
   (1) Developed for high production work

e. Expansion
   (1) Similar to adjustable
   (2) Very limited expansion

f. Jobber's (taper-shank, straight-fluted)
   (1) Precision finishing

g. Chucking Reamer
   (1) For production machining

h. Stub screw machine reamers

i. Center reamers for cleaning out burr from a center

j. Morse taper reamers
   (1) Roughing & finishing morse tapers

k. Tapered pipe reamers

l. Die-makers reamers

INFORMATION

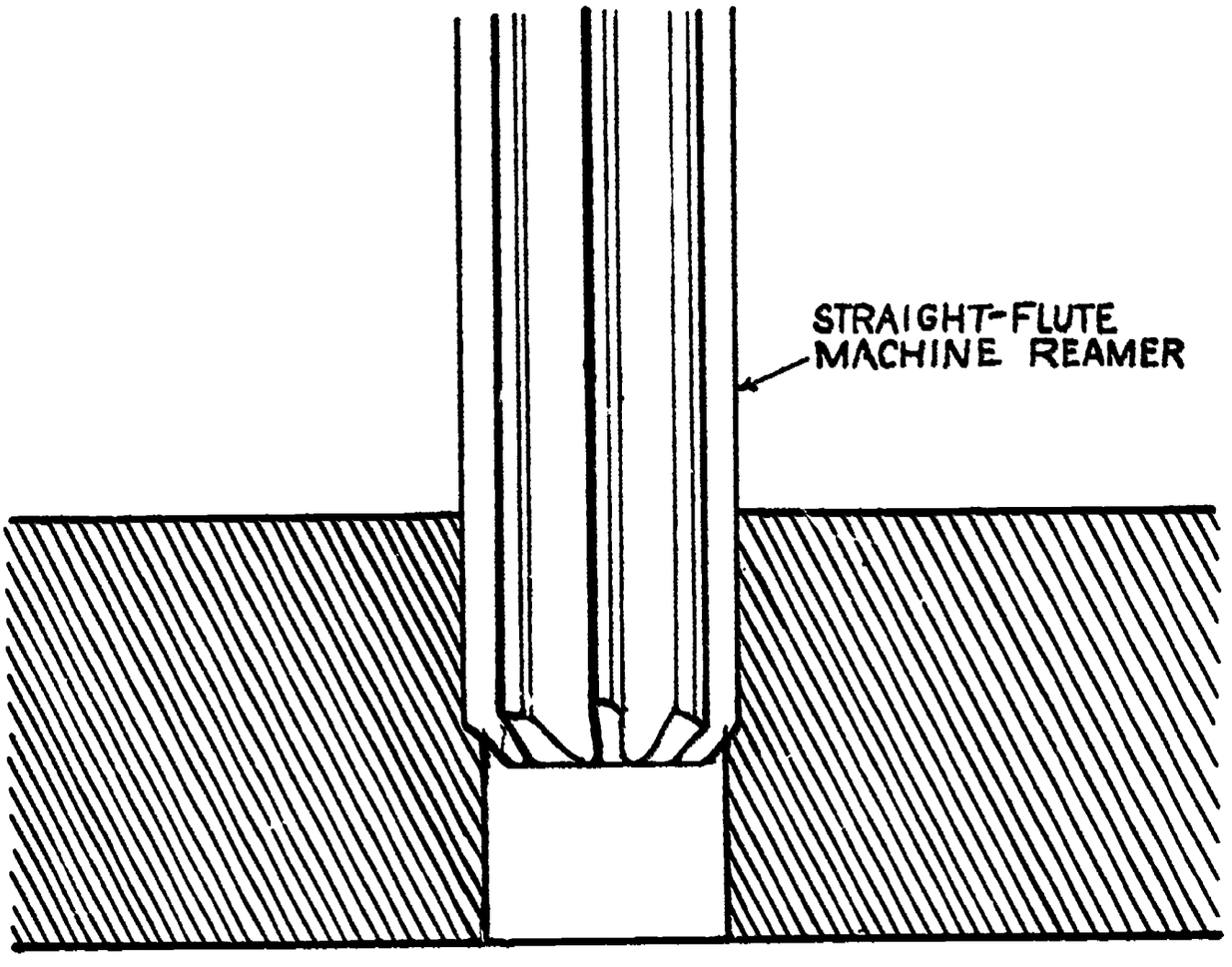
Block: Drilling Machine — Block _____ Job _____

Lesson: How to Select the Proper Reamer — Lesson _____

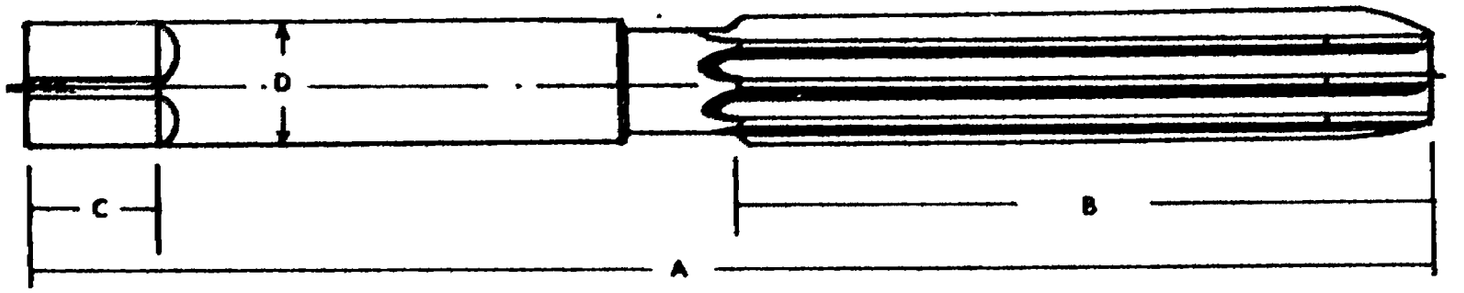
Outline of Information: (Cont'd)

m. Taper pin
   (1) Produces smooth accurate hole for seating a taper pin

Note: Never turn a reamer backwards; this will ruin the cutting edges.



REAMING



HAND REAMER

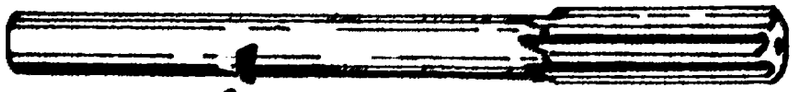
A
Overall Length

B
Flute Length

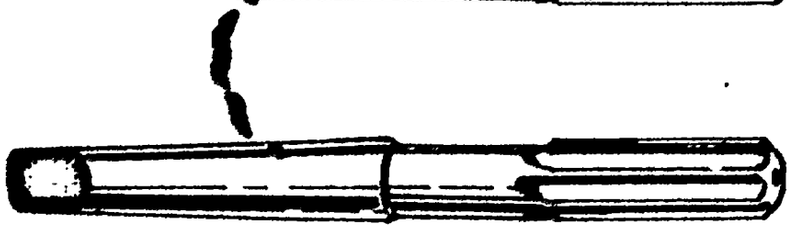
C
Square Length

D
Shank Diameter

CHUCKING REAMERS



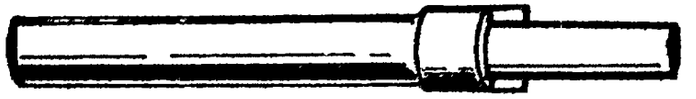
FLUTED CHUCKING REAMER



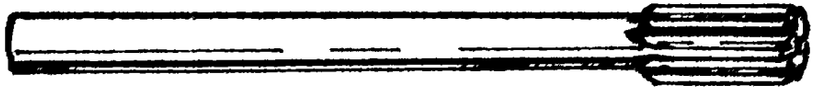
ROSE REAMER

TAPER - PIN CHUCKING REAMER

JOBBERS REAMER



SHELL REAMER SHANK
/ SHELL REAMER



CHUCKING EXPANSION REAMER

OPERATION

Block: Drilling Machines

Lesson: Reaming a Hole

Block ____
Job ____
Operation ____

Performance Objective: Upon completion of this lesson, the student will be able to ream a hole to a predetermined size and with the proper finish.

Tools: Drill press, 1/2" straight shank reamer, drill vise and lock bolts, 31/64 drill bit.

Materials: Mild steel

Teaching Aids: "The Use and Care of Reamers," Cleveland Twist Drill Co.

References:
Machining Fundamentals. Walker, p. 95-120.
Metalworking Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.
Technology of Machine Tools. Krar, Chapter 6.

Steps:

1. Follow previous procedure on drilling a hole, and set up work.
2. Drill hole to be reamed with a drill bit 1/64 smaller than the reamer.
3. Remove drill bit and insert reamer.

   Note: Do not disturb position of work, vise and column.
4. Adjust speed to one-half of that used for drilling.
5. Begin reaming slowly; if reamer chatters, decrease speed.
6. Remove reamer from hole.
7. Stop the machine, check for hole size.

   Note: Use proper lubrication for a finished hole.
8. Remove workpiece.
9. Dissamble set-up.
10. Clean chips and oil from machine and floor.
11. Clean tools and machine vise.

INFORMATION

Block: Drilling Machines

Lesson: Counterboring and Spotfacing

Block ____
Job ____
Lesson ____

Performance Objective: Upon completion of this lesson the student will be able to differentiate between the terms counterboring and spotfacing and also select the proper tool for a specific operation.

Teaching Aids: Transparency Masters:

"Counterboring," p. 3-46.
"Spotfacing," p. 3-47.

References: Machine Tool Metalworking. Feirer and Tatro, P. 142-143.
Machine Tool Technology. Burghardt, Axelrod, Anderson, Chap. 9.

Outline of Information:

A. Counterboring

1. Counterboring is the operation of enlarging a portion of a hole for part of the holes depth, and to a predetermined diameter.

2. Types of counterbores

   a. Straight shank or taper shank
   b. Straight flutes or spiral flutes
   c. Solid pilots or interchangeable pilots

B. Spotfacing

1. Spotfacing consists of machining a flat circular surface around the top of a hole, usually on a rough casting, to finish the surface true and smooth to produce a seat for a bolthead.

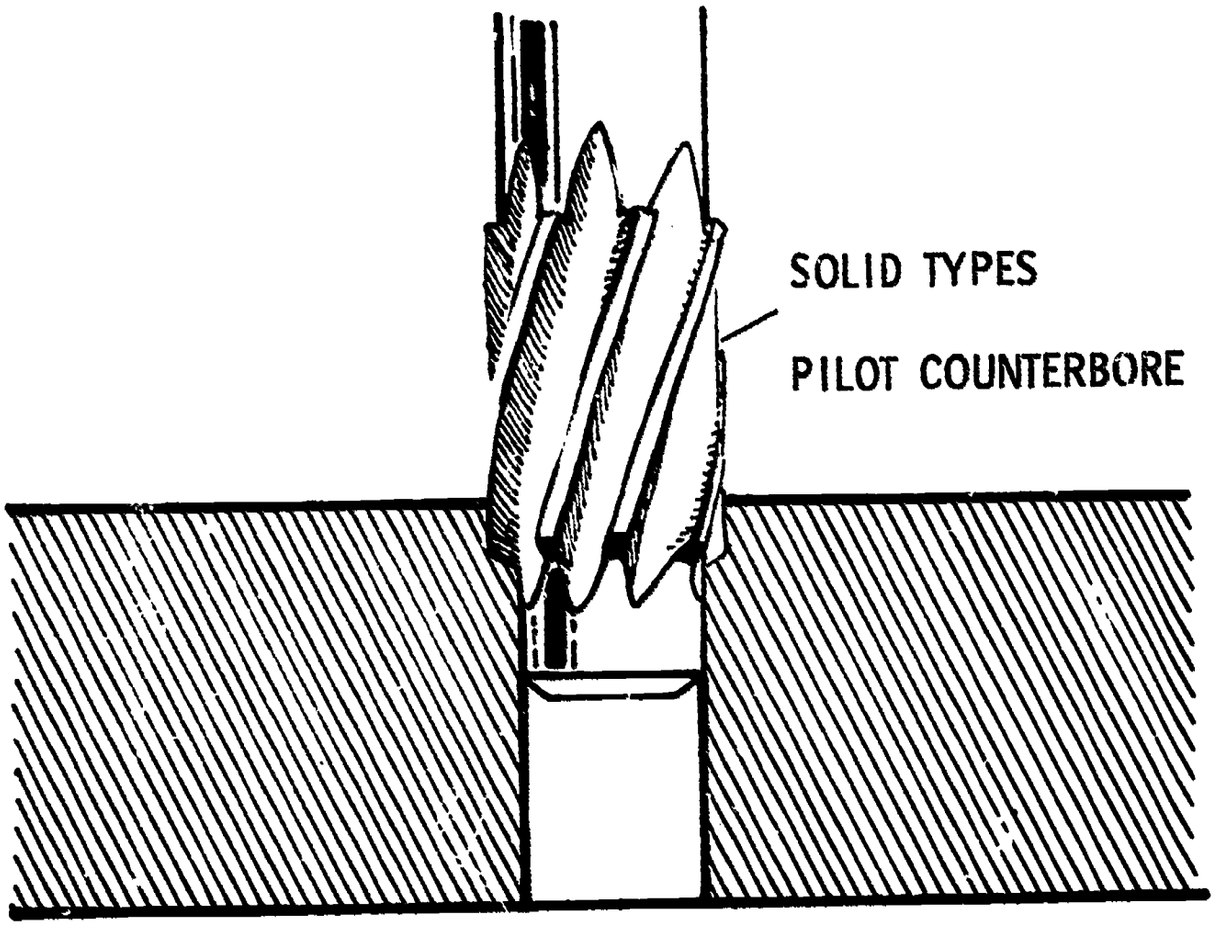
2. Types of spotfacing tools

   a. Counterbore
   b. Special spotfacing tool
   c. Boring bar and tool bit

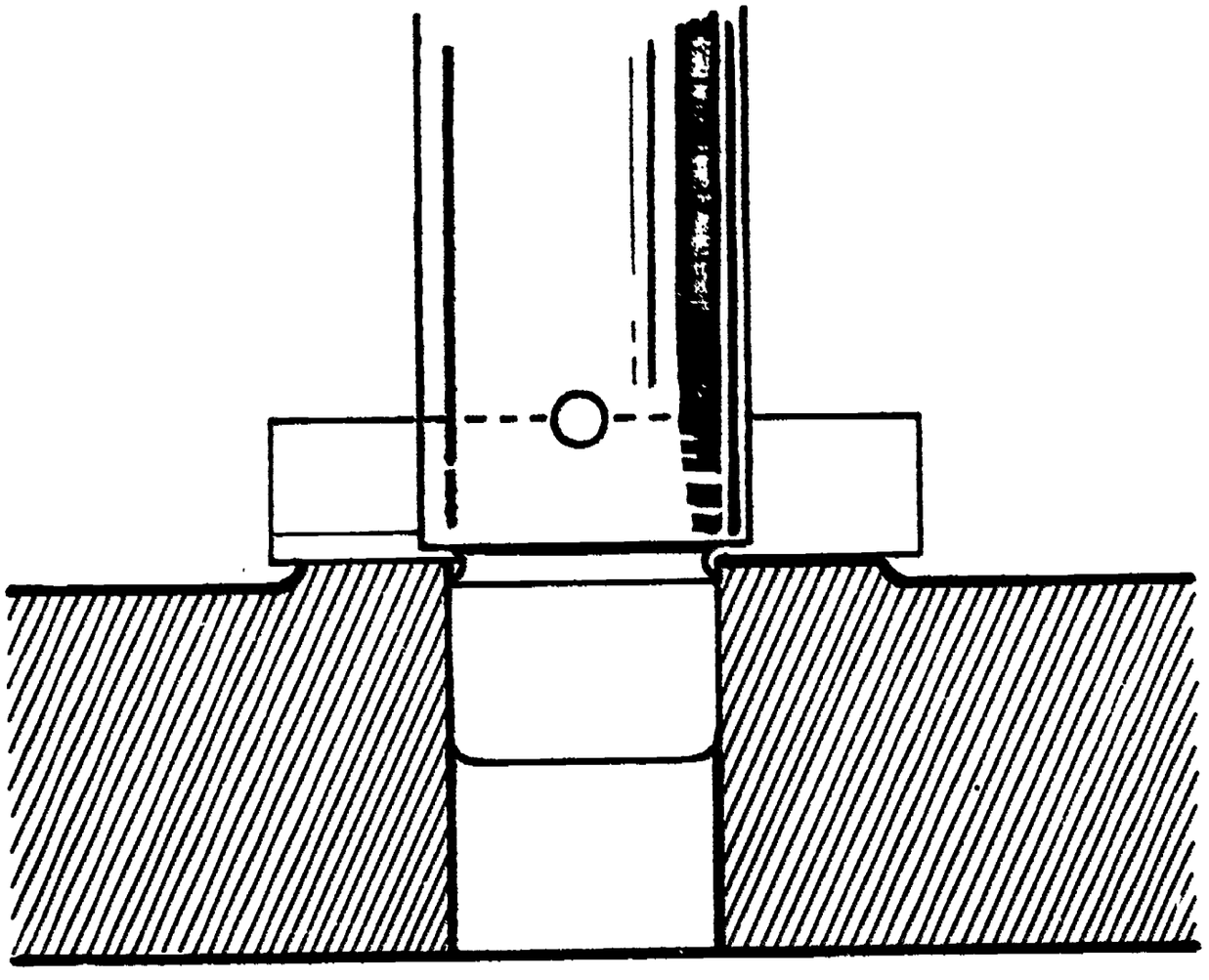
3. Pilots

   a. Solid
   b. Interchangeable

Note: The same tools may be used for both these operations in some cases.



COUNTERBORING



SPOT-FACING

OPERATION

Block: Drilling Machine

Lesson: Counterboring

Block ____
Job ____
Operation ____

Performance Objective: Upon completion of this lesson, the student will be able to select the proper tool, and counterbore a hole to a specified diameter and depth.

Tools: Drill press, drill, counterbore, drill vise, fillister head screw (any size), C.R.S. flat 1" x 2" x 2".

Teaching Aids: Transparency Master:

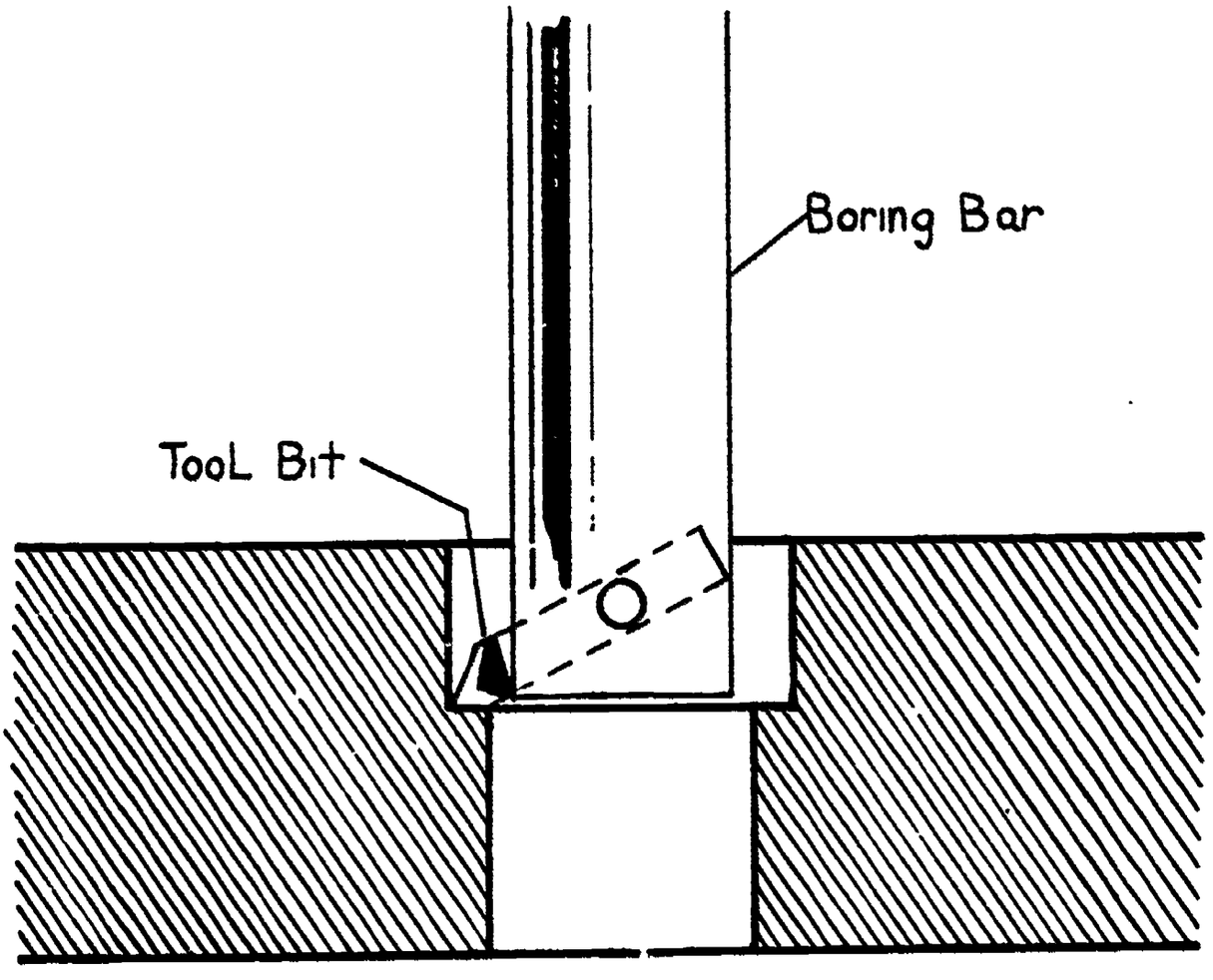
"Boring," p. 3-49.

Charts on fillister head screws and sizes.

References:
Machining Fundamentals. Walker, p. 95-120.
Metalwork Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.
Technology of Machine Tools. Krar, Chapter 6.

Steps:

1. Select boring bar and tool bit.
2. Set up work to be machined as in previous procedures.
3. Drill hole to be counterbored.
4. Remove drill bit and insert counterbore tool.
5. Reduce speed of drill press to 1/2 times the speed used for drilling straight holes.
6. Determine and set depth.
7. Start the machine, apply cutting fluid, and feed counterbore slowly to the required depth.
8. Insert screw head or gage and check fit for depth.



BORING

INFORMATION

Block: Drilling Machines

Lesson: Countersinking

Block ____
Job ____
Lesson ____

Performance Objective: Upon completion of this lesson, the student will be able to define countersinking and list the types of countersinks.

Teaching Aids: Transparency Masters:

"Machine Countersink," pp. 3-52, 3-53.

References: Machining Fundamentals. Walker, p. 95-120.
Metalwork Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.

Outline of Information:

A. Definition of Countersinking

1. Countersinking is the operation of chamfering the mouth of a hole.

B. Types of Countersinks

1. Holes for flat-head screws are beveled at 82°.

2. Holes for machine centers are beveled at 60°.

C. Speed of Countersink

1. The 82° countersink should run at slow speed to avoid chattering.

2. The center drill should run at high speed.

NOTE: Use cutting oil when countersinking steel.

OPERATION

Block: Drilling Machines

Lesson: Countersinking

Block ____
Job ____
Operation ____

Performance Objective: Upon completion of this lesson, the student will be able to select the proper countersinking tools and use the correct methods for countersinking holes.

Tools: Drill press, drill bit, countersink, drill vise, flat head machine screw, soft hammer, parallels, and steel rule.

Materials: Mild steel

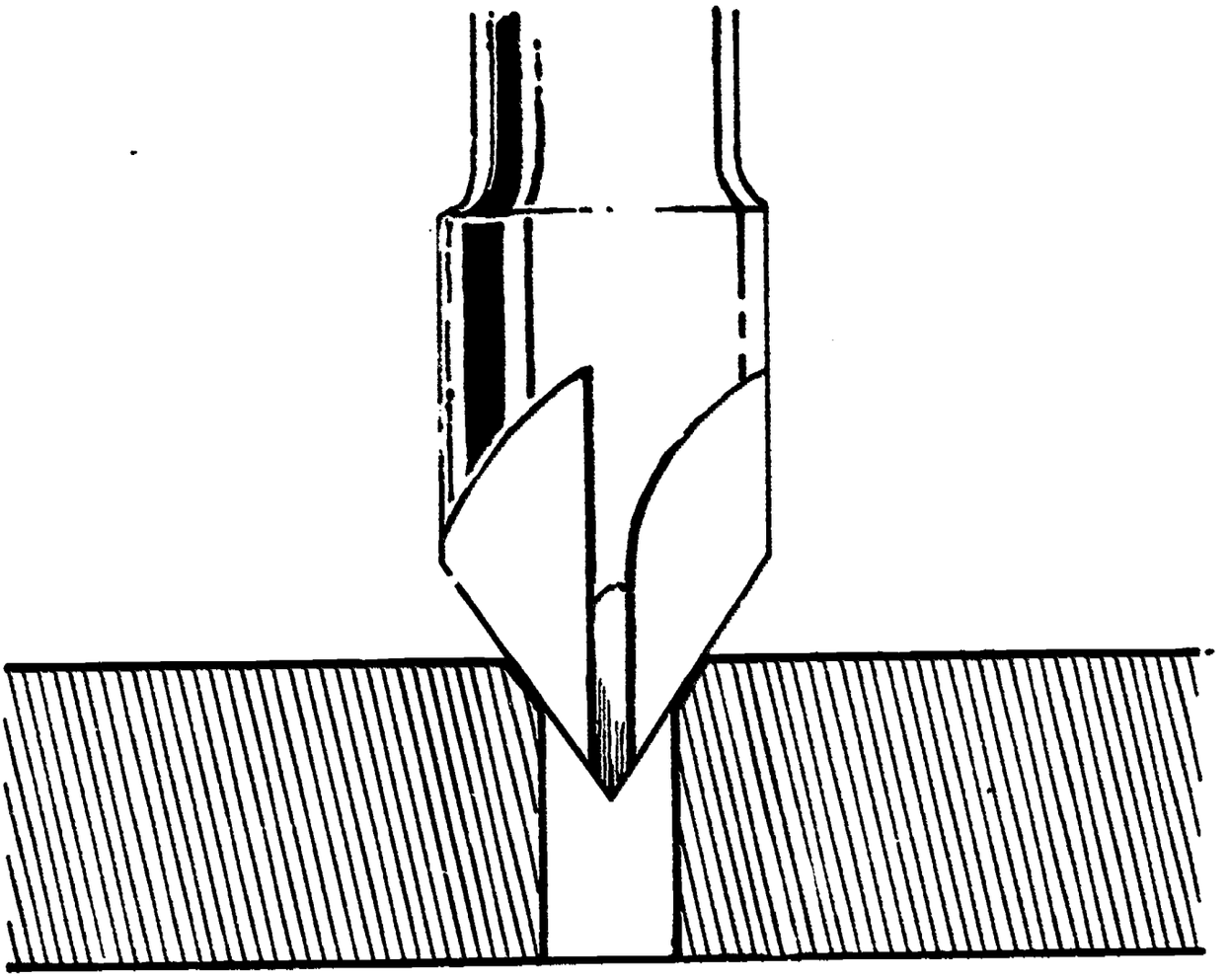
Teaching Aids: Charts on flat head machine screw sizes and angles
Transparency Masters:

"Countersinking," p. 3-52.
"Machine Countersink," p. 3-53.

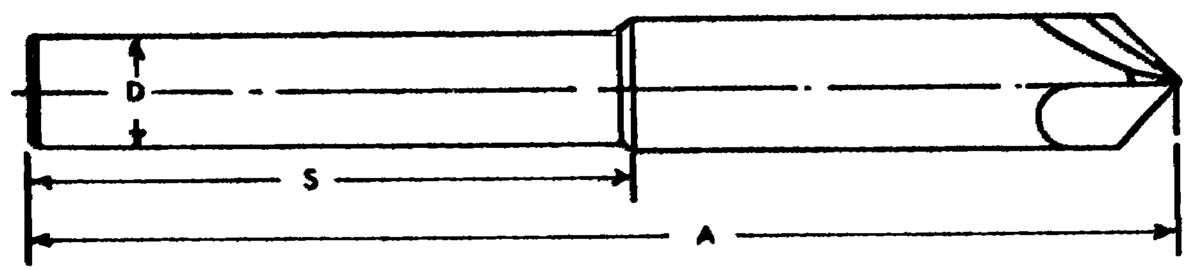
References: Machining Fundamentals. Walker, p. 95-120.
Metalwork Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.

Steps:

1. Select countersink and check cutting edges.
2. Set up work to be machined as in previous procedures.
3. Drill the work for the size of the bolt body.
4. Remove drill and insert countersink.
5. Determine the depth and set stop.
6. Use a slow cutting speed (about 1/4 to 1/2 that recommended for similar size drill).
7. Countersink by feeding slowly into the work.
8. Stop, check, and gauge with the flat-head screw or gauge for fit.



COUNTERSINKING



MACHINE COUNTERSINK

A
Overall Length

S
Length of Shank

D
Diameter of Shank

INFORMATION

Block: Drilling Machine

Lesson: Tapping

Block ____
Job ____
Lesson ____

Performance Objective: Upon completion of this lesson, the student will be able to define tapping and determine the proper tap drill.

Teaching Aids: Tap drill charts, twist drill chart.
Transparency Master:

"Tapping Attachment," p. 3-56.

References: Machining Fundamentals. Walker, p. 95-120.
Metalwork Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.
Technology of Machine Tools. Krar, Chapter 6.

Outline of Information:

A. Definition of Tapping

Tapping is the operation of cutting internal threads in a hole with a cutting tool called a tap. Machine taps are used with a tapping attachment when this operation is performed by power in a machine.

B. Size of Tap

The size of the tap and the number of threads per inch are marked on the shank of the tap.

C. Size of Hole

The hole should be smaller than the size of the tap. Check the chart for the correct size drill.

D. Methods of Tapping

1. Tapping by hand

a. Drill press table supports work.
b. Drill press chuck supports tap by the use of a center in the drill chuck that is inserted into the end of the tap or tap handle.
c. The tap is rotated with a tap wrench.

CAUTION: Power is never used with this setup.

2. Tapping attachment on a drill press

a. Reversing type does not require that the drill press spindle be reversed to extract the tap.

Block: Drilling Machines

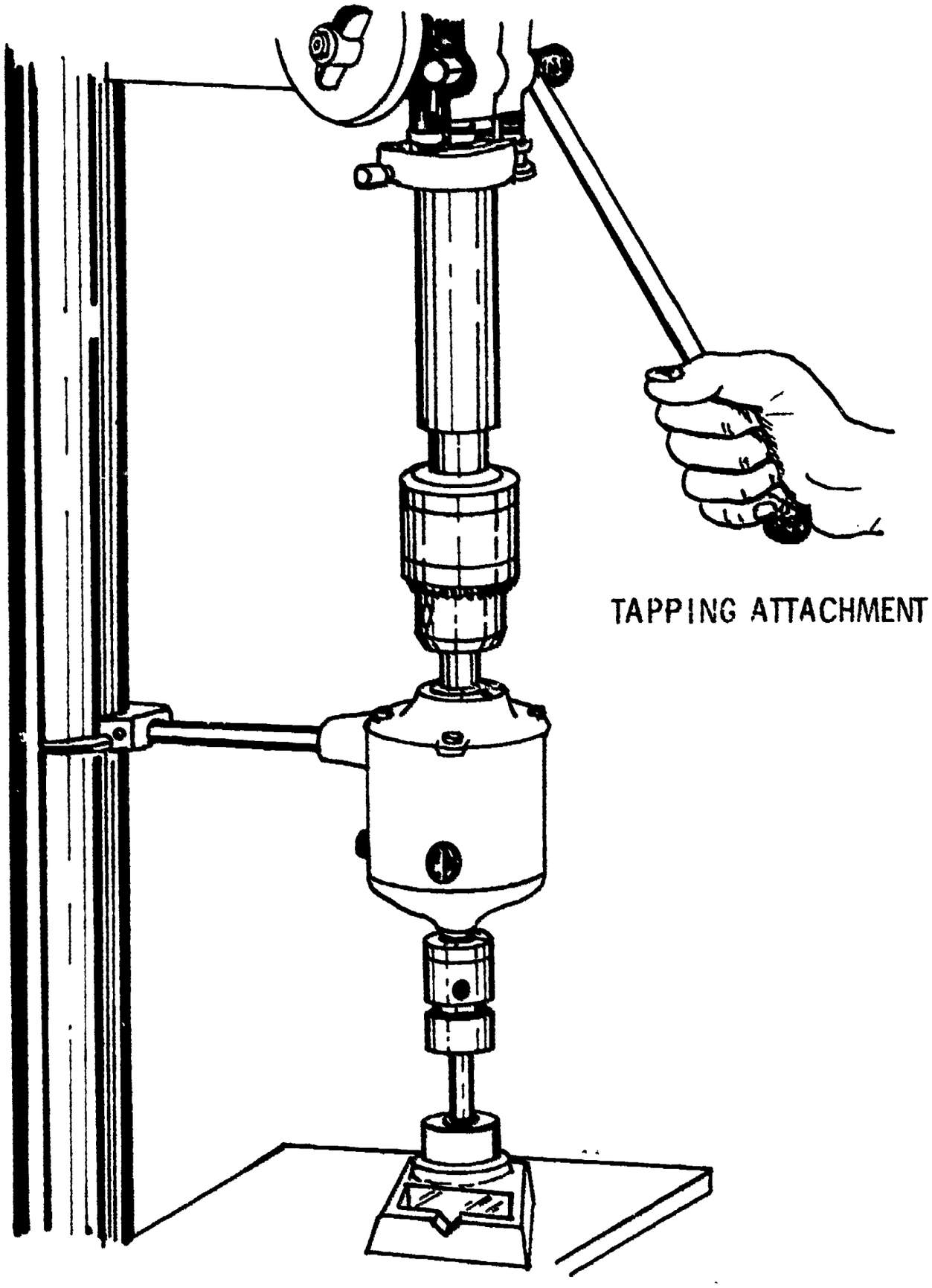
Lesson: Tapping

Block ____
Job ____
Lesson ____

Outline of Information; (Cont'd)

b. Nonreversing type requires reversing of drill press spindle.
c. Attachment has friction clutch that drives tap.

Note: Power is used with this attachment.



TAPPING ATTACHMENT

OPERATION

Block: Drilling Machine

Lesson: Tapping a Hole by Hand

Block _____
Job _____
Operation _____

Performance Objective: Upon completion of this lesson, the student will be able to start a tap and complete the tapping of a straight hole.

Tools: Drill press, tap drill, 1/2" N.C. tap, and tap wrench.

Materials: C.D. steel falt 1" x 3" x 3"

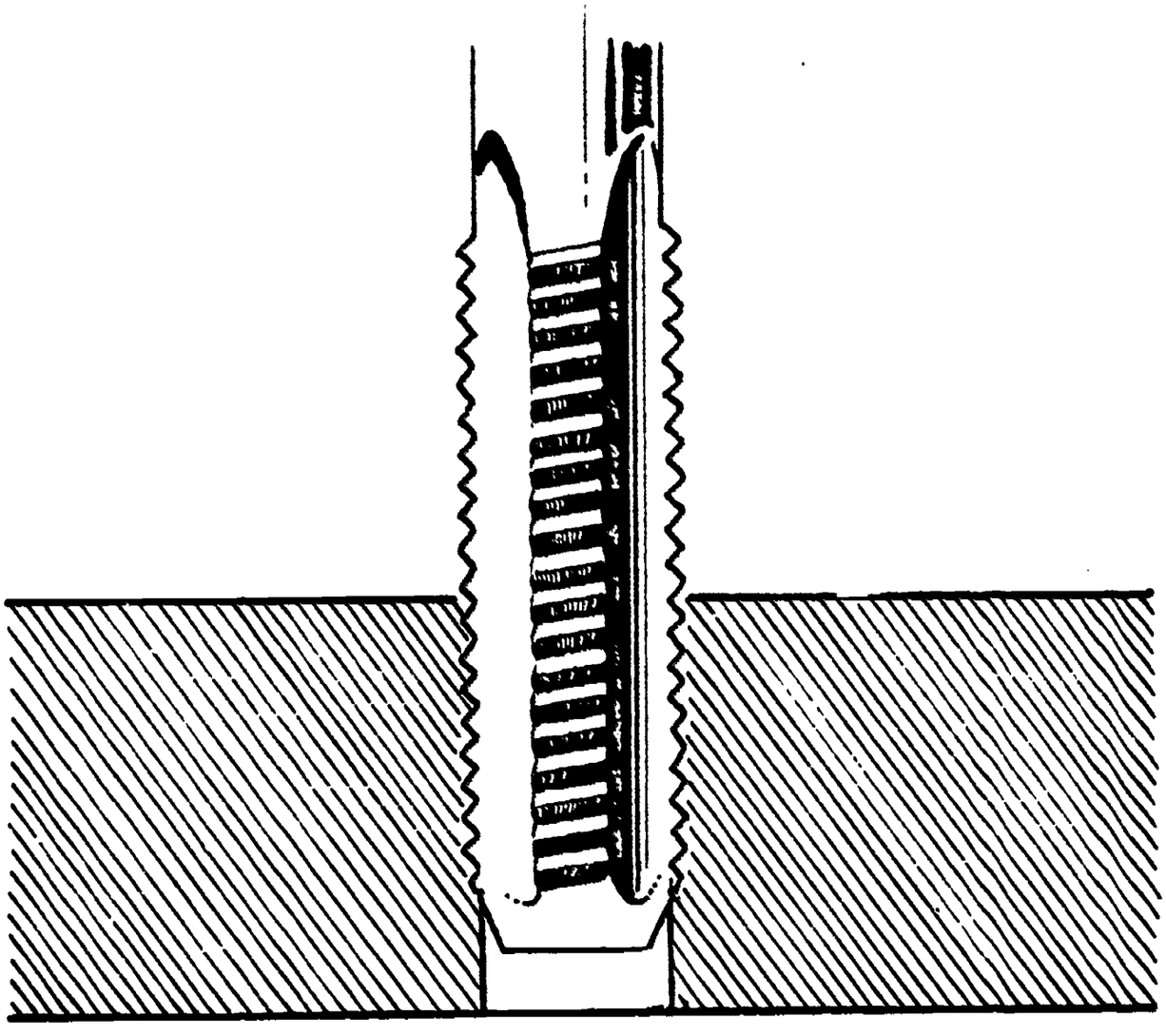
Teaching Aids: Charts on standard taps and drill sizes for tapping.
Transparency Master:

"Tapping," p. 3-58.

References:
Machining Fundamentals. Walker, p. 95-120.
Metalwork Technology and Practice. Ludwig, Unit 25, 30.
Shop Theory. Anderson, Chapter 5.
Technical Metals. Johnson, p. 368-378.

Steps:

1. Select and check tap drill and tap.
2. Chuck tap drill and set speed.
3. Apply previous procedures and set up work.
4. After drilling, do not disturb position of work.
5. Insert tap in the chuck and lock.
6. Lower the tap to the work, apply downward pressure with the feed handle, and begin to turn the drill chuck by hand for two or three turns.
7. Loosen the chuck but leave the tap in the work.
8. Tapping may now be completed by hand with a tap wrench.



TAPPING

INFORMATION

Block: Drilling Machine

Lesson: Lapping

Block ____
Job ____
Lesson ____

Performance Objective: Upon completion of this lesson, the student will be able to define the process of lapping.

Teaching Aids: Transparency Master:

"Copper-head Laps," p. 3-60.

References: Shop Theory. Anderson, p. 123.

Outline of Information:

A. Lapping is a method of removing very small amounts of material by means of abrasive.

B. Types of Lapping Tools

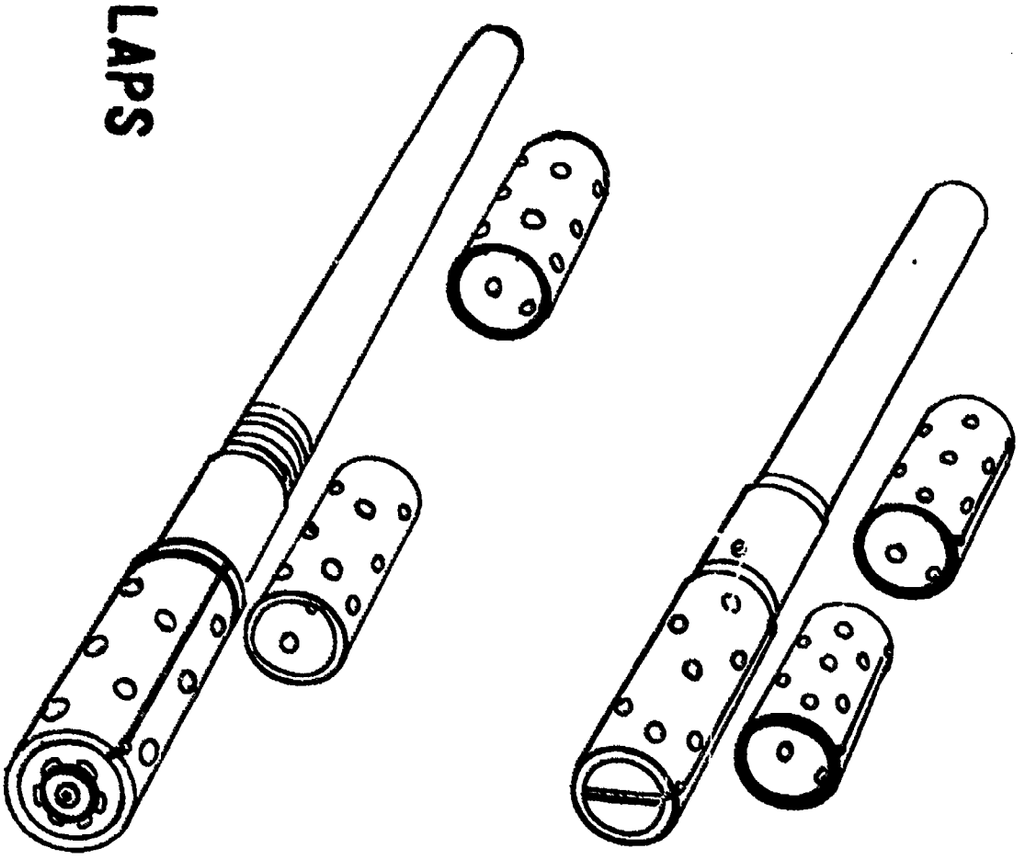
1. Copper-head laps

2. Lapping reamers

3. Wood laps (one- or two-thousandths of an inch less than standard reamer)

Note: As the lap revolves in the hole, it should be constantly moved up and down in order for the hole to be perfectly cylindrical.

COPPER-HEAD LAPS



LISTING OF MANUFACTURERS OF DRILLS AND REAMERS

Source	Types of Drills and Reamers
Ace Drill Corporation Adrian, MI 49221	Twist drills, reamers. drill rod, drill blanks
Bendix Corporation Industrial Tools Division 1925 S. Rockwell Street Chicago, Ill 60608	Drills, reamers
Brown & Sharpe Mfg. Co. Industrial Products Division Precision Park N. Kingstown, RI 02852	Precision tools, ground flat stock, cutting tools
Butterfield, UTD Litton Industries Derby Line, VT 05830	Drills and reamers
Chicago-Latrobe A United Greenfield Division of TRW, Inc. 990 Skokie Road Northbrook, ILL 60062	Twist drill, reamers, end mills, carbide cutting tools
Cleveland Twist Drill Co. Box 6656 1242 E. 49th Street Cleveland, OH 44101	Twist drills, reamers, end mills, milling cutters, arbors, mandrels, and counterbores
Dumont Corporation 289 Wells Street Greenfield, MA 01301	Broaches and cutters, tool bits
Greenfield Tap & Die 100 Sanderson Street Greenfield, MA 01301	Drills, reamers, end mills, carbide drills
Greenlee Tool Corporation 2136-12th Street Rockford, ILL 61101	Drills and reamers
Heli-coil Products, Mite Corporation Shelter Rock Lane Danbury, CT 06810	Drills and reamers
Illinois/Eclipse, Illinois Tool Works 2501 N. Keeler Avenue Chicago, ILL 60639	Metal cutting tools

Sources	Types of Drills and Reamers
Malcus Tool Works 195 Armstrong Road Garden City Park, NY 11040	Drills and reamers
Metal Removal Divison Federal-Mongul Corporation 1801 W. Columbia Avenue Chicago, ILL 60626	Solid carbide burs, end mills, countersinks, reamers, boring tools, drills, high speed end mills.
Morse Cutting Tools A Gulf & Western Precision Engineering Co. 163 Pleasant Street New Bedford, MA 02742	Twist drills, reamers, end mills
National Twist Drill & Tool Co. Lear-Siegler, Inc. 6841 N. Rochester Road Rochester, MI 48063	Twist drills, reamers, hobs, milling cutters.
New England Carbide Tool Corp.,Inc. Industrial Park Peabody, MA 01960	Carbide cutting tools, milling cutters, carbide-tipped masonry drill bits.
Teledyne Firth Sterling P.O. Box 700 Demmler Road McKeesport, PA 15134	Sintered carbides, carbide tips and tools
Union Twist Drill Divison UTD Corporation, Litton Industries 134 Chestnut Hill Avenue Athol, MA 01331	Drills and reamers
Wendt-Sonis/Unimet United Greenfield Division of TRW Inc. 435 W. Ontario Street Chicago, ILL 60610	Carbide-tipped tools, special solid carbide tools
Whitman-Barnes United Greenfield Division of TRW Inc. 40600 Plymouth Road Plymouth, MI 48170	High-speed drills, reamers and end mills, carbide cutting tools

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