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ABSTRACT

These instructional materials provide an orientation to the drill press for use at the postsecondary level. The first of seven sections lists seven types of drill presses. The second section identifies 14 drill press parts. The third section lists 21 rules for safe use of drilling machines. The fourth section identifies the six procedures for proper care and maintenance of the drill press. The fifth section lists 14 workholding and setup devices. The sixth section, on drill press operation, contains the following parts: (1) terms and definitions for safe operation; (2) operations that can be performed; (3) seven cutting tools used (illustrations included); (4) cutting speeds and determination of speeds (information sheet provided); (5) types of drill press spindle drives; and (6) types of coolants. The seventh section outlines four drill press activities. Tools and equipment, procedures, and schematics are provided for each activity. Figures are provided throughout text. A quiz and separate answer sheets are included at the end of this guide. (NLA)

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DRILL PRESSES

I. Types of Drill Presses
   A. Sensitive bench
   B. Upright
   C. Radial arm
   D. Gauge
   E. Multispindle drilling, boring, and tapping machine
   F. Bench turret
   G. Numerical control turret drilling and tapping machine

II. Drill Press Parts

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IV. Care and Maintenance

V. Workholding and Setup Devices

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   C. Tap holes using the drill press
   D. Radial drill press operation

DRILL PRESSES

A drill press is designed to produce round holes in material by using drills and other types of cutting tools.

I. Types of Drill Presses

A. Sensitive bench drill press

B. Upright drill press

C. Radial arm drill press

D. Gauge drill press

E. Multispindle drilling, boring, and tapping machine

F. Bench turret drill press

G. Numerical control turret drilling and tapping machine

II. Parts of a Drill Press

A. Belt drive

B. Motor

C. Depth stop

D. Feed drive

E. Manual feed lever

F. Column

G. Table elevating crank

H. Table locking bolts

I. Coolant pump

J. Base

K. Table stop collar

L. Table

M. Coolant nozzle

N. Spindle

III. Safety

The following are rules for safe use of drilling machines:

A. Always wear safety glasses to protect eyes.

B. Always wear tight-fitting clothes to prevent them from being caught in revolving parts.

C. Never operate the drilling machine with guards removed.

D. Chuck key or drill drift should be removed immediately after use. Never leave key in drill chuck or drift in spindle because if the machine is turned on, parts could be thrown, possibly causing injury.

E. Remove all jewelry before operating a drill press or any machine to prevent possible accidents.

F. Remove chips with a brush, **never** use hands.

G. Rags should never be used while machines are running, and they should never be left on the table of a running machine.

H. Workpieces should always be held in a vise or other workholding device that is secured to the table. Never try to hold work with hands.

I. When the drill is breaking through the work, pressure must be reduced so the drill does not grab the work and leave a big burr.

J. The drill chuck is designed to hold straight shank drills and tools, and should never be used to hold tools with tapered shanks.

K. The drill drift is the only tool that should be used to remove tapered shank tools from spindles or sleeves.

L. Never clean or make adjustments while machines are running.

M. Always use a rag when picking up a drill, work, or any tool that has been in use as they will be hot.

N. Tables should be kept clean and free of tools to eliminate accidents and possible damage to tools.

O. Spindle tapers should never be cleaned when spindles are being turned by power.

P. The feed should be interrupted occasionally to break up chips and clear the drill.

Q. Always place a board on the table under the tool so when the taper is broken with the drill drift, it will not fall and damage the tool or table of the drill press.

R. Keep work area clean and free of slippery materials and chips to prevent accidents.

S. Clean machine and floor after using the drill press.

T. Clean oil or coolant from drills and other tools and place them in the proper storage areas.

U. Long hair must be secured under a hat, in a hair net, or tied back to prevent it from being caught by rotating parts of the drill press.

IV. Care and Maintenance

The following are procedures for proper care and maintenance of the drill press:

A. Check all oil levels for proper levels before using.

B. Check drive belts for proper tightness.

C. Never crank the speed selector on the variable speed drive when spindle is <u>not</u> turning.

D. Never shift gears when spindle is turning. Always shut the machine off.

E. Always clean chips off of the table with a brush.

F. Never use a dull tool, because it may cause friction and will ruin the tool.

V. Workholding and Setup Devices

(**NOTE:** All workholding devices must be secured to the table with clamps or bolts.)

A. Angle vise

B. Parallel clamp

C. C-clamp

D. Drill fixture

E. Strap clamp

F. T-bolt

G. Angle plate

H. V-block

I. Vise

J. Parallels

K. Screw jack

Q. Depth stop

R. Motor

S. Belt guard

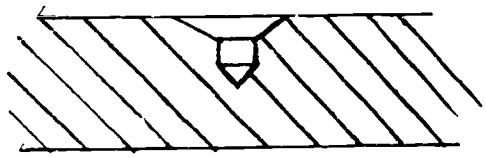
VI. Drill Press Operation

A. Definitions
The following are terms and definitions one must be familiar with in order to operate drill presses efficiently and effectively.

1. Pilot hole--A small hole used to guide a drill of a larger size. (**NOTE:** The pilot hole is no larger than the web of the larger drill.)

2. Center drill--Produces a small hole with a 60° taper at the top of the hole using a combination drill and countersink (center drill).

Figure 1

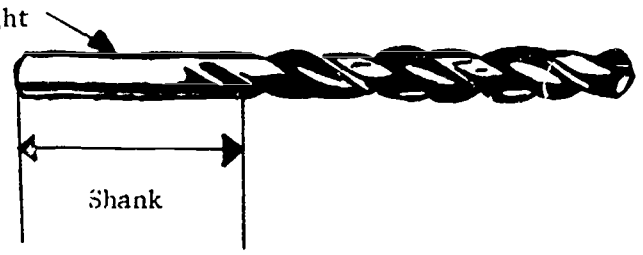


3. Taper shank--The tapered portion of a cutting tool that aligns the tool in the spindle or holder. (**NOTE:** The taper shank cannot be held in a drill chuck).

Figure 2

4. Straight shank--The straight portion of a cutting tool that aligns the tool in the holder.

Figure 3



5. Number drills--Drills that are graduated from number 80 (.0135") to number 1 (.228"). They are sometimes referred to as wire gage size drills.

6. Letter drills--Drills that are graduated from A (.234") to Z (.413").

7. Metric drills--Drills that are graduated from .35 mm to 25 mm and larger.

8. Fractional drills--Drills that are graduated by fractions of inches from 1/64" to 1" and larger.

   (**NOTE**: The decimal equivalents of the number, letter, and metric drills are in between the fractional sizes.)

9. Tang--A tang is a flat or tongue machined on the end of a tapered shank to prevent the taper from rotating in the mating part.

Figure 4

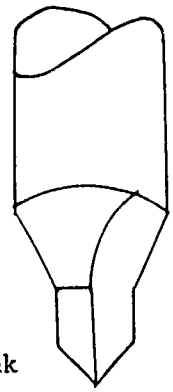
10. Feed pressure--The amount of force put on a tool in the downward direction, expressed in feed per inch per revolution of the tool.

B. Operations

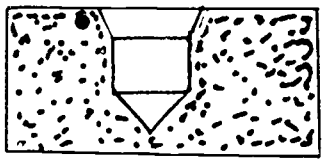
The following are examples of the operations one can perform on drill presses.

1. Center drilling--The making of a hole with a tapered top so the drill will start in the location desired.

Figure 5



Combination
Drill and Countersink
(Center Drill)



Center Drilled Hole

2. Drilling--The production of a hole of a given size and depth.

3. Boring--The enlarging of an existing hole to a given size and depth.

4. Counterboring--The enlarging of a hole with a flat bottom for a screw head to set in below the surface.

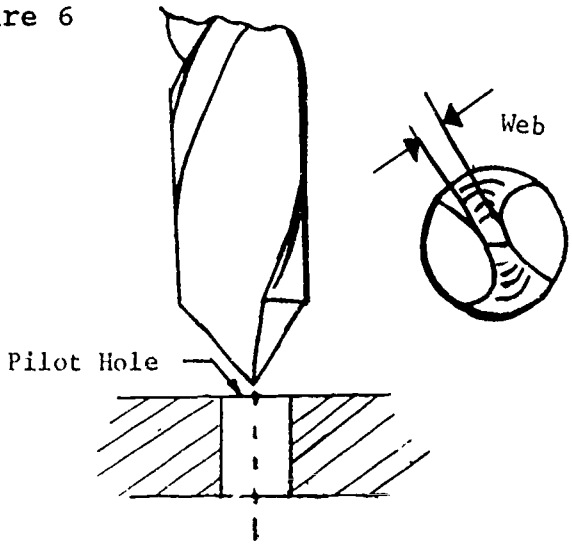
5. Countersinking--The production of a tapered surface in a hole so a flat head screw will be flush with the top surface of the part.

6. Tapping--The production of a screw thread in a hole that has been drilled to a specific size.

7. Drilling a pilot hole--The production of a small hole that is used to guide a larger drill and reduce the feed pressure of the larger drill.

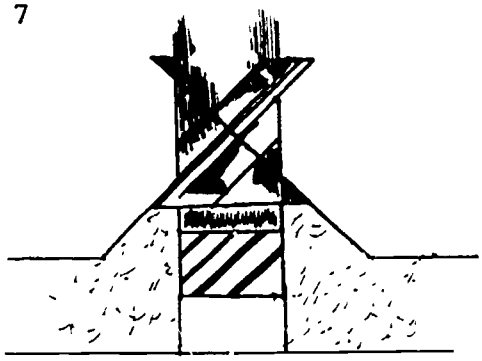
(**NOTE:** The pilot hole is drilled no larger than the web of the larger drill.)

Figure 6



8. Spot facing--The making of a flat surface so a bolt head or nut will seat properly.

Figure 7



9. Reaming--The enlarging of a hole a small amount to make it true to size.

10. Chamfering--The making of a small angular surface at the top of a hole.

C. Cutting tools

The following are cutting tools used for drill press operation.

1. Twist drills

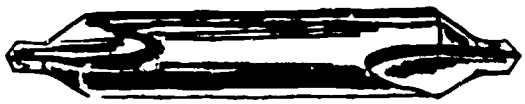
   a. Straight shank

      Figure 8 

   b. Tapered shank

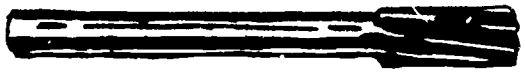
      Figure 9 

2. Center drill (combination drill and countersink)

   Figure 10 

3. Reamers

   a. Straight shank

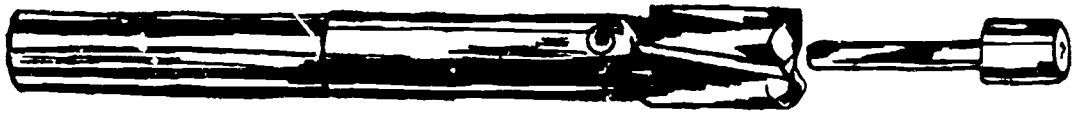
      Figure 11 

   b. Tapered shank

      Figure 12

4. Counterbore or spot face with pilot

   Figure 13



5. Countersink (**NOTE:** Countersinks come with different angles.)

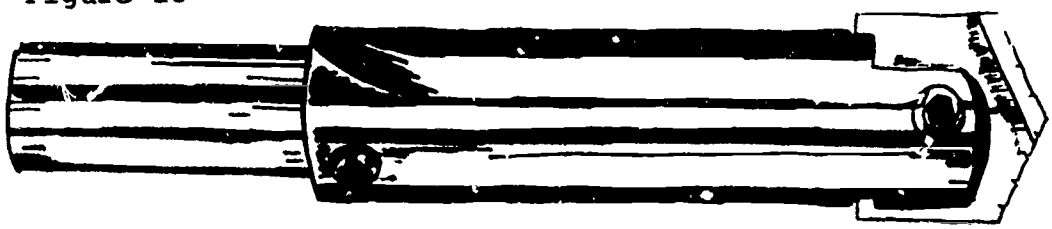
   Figure 14 

6. Tap

Figure 15

7. Spade drill

Figure 16



D. Speeds and Feeds

1. Cutting speeds--Factors that affect cutting speeds for drilling operations include:

   a. drill size
   b. drill material
   c. type of material to be drilled

   EXAMPLE: Carbide-tipped tools will turn approximately two times faster than tools made of high speed steel; reamers turn at 1/2 drill speed; counterbores and countersinks turn at 1/3 drill speed.

2. The following is the procedure for determining RPM for drilling.

   a. Find the material in one of the headings across the top of the chart.

   b. Move down the column marked drill diameter (inches to the size of the drill.

   c. The intersection of the two columns is the RPM for that size of drill and that kind of material.

INFORMATION SHEET

EXAMPLE: Material -- mild steel
Drill size -- 1/4"
RP -- 1528

Drilling Speeds for High-speed Steel Drills								
Drill Diam., Inches	Bronze, Brass, 300 Feet	Cast Iron An-nealed 150 Feet	Cast Iron Hard 70 Feet	Mild Steel 100 Feet	Drop Forg-ings 60 Feet	Mal. Iron 90 Feet	Tool Steel 50 Feet	Cast Steel, 40 Feet
	Revolutions Per Minute							
1/16	....	9170	4278	6111	3669	....	3056	2440
1/8	9170	4584	2139	3056	1830	2745	1528	1220
3/16	6112	3056	1426	2037	1210	1830	1019	807
1/4	4585	2292	1070	1528	915	1375	764	610
5/16	3660	1833	856	1222	732	1138	611	490
3/8	3056	1528	713	1019	610	915	510	407
7/16	2614	1310	611	873	522	784	437	348
1/2	2287	1146	535	764	458	688	382	305
5/8	1830	917	428	611	366	569	306	245
3/4	1525	764	357	509	305	458	255	203
7/8	1307	655	306	436	261	392	218	174
1	1143	573	267	382	229	349	191	153
1 1/4	915	458	214	306	183	275	153	122
1 1/2	762	382	178	255	153	212	127	102
1 3/4	654	327	153	218	131	196	109	87
2	571	287	134	191	115	172	95	77

E. Drill Press Spindle Drives

1. Cone pulley drive--This is found on the most sensitive type bench and floor mounted machines. Speeds are obtained by changing belt position.

2. Variable speed drive--This is found on sensitive type floor mounted machines. Speeds are obtained by turning the speed selector.

3. Gear head drive--This is found on floor mounted machines, like-box column and radial drill presses. Speeds are obtained by changing gears.

F. Types of Coolants

There are many types of coolants used in machine processes. The most common types fall into three categories: cutting oils, emulsifiable oils, and chemical cutting fluids.

1. Cutting oils can be grouped into two categories:

   a. active cutting oils--These oils contain large amounts of sulfur, giving the oil a dark, black color. Active cutting oils are used for heavy duty cutting. The sulfur is released with the work, thus the name "active".

   b. inactive cutting oils--These contain only the amount that the natural state of the oil possesses. The cutting oil is a light clear color, and it is named "inactive" because very little of the sulfur is released with the work. Both of these types of cutting oils are usually used on free machining material.

2. Emulsifiable oils are also known as soluble oils. These are mineral oils containing an emulsifier or soaplike material which makes them dissolve in water. Water is the best medium known for dissipating heat, but the soluble oil is needed for lubrication and the prevention of rust.

3. Chemical cutting fluids are also known as synthetic cutting fluids. These types of fluid are stable, pre-formed emulsions which contain very little oil and mix easily with water. These fluids contain extreme pressure lubricants that react with the fresh cut metal when it is being cut to form a lubrication and reduce the heat of friction. Chemical cutting fluids are mainly used on ferrous metals.

VII. Drill Press Activities

A. Drilling and Reaming

Tools and Equipment:

1. Drill press with 1/8" to 3/4" chuck and chuck key
2. Brush
3. Cutting fluid or oil
4. Vise with T-bolts, nuts, and parallels
5. Blueprint of tap and body drill gage
6. 1/8" letter stamps
7. 3/16" x 3" x 4 3/4" steel plate
8. Drills-#7, #3, F, I, Q, 5/16", 1/4", 23/54", 3/8", 25/64", 3/8", 27/64", and 12"
9. Reamers--17/64"; 21/64"; 29/64"; and 33/64"
10. 1/8" number set or etching pencil
11. Combination drill and countersink #3
12. Countersink 3/4" with 90° point
13. Scribe and layout fluid
14. Combination square set (12")
15. File
16. Center punch and ball peen hammer

Procedure:

1. Lay out center location of all holes to be drilled.
2. Center punch location of holes.
3. Set part in vise on parallels and tighten.
4. Fasten the center drill in chuck so only 1/2 its length extends beyond the chuck.

   (**CAUTION:** Be sure to remove chuck key.)

5. Set speed to approximately 1,000 rpm.

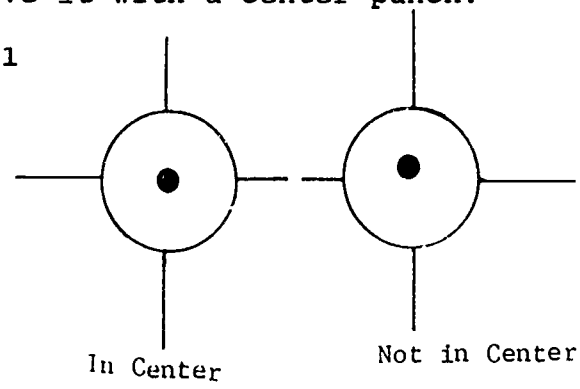
6. Locate the center punch mark in the part directly below the center drill point.

7. Carefully feed the center drill until it just touches the work.

8. Raise the enter drill and examine the location.

   (**NOTE:** It should be in the center of the two lines. If not, move it with a center punch.

Figure 1



9. When center drill is on center, apply cutting oil and continue to center drill to depth.

   (**NOTE:** The diameter of the center drilled hole should not exceed the diameter of the drill or be any deeper than the tapered portion of the center drill. (See Figure 2)

Figures 2 3 4 5

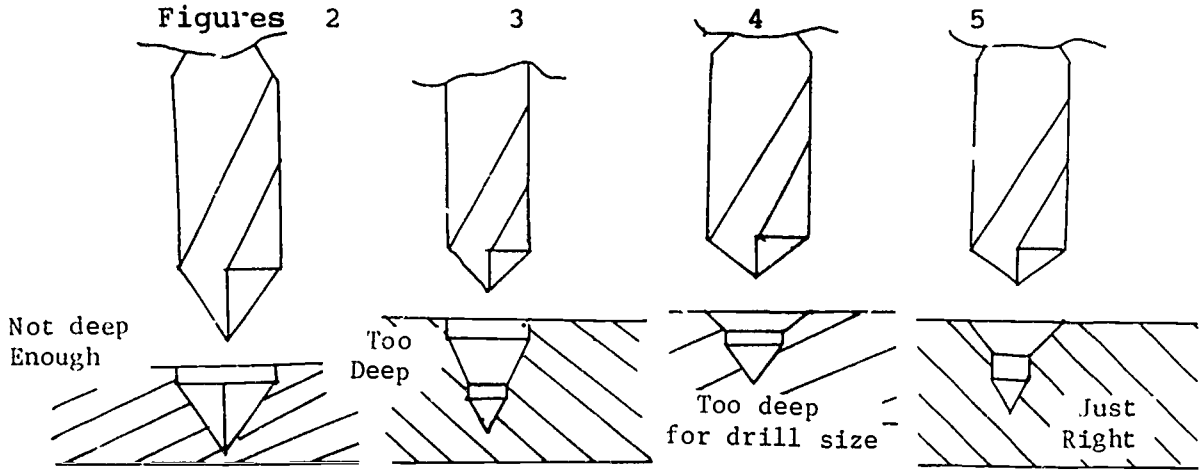
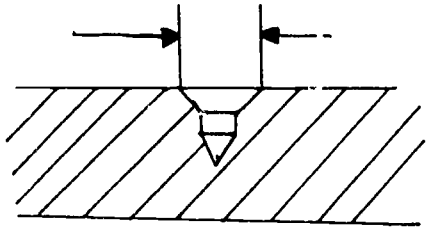


Figure 6



10. Continue to center drill all holes, repeating steps F through I. (**NOTE:** Body drill hole sizes are to be drilled 1/64" smaller and will be reamed to size.)

11. Remove center drill and secure the #7 drill in drill chuck.

12. Set rpm for #7 drill and position the center of the drill in the center drilled hole and clamp or bolt vise to table of drill press.

13. Apply cutting oil and feed the drill into the part.

    (**CAUTION:** Remember to ease up on the feed pressure as the drill breaks through the work.)

14. Remove #7 drill and secure #3 drill in drill chuck and repeat steps 12 and 13.

    (**NOTE:** In some cases the rpm will be close enough that you will not need to change rpms; however, as your drills get larger you will need to change rpms.)

15. Continue this process and drill with a 1/" drill (1/64" smaller than 17/64").

16. Remove the drill and insert the 17/64" reamer in drill chuck and tighten.

17. Reduce the rpm to 1/2 that of the 1/4" drill.

18. Apply oil to the reamer and ream the hole to size.

19. Drill and ream all holes to correct size

20. Use countersink and chamfer all holes 1/64" on both sides.

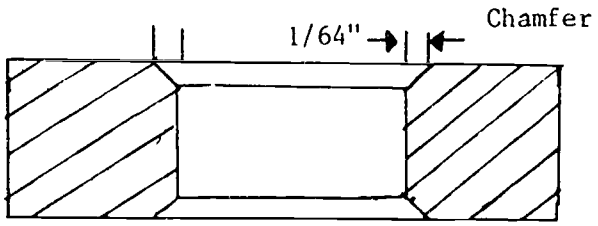


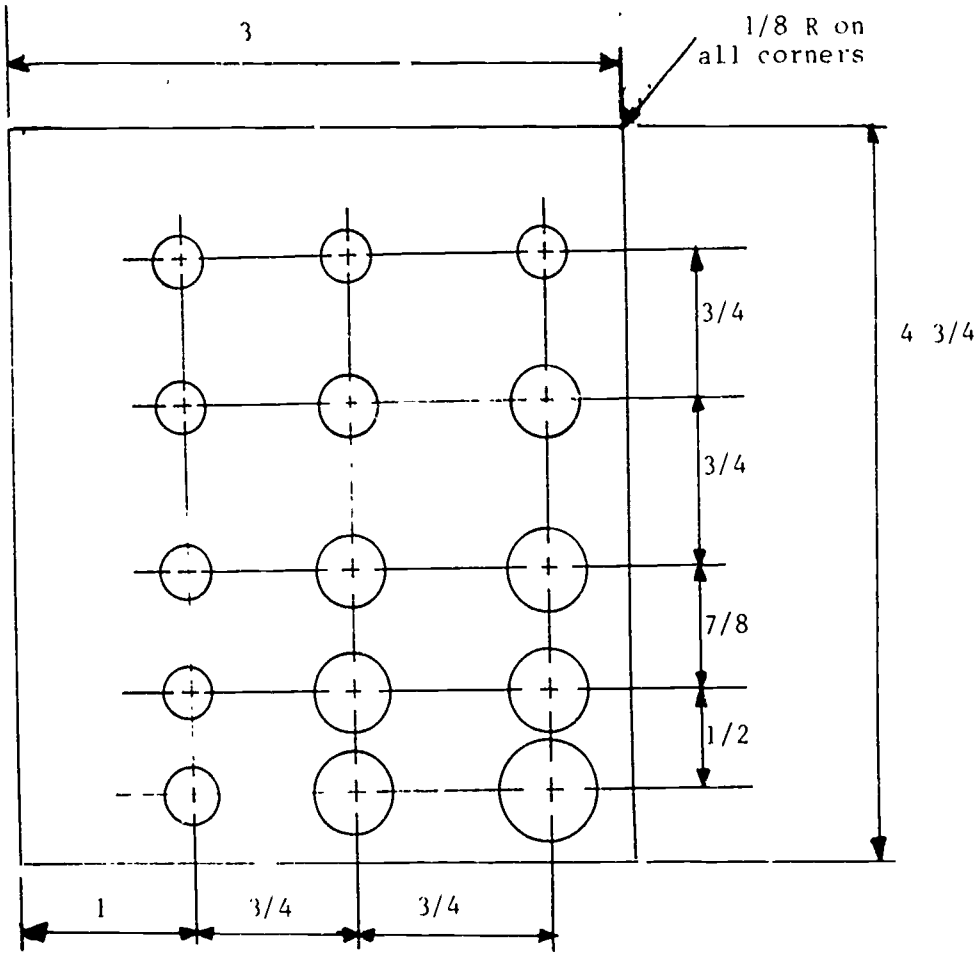
Figure 7

21. Use stamps or electric etching pencil and mark letters and fractional drill sizes of the different tap sizes and series.

22. File 1/8" radius on all corners.

23. Clean up machine and put all tools up in proper locations.

SCHEMATIC #1



B. Countersinking and Counterboring

Tools and Equipment:

1. Drill press with 1/2" chuck
2. Vise and parallels
3. 7/16" counterbore with 5/16" pilot
4. Countersink 82° angle, 3/4" diameter
5. 5/16-18 socket head cap screw
6. #10-32 and 5/16-18 flat head screws
7. Drills, 5/16" and #11
8. Brush
9. Cutting oil
10. C-clamps or T-bolts and nuts
11. 3/4" x 2" x 4" 1018 CRS stock
12. Blueprint
13. Combination square and scribe
14. Center punch and ball peen hammer

Procedure:

1. Lay out center locations of all holes where work is required.
2. Center punch locations for holes.
3. Set part in vise on parallels and secure.
4. Fasten the #11 drill in drill chuck and set the rpm at 1470; then drill the two holes.
5. Change drills and tighten the 5/16" drill in chuck; set rpm to 890 and drill the two 5/16" holes.

   (**CAUTION**: If the drill press is variable drive, turn on the spindle before moving the speed selector.)
6. Remove the drill and secure the countersink.

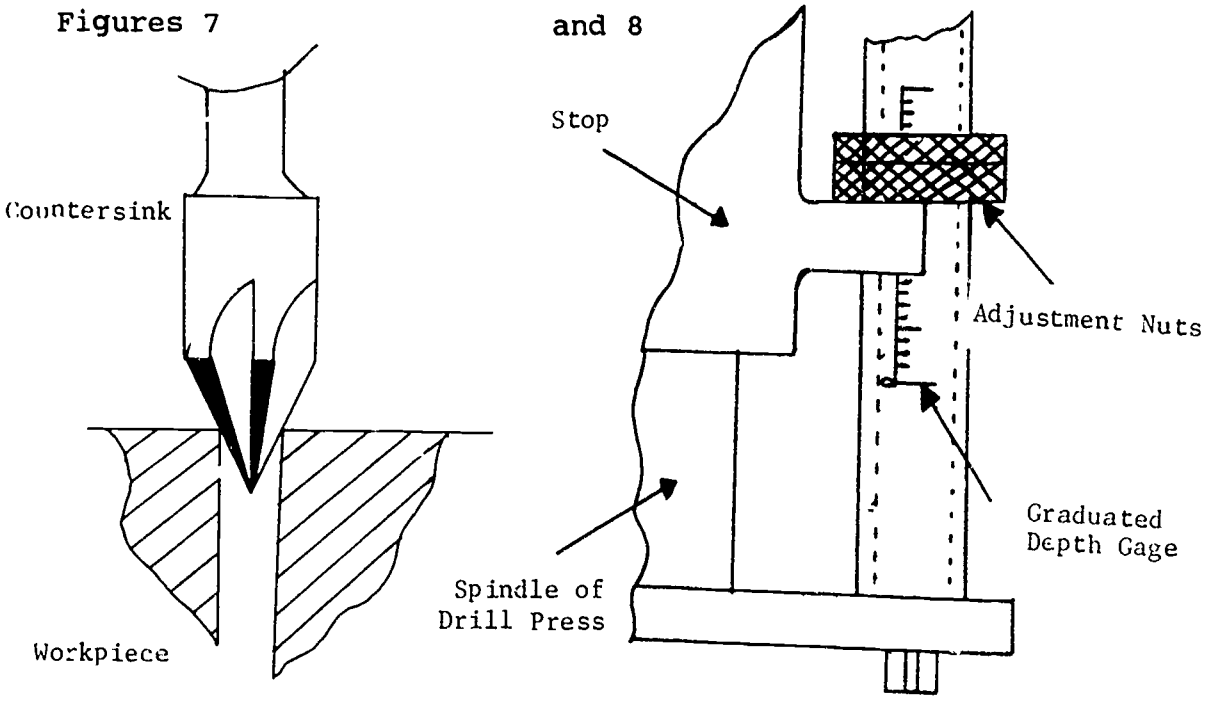
(**CAUTION:** If the drill press is variable drive, turn on the spindle before moving the speed selector.)

6. Remove the drill and secure the countersink.

7. Set the speed to 70 rpm.

8. Bring the countersink down into the hole and set the graduated stop.

Figures 7 and 8

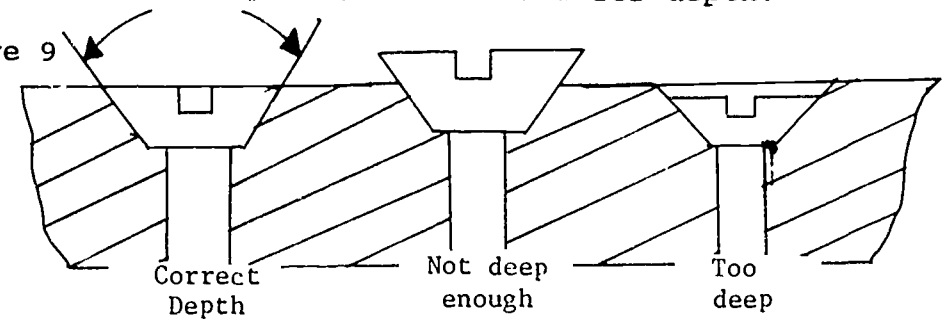


9. Tighten the spindle lock and back the adjusting nuts off the stop approximately .116".

10. Countersink the first hole.

11. Check it with the #10 flat had screw for depth.

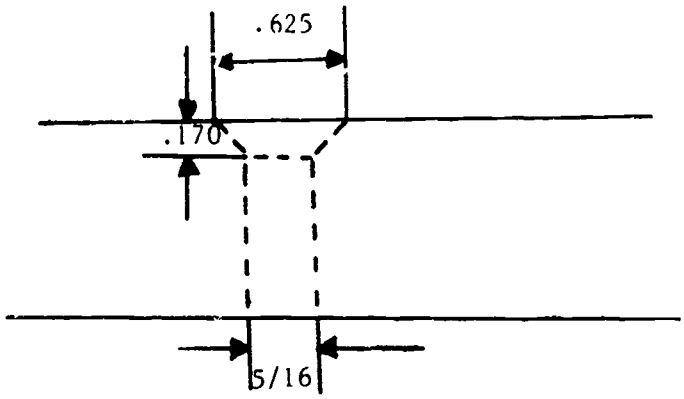
Figure 9



12. Adjust stop if necessary and countersink other hole.

13. Repeat operations H through L and countersink hole for the 5/16" flat head screw.

Figure 10



14. Remove the countersink and put the counterbore in the drill chuck and tighten.

15. Bring the counterbore down on the work and set the stop for 5/16" more.

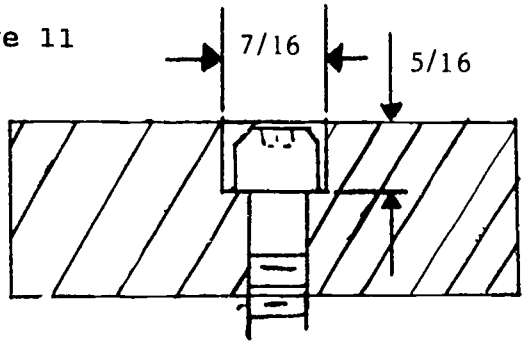
16. Make sure the pilot turns freely in the hole by turning the drill chuck by hand.

17. Pull the pilot out of the hole; apply cutting oil to hole and counterbore.

18. Start the machine and counterbore the hole.

19. Check the depth of the counterbore with the 5/16" socket head cap screw. (NOTE: It should be slightly below the surface.)

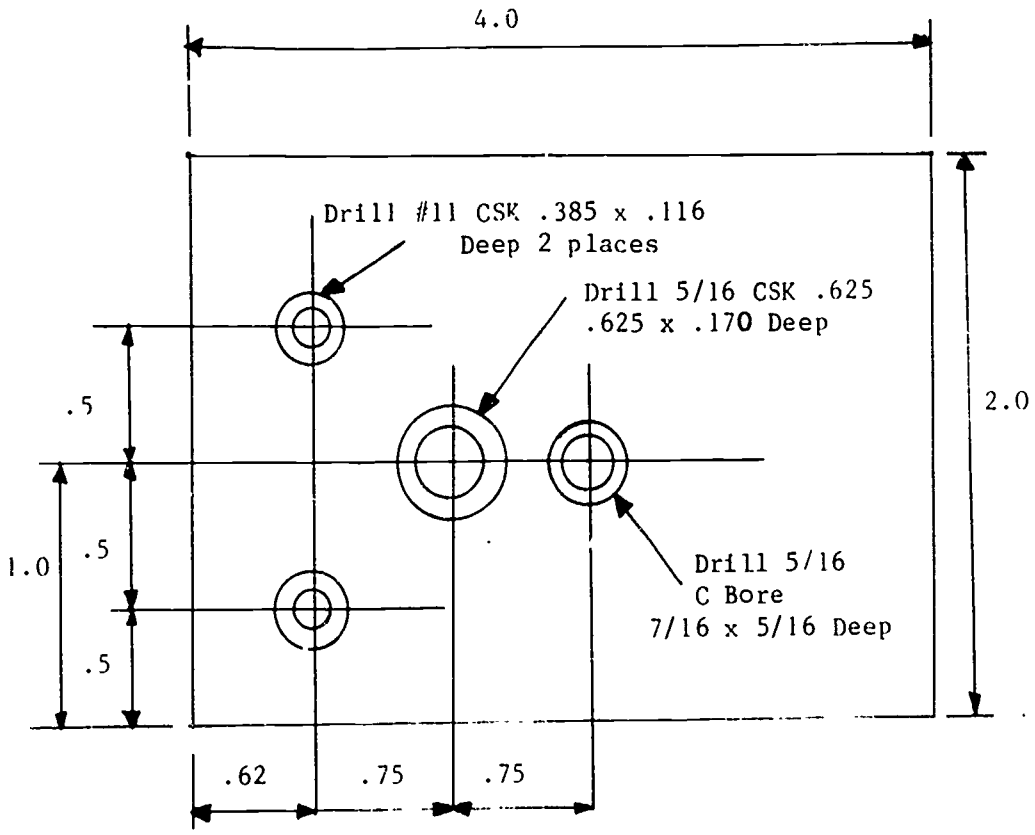
Figure 11

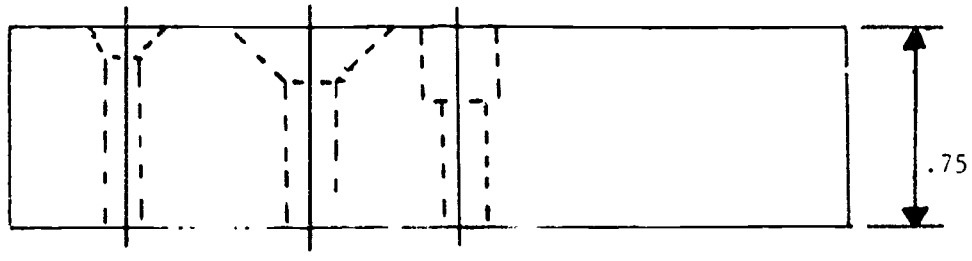


20. Remove the counterbore.

21. Clean up the drill press and other tools and put them up in proper locations.

SCHEMATIC #2


4.0
Drill #11 CSK .385 x .116
Deep 2 places
Drill 5/16 CSK .625
.625 x .170 Deep
2.0
.5
1.0
.5
.5
Drill 5/16
C Bore
7/16 x 5/16 Deep
.62
.75
.75


.75

C. Tap Holes Using the Drill Press

Tools and Equipment

1. Drill press with chuck
2. Centering tool
3. Tap wrench
4. 3/8-16 NC taper tap
5. 5/16" drill
6. Cutting oil
7. Vise with parallels
8. T-bolts and nuts
9. Wrench
10. Blueprint
11. Countersink (90°)
12. Brush
13. Center drill

Procedure #1:

1. Layout location of hole to be tapped.
2. Center drill holes.
3. Put the tap drill for the 3/8-16 NC tap in the drill chuck and secure.
4. Locate center of drill directly over center location of hole to be drilled.
5. Use the formula to set the correct rpm for drilling.

$$\frac{(4 \times CS)}{D}$$

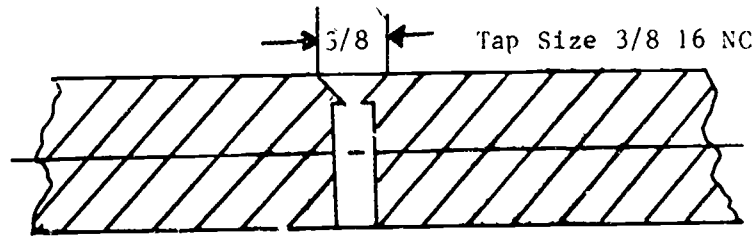
6. Secure the vise.
7. Turn the switch on and drill the hole through the work.

8. Remove the drill, insert the countersink and secure in chuck.

9. Set rpm at 90.

10. Chamfer the hole so the angular surface is diameter of the tap.

Figure 12

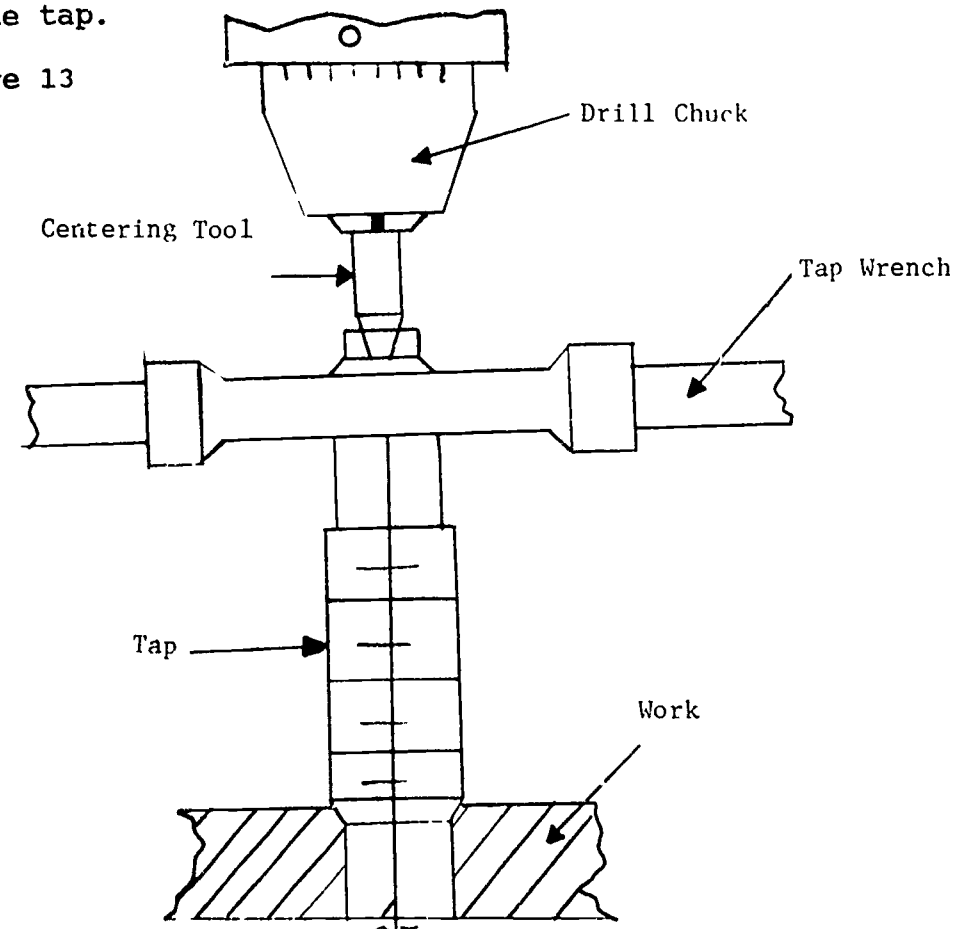


11. Remove the countersink, insert the center point in the chuck and secure.

12. Install tap in tap wrench.

13. Set the point of the tap in the hole and bring the spindle down until the centering tool is in the center of the tap.

Figure 13



14. Lock spindle clamp.

15. Apply cutting oil to tap and hole.

16. Gently turn the tap wrench to start thread, approximately one turn.

17. Unlock the spindle and bring the center point down securely in center of tap and lock spindle again.

18. Turn tap handle one more turn.

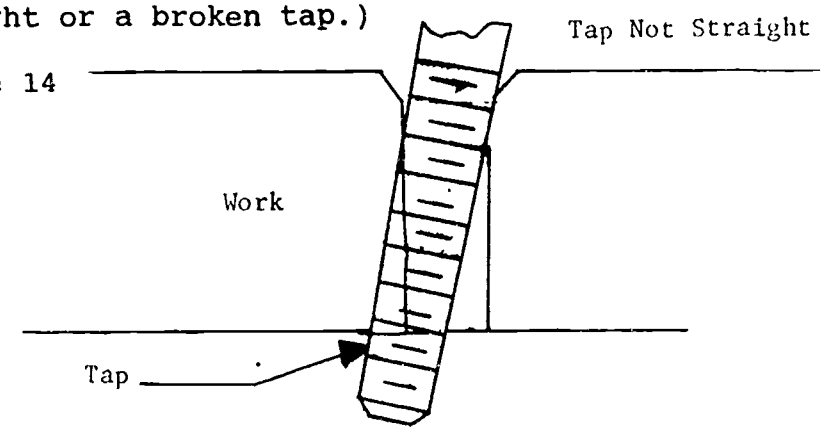
    (**NOTE:** Repeat above procedure until tap has started and will stand.)

19. Remove work from the drill press vise and finish tapping in bench vise after thread is started.

    (**NOTE:** Apply more cutting oil and back the tap up 1/2 turn to break chip after each revolution.)

    (**CAUTION:** Do not apply more pressure to one side of tap handle as it will result in a threaded hole that is not straight or a broken tap.)

Figure 14



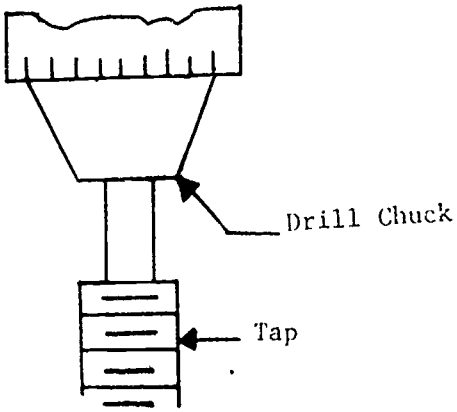
20. Clean machine and put up all tools.

Procedure #2:

1. Drill and chamfer as in the above procedure, steps 2 through 10.

2. Place chuck directly on tap since tap has no center hole for center point.

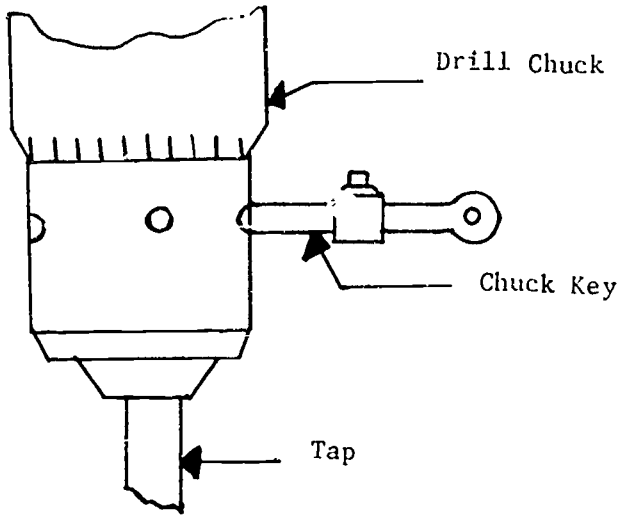
Figure 15



3. Bring the tap down into the hole and apply light downward pressure with feed handle.

4. Insert the chuck key in the hole of the drill chuck and rotate the chuck by hand.

Figure 16



5. Apply cutting oil to tap and hole.

6. When tap has started, release the feed handle and continue to tap approximately two revolutions.

7. Grasp the feed handle with one hand and loosen the chuck until the tap is free; allow the spindle to withdraw slowly.

   (**NOTE:** Tapping can also be accomplished with the use of a tapping attachment mounted to the spindle of a drill press. Ask your instructor to explain.)

8. Remove part from drill press vise and clamp in bench vise.

9. Put tap wrench carefully on tap and finish tapping hole.

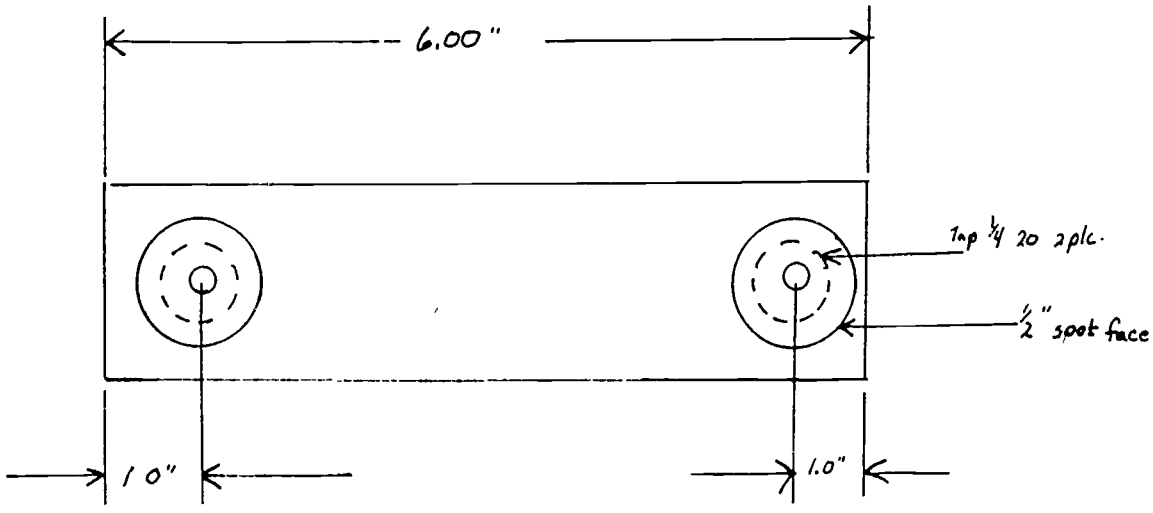
   (**NOTE:** Apply more cutting oil and back the tap up 1/2 turn to break chip after each revolution.)

   (**CAUTION:** Do not apply more pressure to one side of tap handle as it will result in a threaded hole that is not straight or a broken tap.)

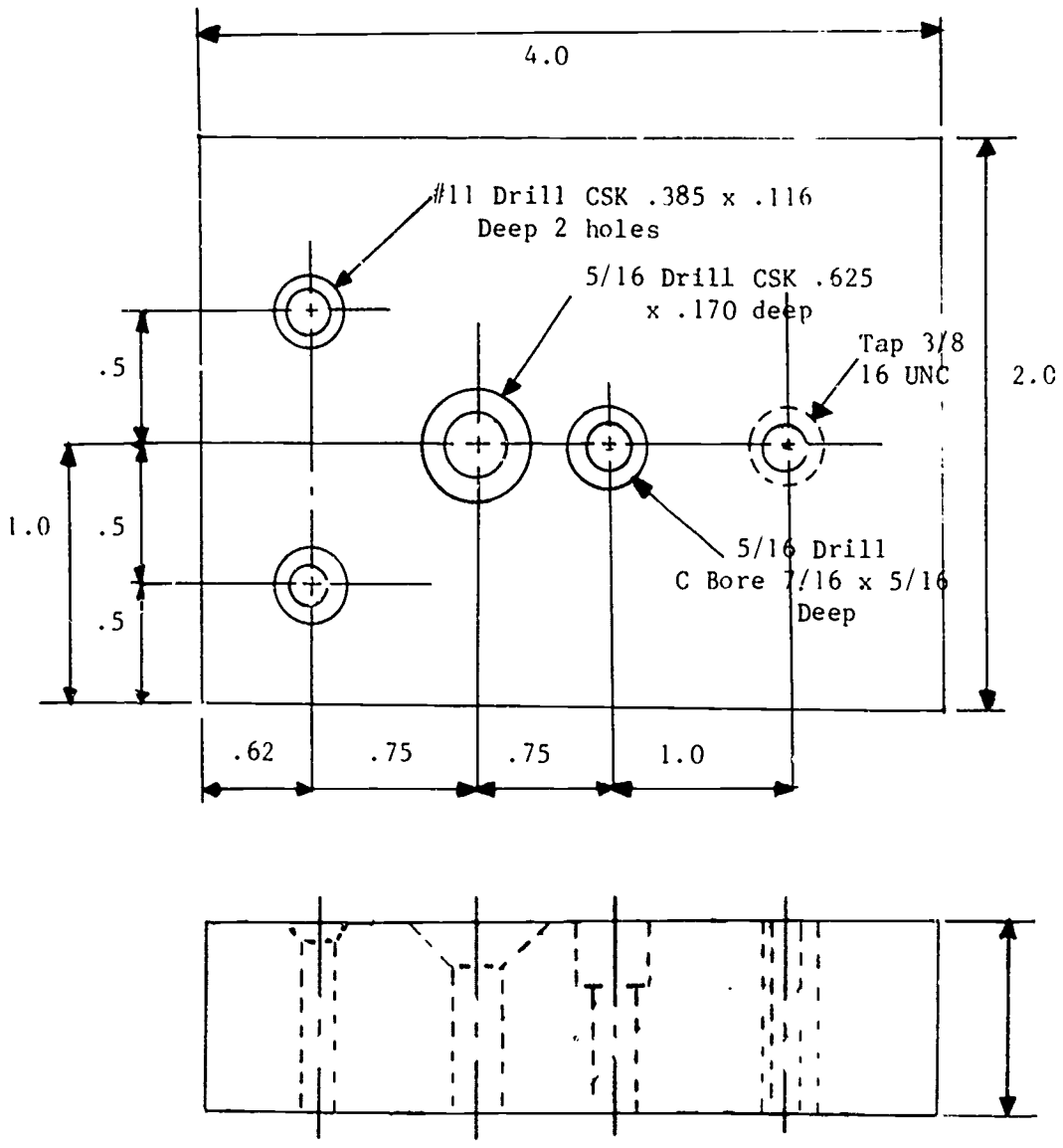
Procedure #3:

1. Layout location of hole to be spot face and tapped.
2. Mount workpiece in V-block.
3. Center drill holes.
4. Locate center of drill directly over center location of hole to be drilled.
5. Use formula to set correct rpm for drilling:
   $\frac{4xCS)}{D}$
6. Drill holes through work piece.
7. Remove drill and insert counter bore for spot facing.
8. Set proper speed for spot facing.
9. Remove counterbore and insert countersink.
10. Chamfer holes on both sides, so the angular surface is the diameter of the tap.
11. Remove the countersink and insert the center point.
12. Install tap wrench.
13. Tap hole as done in previous procedure.
14. Clean machine and put all tools away.

1.00" outside diameter round stock material cold rolled steel (**NOTE:** Spot face deep enough for flat on the round stock size of the counterbore.)



SCHEMATIC #3


4.0
#11 Drill CSK .385 x .116
Deep 2 holes
5/16 Drill CSK .625
x .170 deep
Tap 3/8
16 UNC
2.0
.5
1.0
.5
.5
5/16 Drill
C Bore 7/16 x 5/16
Deep
.62
.75
.75
1.0

D. Radial Drill Press Operation

Tools and Equipment

1. Radial drill press
2. Cutting fluid or oil
3. Vise with T-bolts, nuts, and parallels
4. Blueprint
5. 1 3/4" x 4 1/2" x 1/2" steel plate
6. Drills: 1 1/8, 3/4, 1/8, 5/16
7. Taps 3/8"-16 tapper tap
8. Center drills
9. Countersinks
10. Tapping attachment
11. Scribe and lay die
12. Combination square set
13. Center punch and ball peen hammer

Procedure:

1. Lay out center location of all holes to be drilled.
2. Center punch location of the two large holes.
3. Set part in jig and mount jig to the vise.
4. Install the drill chuck with the tapered shank into the drill press shaft. Be sure the taper is clean and the flat line up to ensure proper fit.
5. Fasten center drill into the drill chuck.
6. Set drill at approximately 1000 rpm for proper speed.
7. Locate the center drill directly over the enter punch mark using the hand crank and surging the drill head on the drill. Once positioned, push the electric clamping button, which locks the drill into position. The lock on the hand crank must also be tightened.

8. Carefully feed the center drill until it touches the work. Then raise the drill and examine the location.

9. When the center drill is on center, apply cutting fluid and drill to the proper depth.

10. Using the same procedure, center the drill to the other large hole.

11. Remove the center drill from the chuck and install the 1/8" drill.

12. Set the proper speed and feed for the 1/8" drill. Remove part from vise and insert it into the drill jig. Mount the jig in the vise, move the 1/8" drill into the bushing of the jig, and drill out all three holes. Remember to apply coolant.

13. Remove the 1/8" drill and install the 5/16" drill for the tapered holes.

14. Set the 5/16" drill for proper feed and speed, apply coolant, and drill the two holes.

15. Remove the 5/16" drill from the chuck. Using a drift, insert it into the slot of the drill shank and drive it in with a rubber mallet, forcing out the drill chuck.

    (**NOTE:** Hold onto the chuck so it does not come down and hit the vise. A wooden board placed on top of the vise would be a good vise protector.)

16. Install the 3/4" tapered shank drill into the drill shank.

    (**NOTE:** A reducer may have to be used to ensure proper fit.)

17. Set proper feed and speed, apply coolant, and drill the hole.

18. Using the drift, drive out the drill from the drill shank. Make sure the drill does not hit the part or the vise.

19. Install the 1" tapered shank drill. Set the proper speed and feed, and drill the 1" hole.

20. Remove the 1" drill in the same manner as mentioned previously.

21. Install the drill chuck and countersink. Chamfer the to holes to be tapered, and then remove the countersink and drill chuck.

22. Install the tapping attachment with its tapered shank that allows it to fit the drill shaft.

23. Bolt the stop slide to the table of the drill. This must be done so the attachment will not spi.. around while tapping.

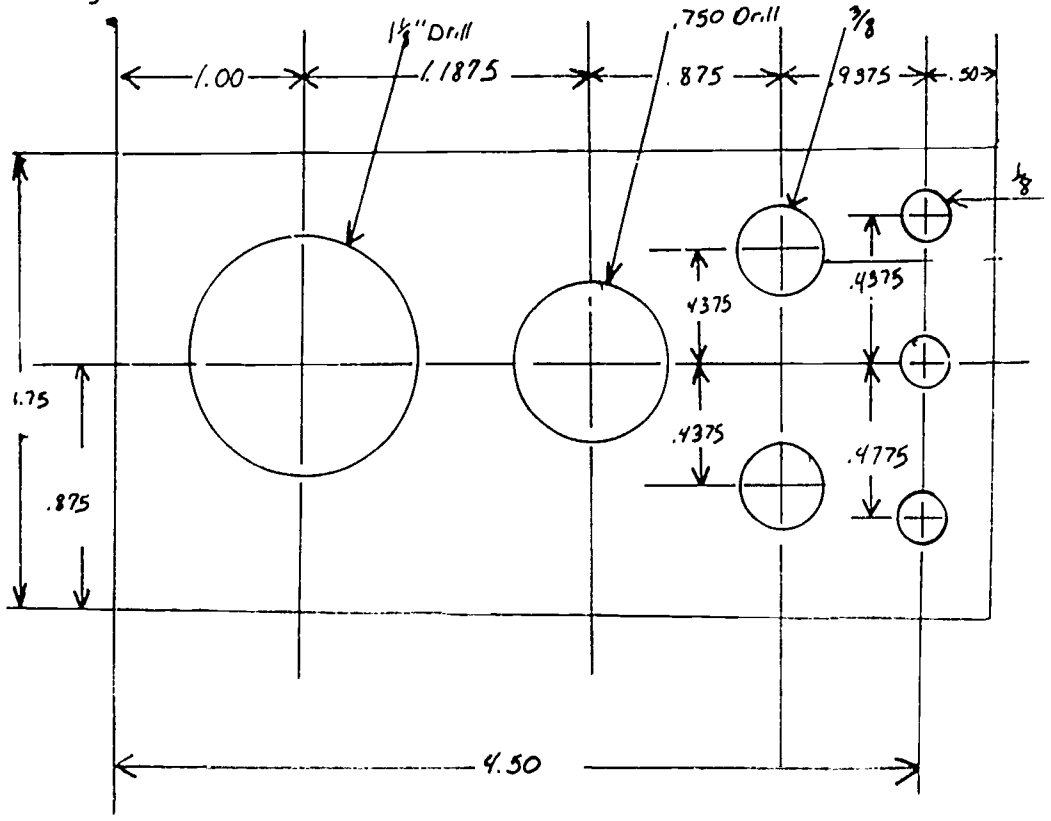
24. Insert the proper size collet into the attachment. Insert a 3/8"-16 tap and tighten collet nut.

25. Set drill for a slow rpm. Move the part in the jig so that the holes to be tapped aligr with the jig mark tapping holes.

    (**NOTE:** The jig has stops to ensure proper location of the holes to be drilled and tapped.)

    Proceed to tap the hole. Downward pressure will rotate the tap in a forward direction. When the tap is through, an upward pressure will reverse the tap and back it out of the hole. Remove part and clean machine. Return all tools to their proper locations.

Figure 17



QUESTIONS - DRILL PRESS

1. Match the terms associated with drill press operations to the correct definitions. Write the correct numbers in the blanks.

_____ a. Tapered portion of a cutting tool that aligns the tool in the spindle or holder.

_____ b. Drills that are graduated from number 80 (.0135") to number 1 (.228"); sometimes referred to as wire gage size drills.

_____ c. The amount of force put on a tool in the downward direction, expressed in feed per inch per revolution of the tool.

_____ d. Drills that are graduated from .35 mm to 25 mm and larger.

_____ e. Straight portion of a cutting tool that aligns the tool in the holder.

_____ f. Flats or tongue machined on the end of a tapered shank to prevent the taper from rotating in the mating part.

_____ g. Small hole used to guide a drill of a larger size.

_____ h. Drills that are graduated from A (.234") to Z (.413").

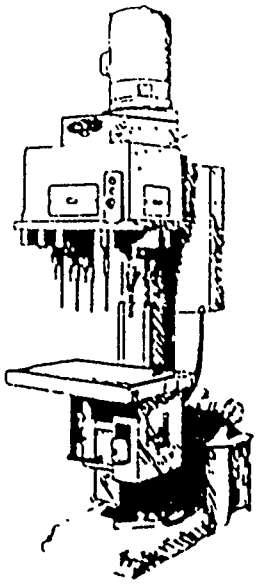
_____ i. Producing a small hole with a 60° taper at the top of the hole using a combination drill and countersink (center drill).

____ j. Drills that are graduated by fractions of inches from 1/64" to 1" and larger.

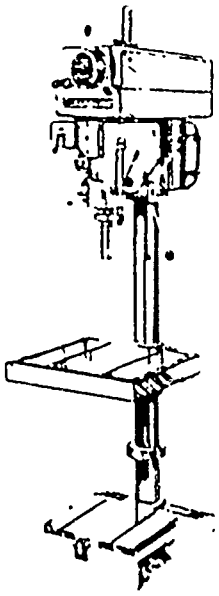
1. Pilot hole
2. Center drilling
3. Taper shank
4. Straight shank
5. Number drills
6. Letter drills
7. Metric drills
8. Fractional drills
9. Tang
10. Feed pressure

2. Identify types of drill presses seen in the following illustrations. Write the correct names in the blanks.

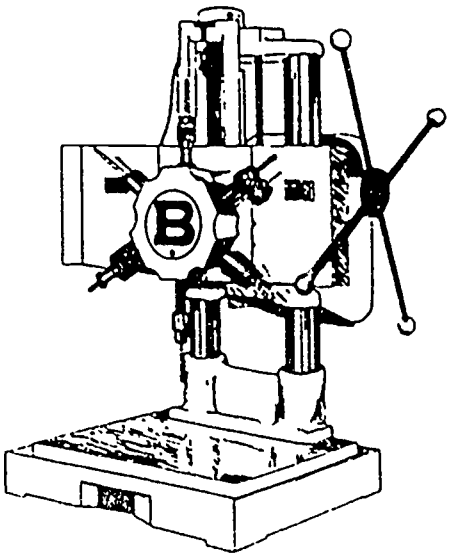
Sensitive bench drill press
Upright drill press
Radial arm drill press
Gang drill press
Multispindle drilling, boring, and tapping machine
Bench turret drill press
Numerical control turret drilling and tapping machine



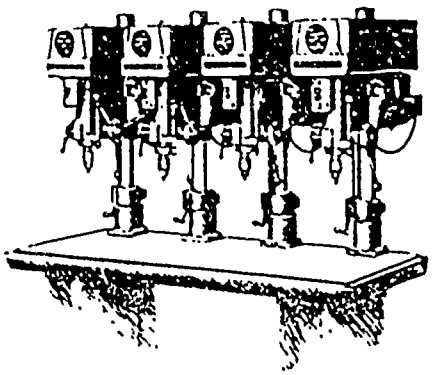
a. _____



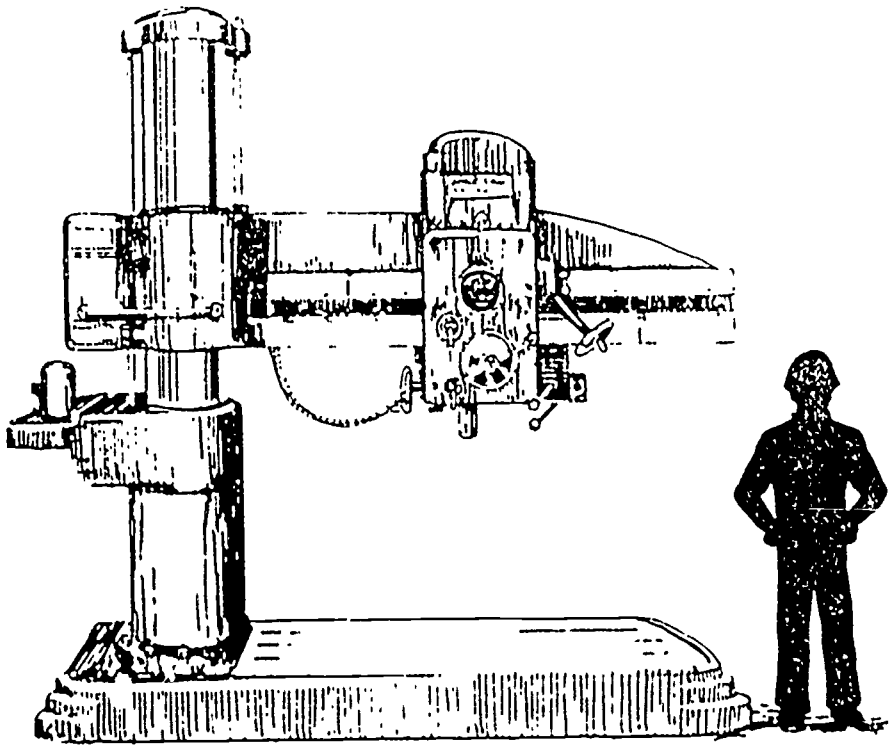
b. _____



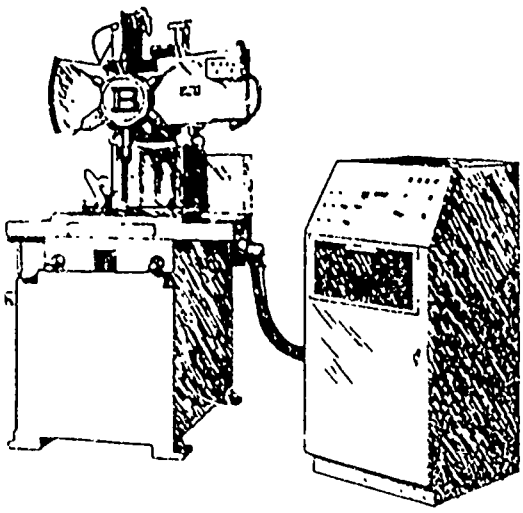
c. _____

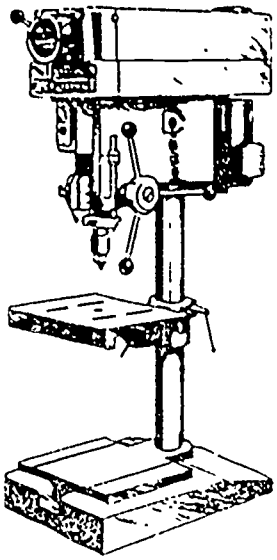


d. _____



e. _____





f. _____ g. _____

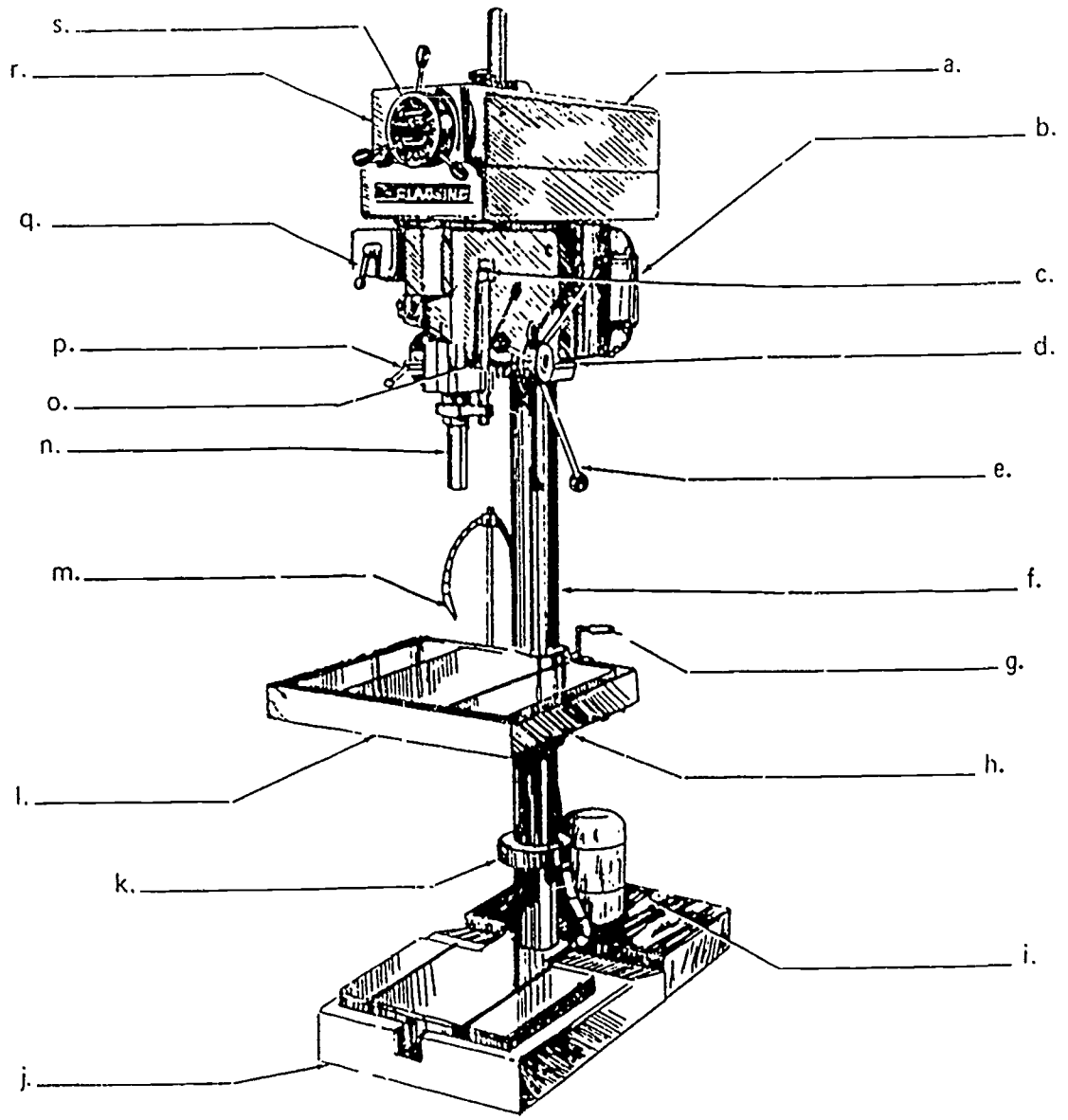
3. Describe the function of a drill press--_____

_____

_____

4. Identify major parts of a drill press as seen on the next page. Write the correct numbers in the blanks.

Speed selector	Coolant pump	Spindle
Head	Table locking bolts	Coolant nozzle
Switch	Table elevating crank	Table
Spindle lock	Column	Table stop collar
Depth gage	Manual feed lever	Feed drive
Motor	Belt guard	Base
		Depth stop



5. Match operations performed on a drill press to the correct definitions. Write the correct numbers in the blanks.

____ a. Producing a screw thread in a hole that has been drilled to a specific size.

____ b. Producing a tapered surface in a hole so a flat head screw will be flush with the top surface of the part.

____ c. Producing a hole of a given size and depth

____ d. Making a small angular surface at the top of a hole.

____ e. Making a flat surface so a bolt head or nut will seat properly.

____ f. Making a hole with a tapered top so the drill will start in location desired.

____ g. Producing a small hole that is used to guide a larger drill and reduce the feed pressure of the larger drill.

____ h. Enlarging a hole with a flat bottom for a screw head to set in below the surface.

____ j. Enlarging a hole a small amount to make it true to size.

____ j. Enlarging an existing hole to a given size and depth.

1. Center drilling
2. Drilling
3. Boring
4. Counterboring
5. Countersinking
6. Tapping
7. Spot facing
8. Reaming
9. Chamfering
10. Drilling a pilot hole

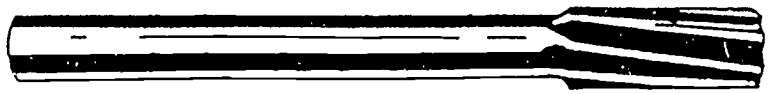
6. Name cutting tools used for drill press operations as seen in the following illustrations. Write the correct names in the blanks.

a. _____

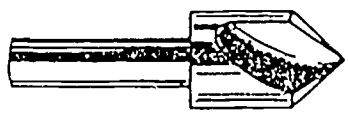
b. _____

c. _____

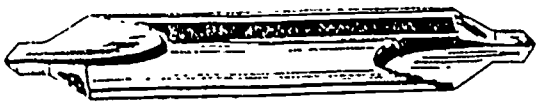
. _____



e. _____

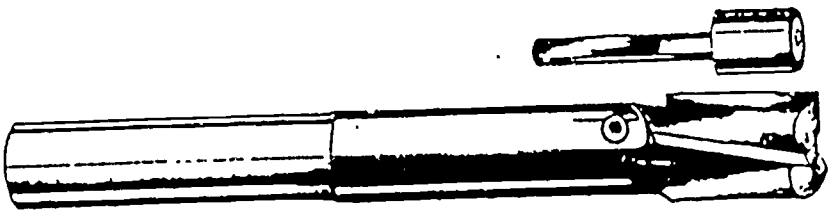


f. _____



g. _____

h. _____



i. _____

7. Describe types of drill press spindle drives.

a. Cone pulley drive--_____

_____

_____

b. Variable speed drive--_____

_____

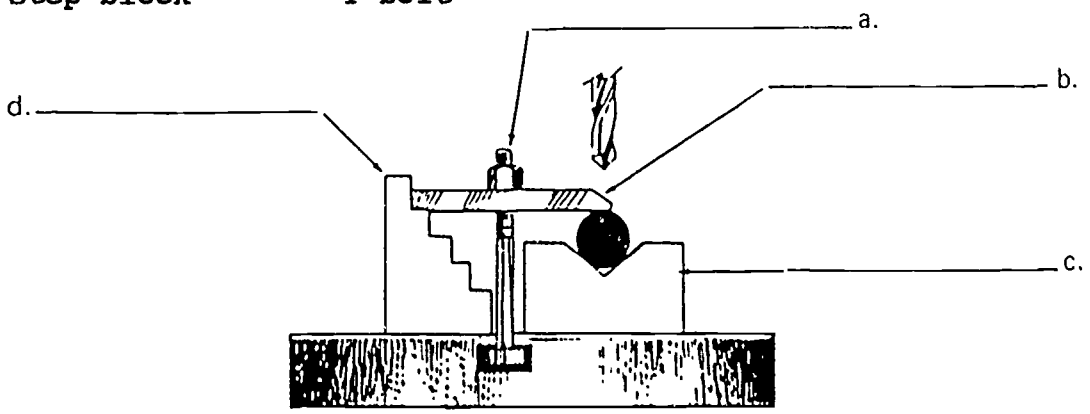
_____

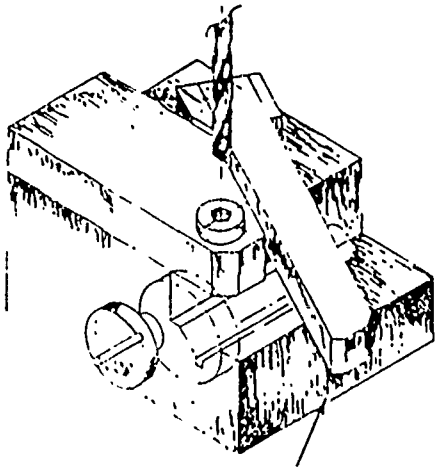
c. Gear head drive--_____

_____

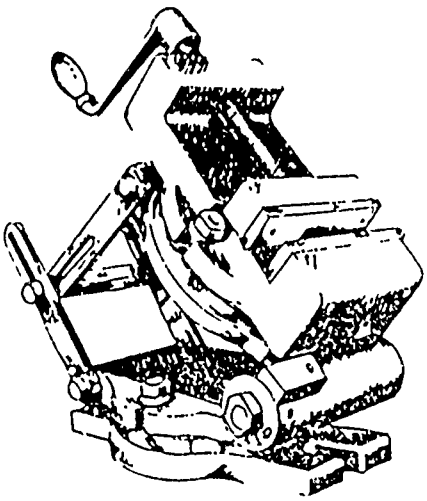
8. Identify workholding and set-up devices used in drill press operations as seen in the following illustrations. Write the correct names in the blanks.

Vise	Strap clamp	Parallels
Parallel clamp	Angle plate	Screw jack
C-clamp	V-block	
Drill fixture	Angle vise	
Step block	T-bolt	

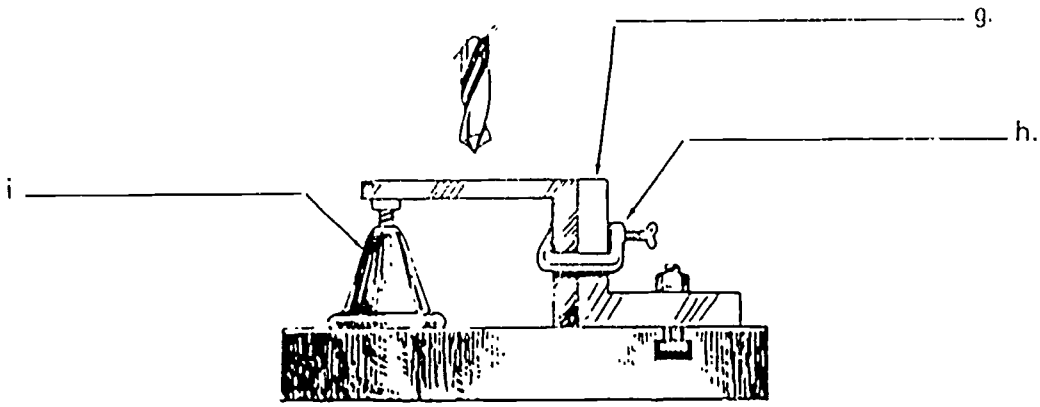


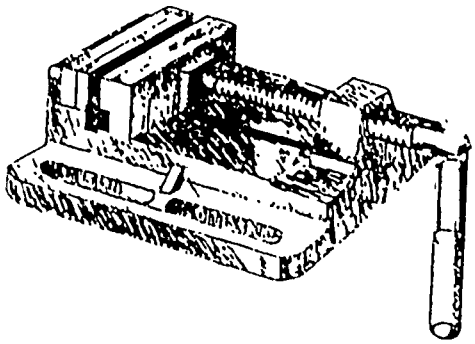


e. _____

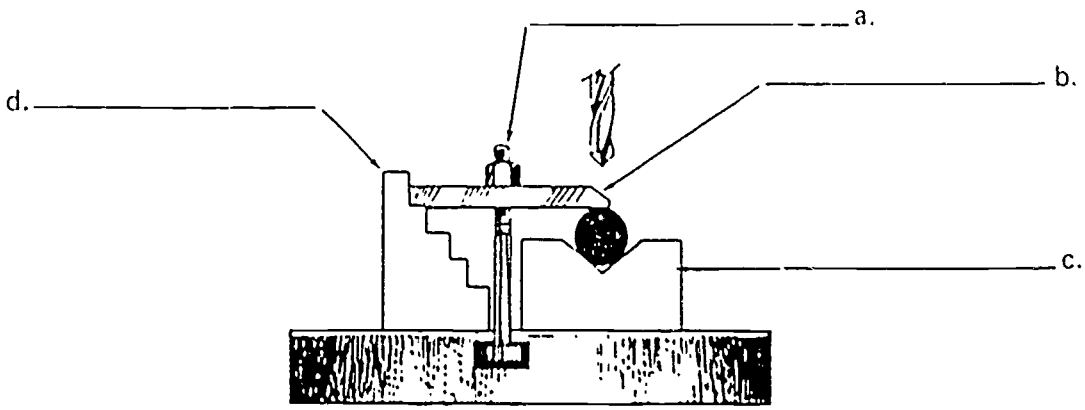


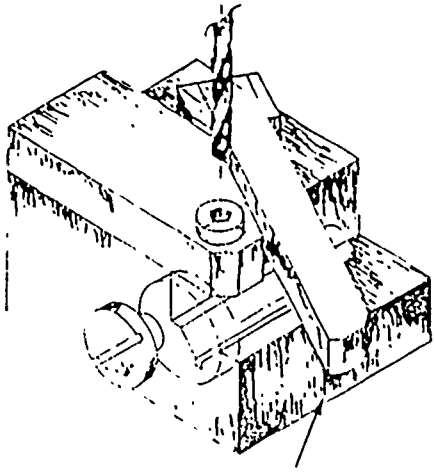
f. _____



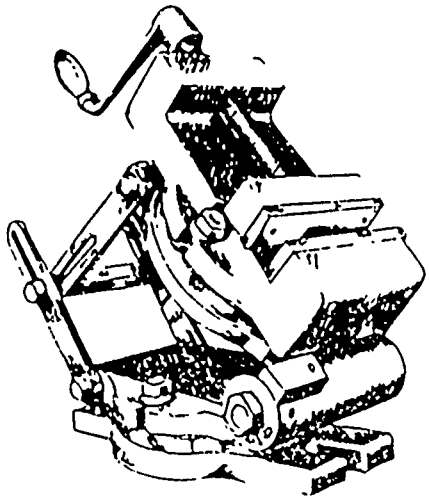


j. _____





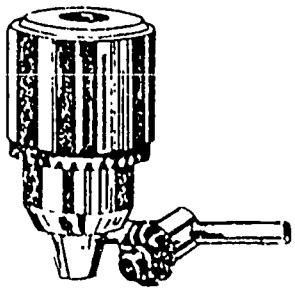
e. _____

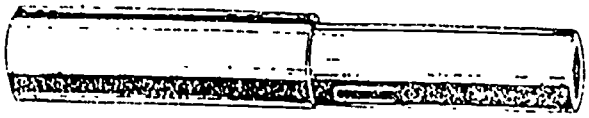


f. _____

9. Identify attachments and accessories used with drill presses. Write the correct names in the blanks.

Tapping attachment	Steel sockets
Floating chuck	Drill chuck
Drill drift	Morse taper shank adapter sleeve

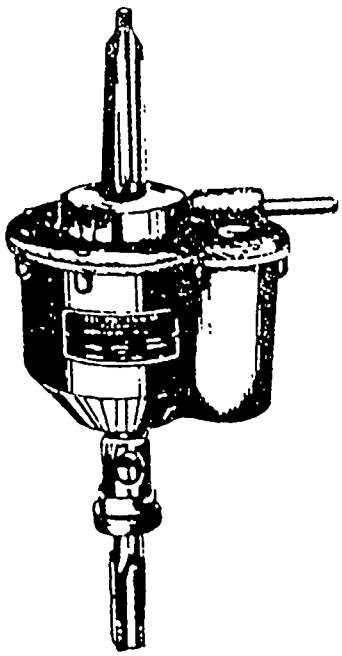




b. _____

a. _____

c. _____



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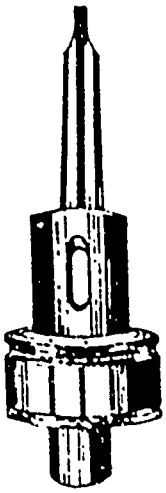

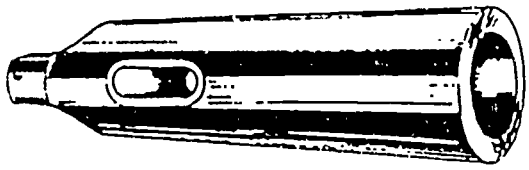

e. _____ f. _____

10. List three methods of applying coolants.

a. _____

b. _____

c. _____

11. State rules for safe use of drilling machines

a. Eyes--_____

b. Clothing--_____

c. Guards--_____

d. Chuck Key or Drill Drift--_____

e. Watches and Rings--_____

f. Chips--_____

g. Rags--_____

h. Work--_____

i. Feed Pressure--_____

j. Drill Chuck--_____

k. Drill Drift--_____

l. Machine in Motion--_____

m. Hands- _____

n. Table--_____

o. Spindle Tapers--_____

p. Deep Holes--_____

q. Chucks and other Tools with Tapered Sharks--_____

r. Floor--_____

s. Drill Press--_____

t. Tools--_____

u. Hair--_____

12. Discuss care and cleaning of drilling machines.

a. Lubrication--_____

b. Belts--_____

c. Variable Speed Drives--_____

d. Gear Drives--_____

e. Chips--_____

f. Tools--_____

13. Select from the following list factors that affect cutting speeds for drilling operations. Mark each correct answer with an "X".

_____ a. Kind of coolant

_____ b. Rigidity of set-up

_____ c. Drill size

_____ d. Thickness of material

_____ e. Type of material to be drilled

_____ f. Type of drilling operation

_____ g. Drill material

14. Determine rpm for drilling using the following drill speed chart. Write your answers in the blanks provided.

    a. 1/2" drill, drilling holes in tool steel with a CS of 60 feet

       Answer _____ rpm

    b. 1" drill, drilling holes in 2" thick aluminum plate with a CS of 300

       Answer _____ rpm

Drilling Speeds for High-speed Steel Drills

Drill Diam., Inches	Bronze, Brass, 300 Feet	Cast Iron An-nealed 150 Feet	Cast Iron Hard 70 Feet	Mild Steel 100 Feet	Drop Forg-ings 60 Feet	Mal. Iron 90 Feet	Tool Steel 50 Feet	Cast Steel, 40 Feet
	Revolutions Per Minute							
1/16	....	9170	4278	6111	3669	....	3056	2440
1/8	9170	4584	2139	3056	1830	2745	1528	1220
3/16	6112	3056	1426	2037	1210	1830	1019	807
1/4	4585	2292	1070	1528	915	1375	764	610
5/16	3660	1833	856	1222	732	1138	611	490
3/8	3056	1528	713	1019	610	915	510	407
7/16	2614	1310	611	873	522	784	437	348
1/2	2287	1146	535	764	458	688	382	305
5/8	1830	917	428	611	366	569	306	245
3/4	1525	764	357	509	305	458	255	203
7/8	1307	655	306	436	261	392	218	174
1	1143	573	267	382	229	349	191	153
1 1/4	915	458	214	306	183	275	153	122
1 1/2	762	382	178	255	153	212	127	102
1 3/4	654	327	153	218	131	196	109	87
2	571	287	134	191	115	172	95	77

15. Calculate drill speeds using rpm formula of the following drilling operations., Show your work, and write your answers in the blanks provided.
(**NOTE**: All drills are H.S.S.)

    a. You are to drill 5 holes 1/2" in diameter in a mild steel plate with a CS of 100" per minute. How many rpms should the drill turn?_____

    b. If you are using a drill press with a step pulley drive having speeds of 240,380, 600, 900, and 1500 rpm, what speed would you use for problem 15a?_____

    c. You are to drill five 5/16" diameter and two 3/4" diameter holes in a tempered aluminum plate 1 1/2" thick. The CS for the aluminum is 250 feet per minute. How many rpms should the two drills turn?

        1. 5/16" drill_____

        2. 3/4" drill _____

16. Demonstrate the ability to:

    a. Drill and ream holes to layout.

    b. Countersink and counterbore holes to specification.

    c. Tap holes using the drill press.

    (**NOTE**: If the above activities have not been finished before the test, ask your instructor when they should be completed.)

DRILL PRESS- ANSWERS

(Note: The point system designated in parentheses is intended to be a guideline and should be adapted as needed. The point total is 350.)

1. (20 points)
   a. 3
   b. 5
   c.10
   d. 7
   e. 4
   f. 9
   g. 1
   h. 6
   i. 2
   j. 8

2. (14 points)
   a. Multispindle drilling, boring, and tapping machine
   b. Upright drill press
   c. Bench turret drill press
   d. Gang drill press
   e. Radial arm drill press
   f. Numerical control turret drilling and tapping machine
   g. Sensitive bench drill press

3. (4 points)
   To produce round holes in material by using twist drills and other types of cutting tools.

4. (38 points)
   a. Belt guard
   b. Motor
   c. Depth stop
   d. Feed drive
   e. Manual feed lever
   f. Column
   g. Table elevating crank
   h. Table locking bolts
   i. Coolant pump
   j. Base
   k. Table stop collar
   l. Table
   m. Coolant nozzle
   n. Spindle
   o. Depth gage
   p. Spindle lock
   q. Switch
   r. Head
   s. Speed selector

5. (20 points)
   a. 6
   b. 5
   c. 2
   d. 9
   e. 7
   f. 1
   g. 10
   h. 4
   i. 8
   J. 3

6. (18 points)
   a. Tapered shank twist drill
   b. Straight shank twist drill
   c. Tap
   d. Tapered shank reamer
   e. Straight shank reamer
   f. Countersink

thrown and possibly cause injury.

e. Watches and rings--Remove before operating drill press or any machine to prevent possible accidents.

f. Chips--Remove with a brush, never your hands.

g. Rags--Should never be used while machine is running, and never left on the table of a running machine.

h. Work--Should always be held in a vise or other workholding device that is secured to the table; never try to hold work with your hands.

i. Feed pressure--Ease up when the drill is breaking through so it will not grab and leave a big burr.

j. Drill chuck--Designed to hold straight shank drills and tools; should never be used to hold tools with tapered shanks.

k. Drill drift--The only tool that should be used to remove tapered shank tools from spindles or sleeves.

l. Machine in motion--Never clean or make adjustments while machine is running.

m. Hands--Never pick up a drill, work, or any tool that you have been using as it is hot and will burn; use a rag.

n. Table--Should be kept clean and free of tools to eliminate accidents and possible damage to tools.

o. Spindle tapers--Should never be cleaned when spindle is being turned by power.

p. Deep holes--Interrupt the feed occasionally to break up chips and clear the drill.

q. Chucks and other tools with taperd shanks--Always place a board on the table under tool so when you break the taper with the drill drift it will not fall and damage the tool or table of the drill press.

r. Floor--Keep work area clean and free of slippery materials or chips to prevent accidents.

s. Drill press--Clean machine and floor after using drill press.

t. Tools-Clean oil or coolant from drills and other tools and put them up in the proper place.

u. Hair--Long hair must be secured under a hat, in a hair net, or tied back to prevent it from being caught by rotating parts of the drill press.

12. (12 points)
a. Lubrication--Check all oil levels for proper levels before using.

b. Belts--Check drive belts for proper tightness.

c. Variable speed drives--Never crank the speed selector when spindle is not turning.

d. Gear drives--Never shift gears when spindle is turning; shut off machine.

e. Chips--Clean chips off table with a brush

f. Tools--Never use a dull tool since it causes more friction and will ruin the tool.

13. (14 points)
c, e, g

14. (8 points)
a. 458
b. 1143

15 (20 points)
a. $\frac{4 \times 100}{.5} = 800$ rpm

b. 900

c. 1) $\frac{4 \times 250}{.312} = 3205$

2) $\frac{4 \times 250}{.75} = 1333$ rpm

15. (65 points) Performance skills evaluated to satisfaction of instructor.

END

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