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INGLÉS TÉCNICO PARA MECÁNICO DE MANTENIMIENTO

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UNIT ONE

TURNING HAND TOOLS

OBJECTIVES

1. Given pictures of different wrenches the student will orally and/or in writing identify the following features:
- open end wrench
- box end wrench
- combination wrench
- 6 point box
- 12 point box
- bolt head
- nut

2. Given a picture of a socket wrench, ratchet handle, hinge or flex handle, T-bar, speeder handle, torque handle, extensions, adapter, universal joint, and a crecent wrench, the student will orally and/or in writing correctly identify each.

3. Given the task of state the meaning of the terms below, the student will orally and/or in writing explain the meaning of each :
- fraction
- jaw
- offset
- tighten
- loosen
- hexagonal
- size

UNIT ONE

TURNING HAND TOOLS

LESSON A

1. OPEN-END WRENCHES

Wrenches are turning tools that are used to *tighten* or loosen nuts and bolts. When you tighten a nut or bolt, it holds things together with pressure; when you loosen a nut or bolt, you make the pressure less. The size of a nut or bolt head is measured from one side to the opposite side. Nuts and bolt heads are made in standard sizes which are based on the inch, or fractions of an inch. Since wrenches are made to fit nuts and bolt heads, they are measured by the same system. See figure 1.

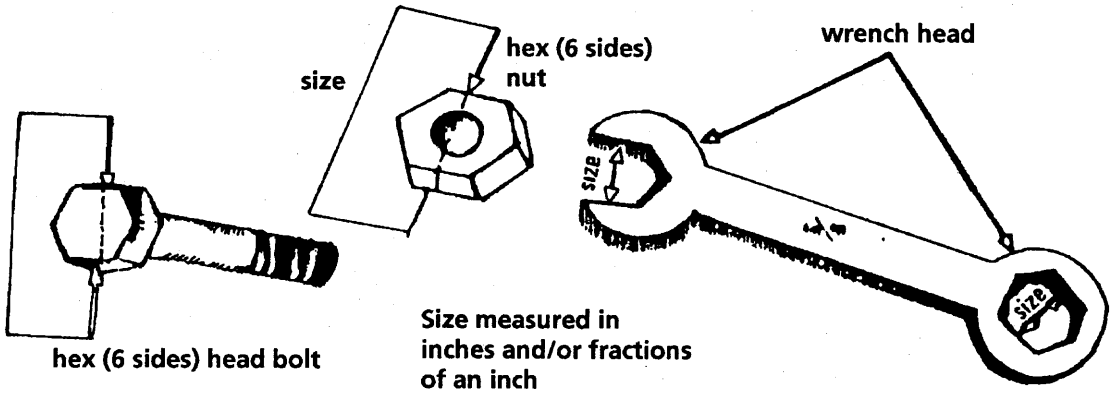


Figure 1.- Size of nut, bolt head, and wrenches

The inch-fraction system used to measure nuts, bolt heads, and wrenches is derived by dividing by two. If an inch is divided by two, it is divided into two halves (1/2, 1/2). If each halfs is divided by two, the inch is divided into fourths or quarters (1/4, 1/4, 1/4, 1/4).

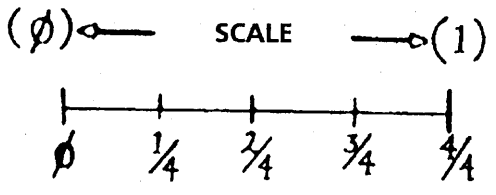


Figure 2

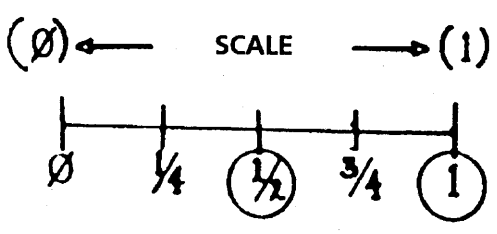


Figure 3

Normally, in measuring a distance the fractions would be numbered to show the total length as in figure 2. Most of the time the fractions will be converted to the larger number as in figure 3.

The most typical scale used to measure nuts, bolt heads, and wrenches divides the inch into sixteenths (1/16s) for normal mechanical work. Often when working with small nuts and bolts as in electrical systems, the wrench and bolt sizes will be measured in thirty-seconds (1/32s) of a inch. At this time you should learn the sequence based on sixteenths given in figure 4.

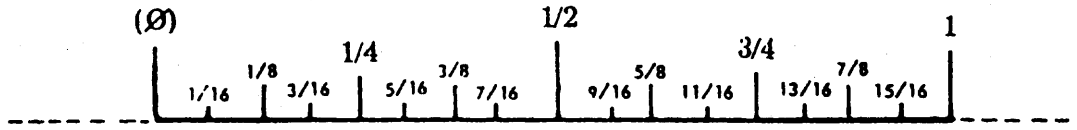


Figure 4.- Enlarged (4x) one-inch scale by sixteenths

The wrench pictured in figure 5 is an open-end wrench. It is called an open-end wrench because there is a space between the jaws so it can be fitted to a bolt head or nut from the side. The jaw opening is not in a straight line with the handle, it is offset so that the wrench can be turned over to get a new holding angle in a small space.

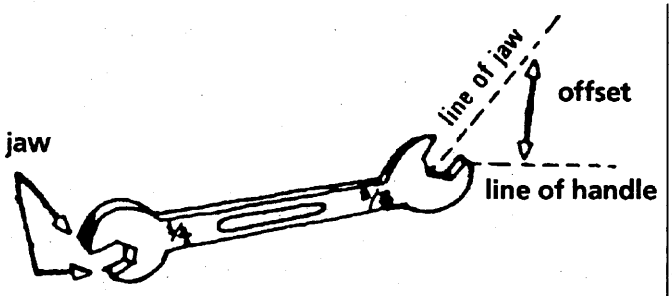


Figure 5.- Open-end wrench

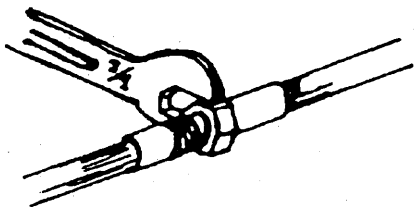


Figure 6.- Use of open-end wrench.

2. BOX END WRENCHES

The wrench pictured in figure 7 is a *box-end wrench*. As the opening goes completely around the nut, the box-end wrench will not slip off the nut when pressure or force is applied. Box-end wrenches may have 6 *points*, the exact shape of the nut as in figure 1, or they may have 12 *points* as in figure 7.

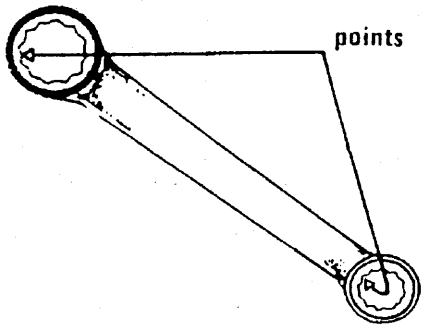


Figure 7.- 12-Point box-end wrench.



Figure 8.- Use of box-end wrench.

The wrench pictured in figure 8, and the wrench pictured in figure 1, are combination wrenches. A combination wrench has an open-end wrench on one end and a box-end wrench on the other end. Normally, a simple box-end wrench or open-end wrench has a different size, one size step difference, on each end (see figure 5). A combination wrench is usually the same size on both ends.

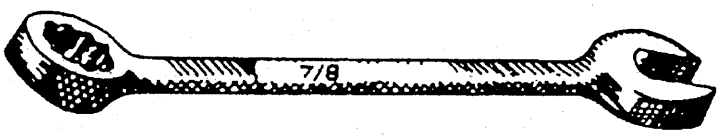


Figure 9.- Combination wrench.

UNIT ONE

CLASSWORK ASSIGMENT : LESSON A

The following exercises should be completed in class with the instructor´s assistance :

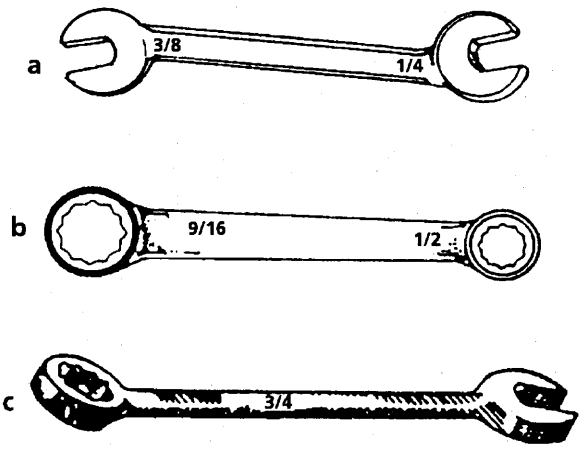


Figure 1

1. Look at figure 1. Write the answers to the questions below in the spaces provided.

a. Figure 1 shows three _____

b. Wrench a is a _____

c. Wrench b is a _____

d. Wrench c is a _____

e. Wrench _____ is the same size on both ends.

f. Wrenches are called _____ tools.

g. Which wrench has no jaws ?. _____.

h. Nuts, bolt heads, and _____ are measured in _____ of an inch.

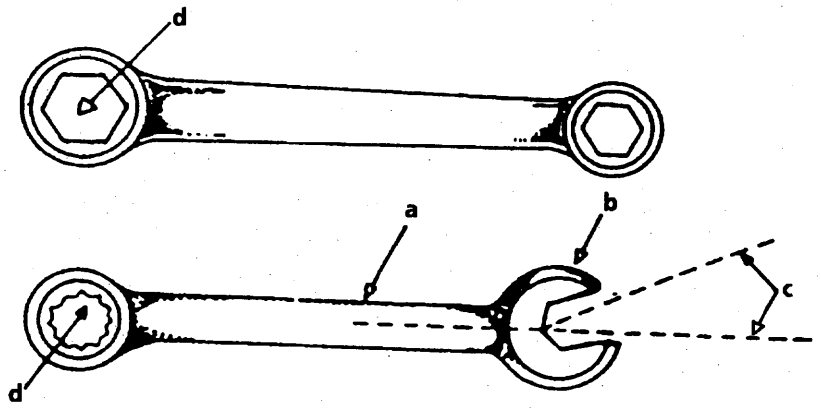


Figure 2

2. Look at figure 2. Identify the parts shown on the lines below.

   a shows the _____

   b shows the _____

   c shows the _____

   d is a _____ -point box wrench.

   e is a _____ -point box wrench.

3. If a bolt head has four equal sides, it is called a _____ bolt.

   If a bolt head has six equal sides, it is called a _____

   bolt. (_____is the short form for hexagonal).

UNIT ONE

TURNING HAND TOOLS

LESSON B

1. SOCKET OR SOCKET WRENCH

A socket or *socket wrench* is similar to a box-end wrench except that the "box" part is deeper and the socket does not have a fixed handle. It has a square opening in the end so that several special handles can be fitted to it (see figure 1).

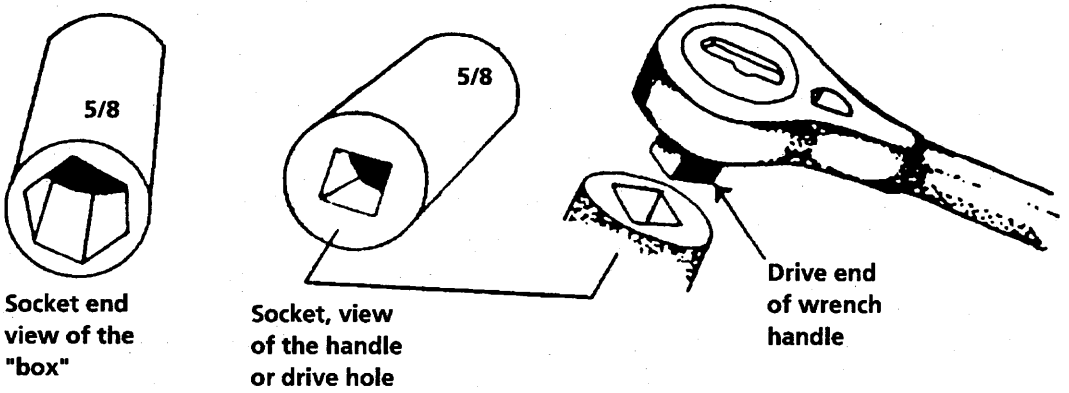


Figure 1

The socket "boxes" are made in the same sizes as other wrenches and are marked in inch fractions by the same system. *Socket wrench sets* are also classified by the size of the *square drive* handle and drive hole. There are three sizes of "drive" handles, 1/4-inch square, 3/8-inch square, and 1/2-inch square. Small sockets, such as those that fit small nuts and bolt heads in the 3/16-to 1/2-inch size range, take 1/4-inch square drive handles. Medium size sockets, such as those that fit nuts and bolts in the 3/8- to 13/16-inch size range, take 3/8-inch square drive handles. Large sockets, such as those that fit nuts and bolts in the 7/16-to 1 11/16-inch size range, take 1/2-inch square drive handles. The use of different size drive handles prevents using a very large handle with a very small socket, or the use of a very small handle with a very large socket. All of the different handles are made in all three sizes.

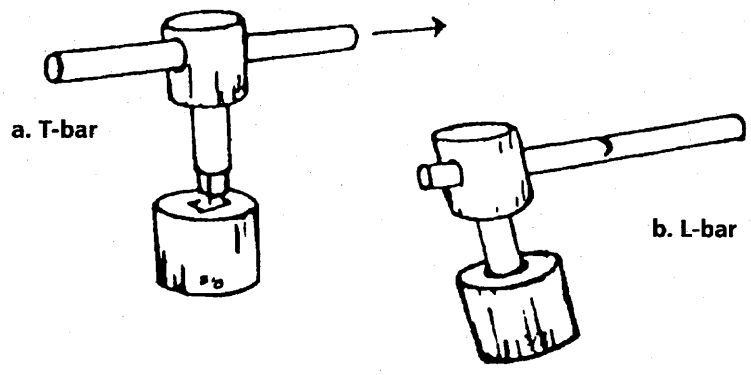


Figure 2.- T-bar socket handle

2. SOCKET WRENCH HANDLE

The socket wrench handle pictured in figure 2 is called a *T-bar handle.* The bar may be moved to one side or the other. When the bar is extended to one side, it is known as an *L-bar.* The T-bar handle is used when only a small amount of fource is required to turn the nut or bolt.

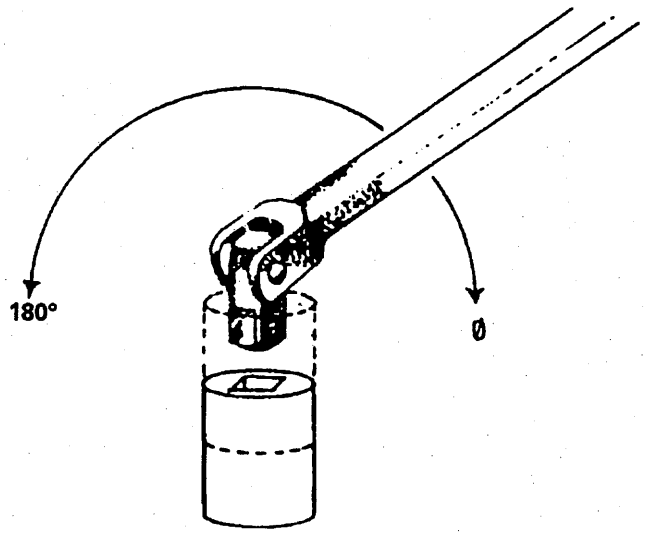


Figure 3.- Hinge (flex) handle

The socket handle pictured in figure 3 is called a *hinge* or *flex handle.* It is jointed so that it can be used at any angle. It is a longer and stronger handle than the T-bar and it is used when more pressure is required.

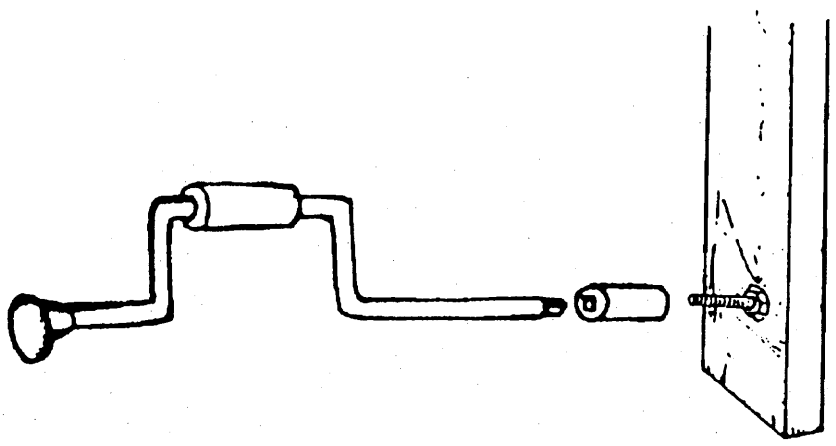


Figure 4.- Speed or speeder handle

The handle in figure 4 is called a speed or *speeder handle*. It is used when it is necessary to turn the nut or bolt a large number of turns without much force.

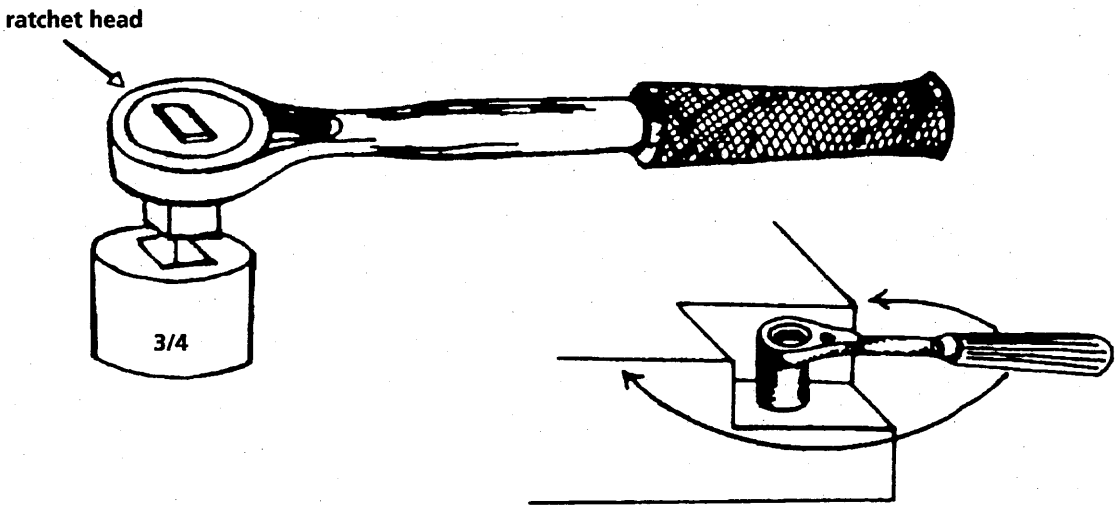


Figure 5.- Ratchet handle

The handle pictured in figure 5 is the *ratchet handle*. The ratchet handle is probably used more often than the other handles. There is a mechanism in the ratchet head that lets the handle apply force in one direction but turn free in the opposite direction. The mechanism lets a person turn a nut continuously without removing the socket from the nut (see figure 6).

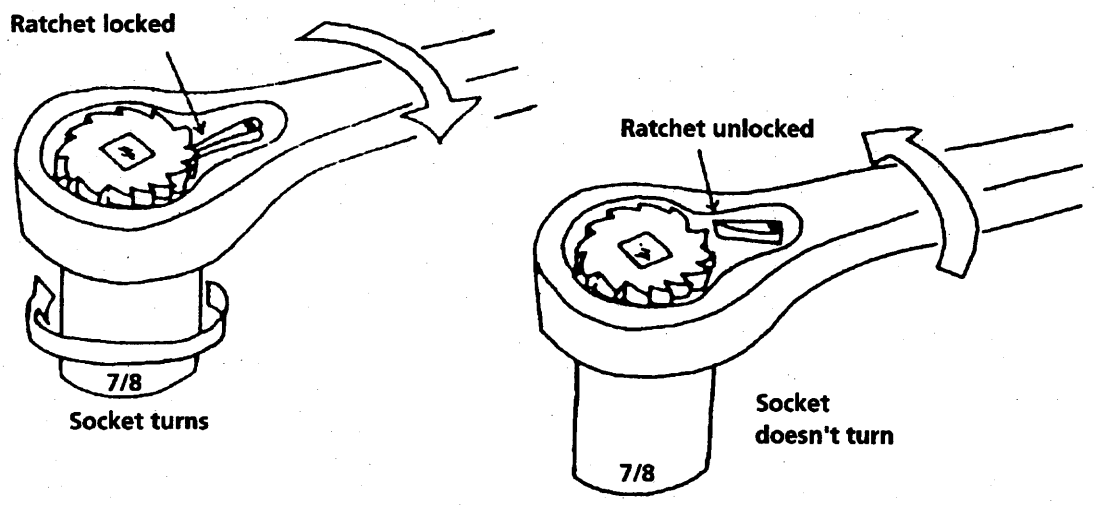


Figure 6.- Operation of ratchet handle

The handle pictured in figure 7 is a *torque wrench handle. Torque* means turning force. A torque wrench handle measures the turning force applied when tightening a nut or bolt. The use of a torque wrench handle lets a person tighten a nut or bolt to a particular pressure. This is important because too much pressure may damage a nut or bolt, and too little pressure may not hold and the nut will become loose.

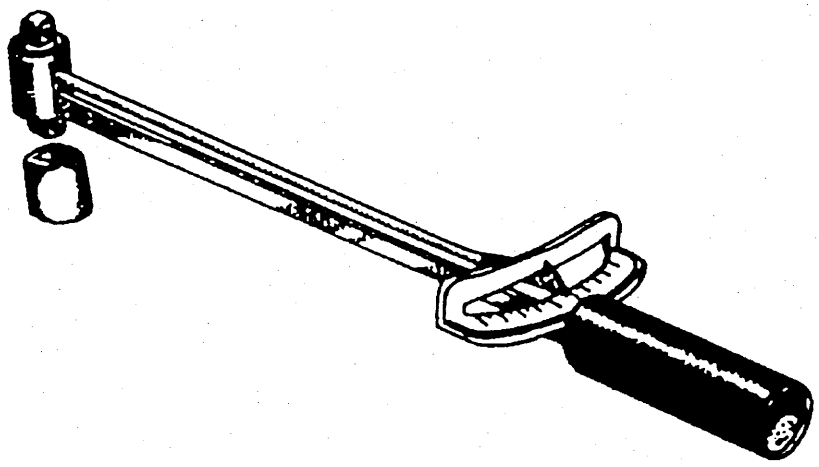


Figure 7.- Torque wrench handle

The part pictured in figure 8 is an *extension*. It is put between the socket and the handle when it is difficult to reach a nut or bolt, or when there isn't enough space to turn the handle. Extensions usually come in three lengths : short, medium, and long.

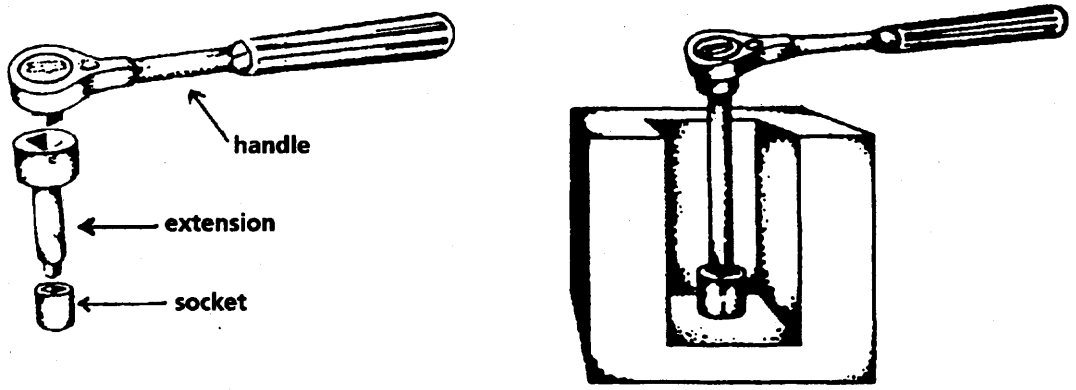


Figure 8.- Extension

The part pictured in figure 9 is an adapter. It resembles an extension but its purpose is to let a person use one square-drive size socket with a handle that has a different size square drive. It would, for example, permit using a 1/4-inch square-drive socket with a 3/8-inch square-drive handle.

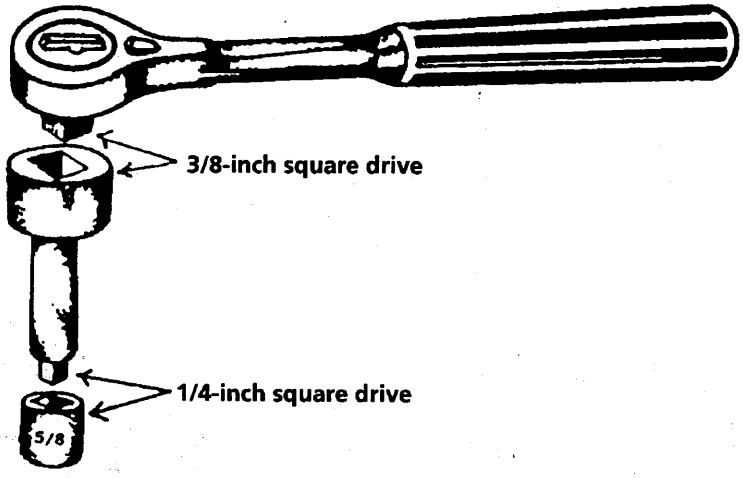


Figure 9.- Adapter

The part illustrated in figure 10 is a universal joint. It is contructed so it will turn freely and apply force to the socket even though the force is not in straight line from the handle to the socket.

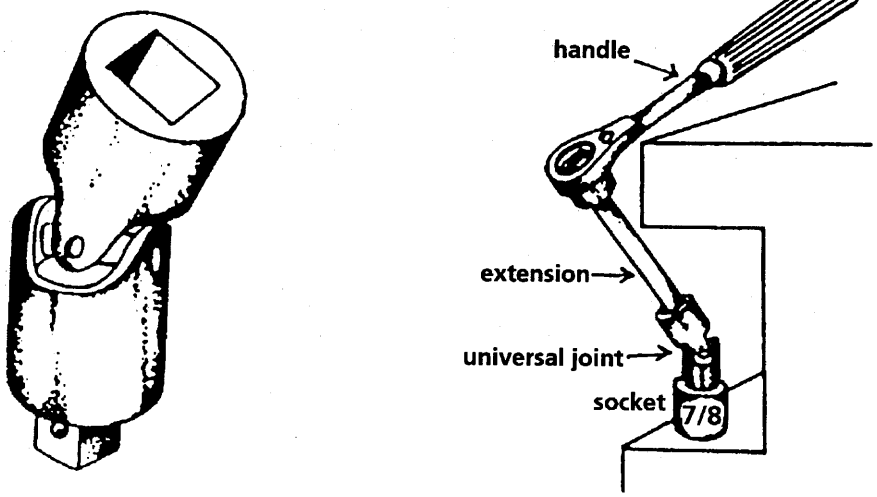


Figure 10.- Universal joint

UNIT ONE

TURNING HAND TOOLS

CLASSWORK ASSIGMENT : LESSON B

The following exercises should be completed in class with the instructor´s assistance

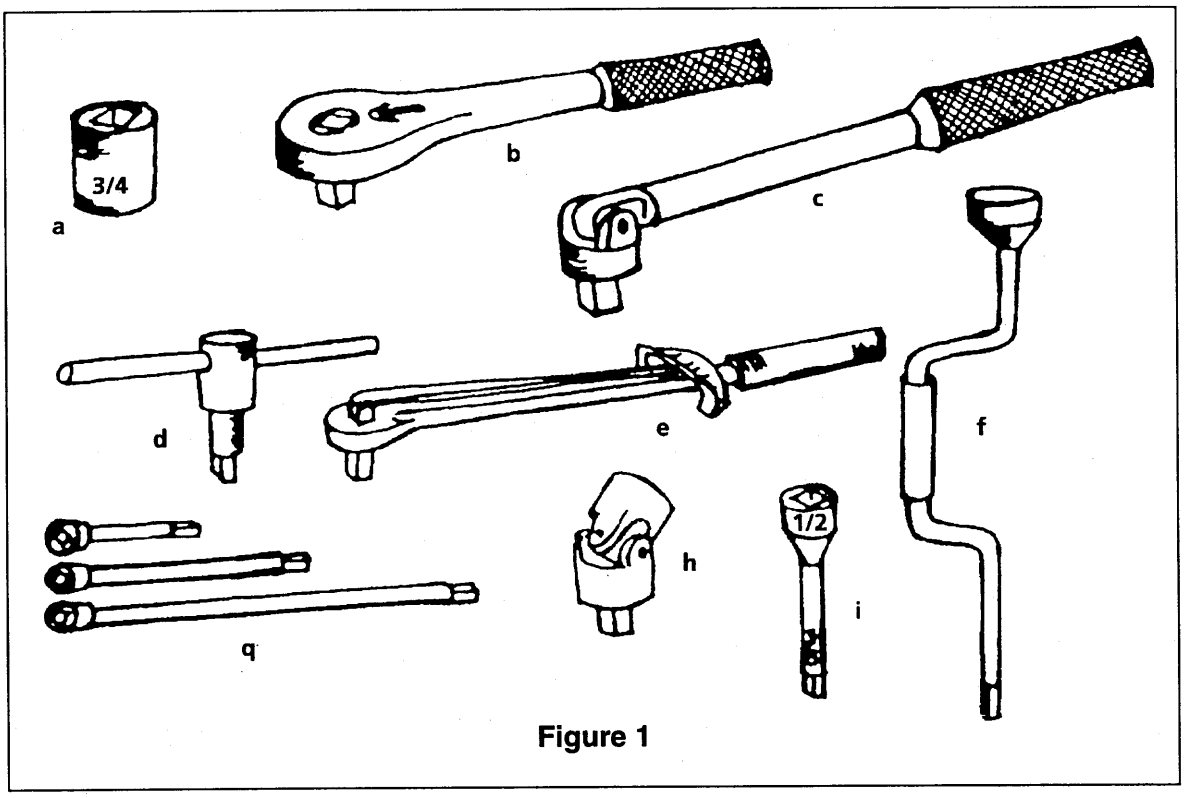


Figure 1

1. Look at figure 1 above. Write the name of each tool on the lines provided below. If the tool has two names, write both names.

a _____

b _____

c (1) _____

(2) _____

d _____

e _____

f (1) _____

(2) _____

g _____

h _____

i _____

2. Complete the following statements. Write the missing words or phrases in the spaces provided.

a. Socket wrench sizes are stated in _____ of an _____.

b. Socket wrenches and handle are made in _____ different Square-drive sizes.

c. The _____ handles is probably used more often than the others.

d. When it is necessary to apply a lot of force to turn a nut, the _____ (or _____) handle is used.

e. The small bar on the _____ handle may be moved from one side to the other.

f. When the bar of the T-bar handles is extended to one side, it is known as an _____ handle.

g. Turning force is called _____

h. A _____ handle measures turning force.

i. The _____ handle is useful when the nut or bolt must be turned a large number of times.

j. _____ are rods placed between the socket and the handle to make the wrench longer.

k. Extensions usually come in three sizes : _____, _____, and _____.

l. The _____ is used because it will turn freely and apply force at all angles.

m. If you want to use a 1/2-inch square-drive handle with a 3/8-inch square-drive socket, you have to use an _____.

n. The socket wrench is similar to a _____ wrench.

o. Sockets are available in _____ - point openings and _____-point openings, the same as box-end wrenches.

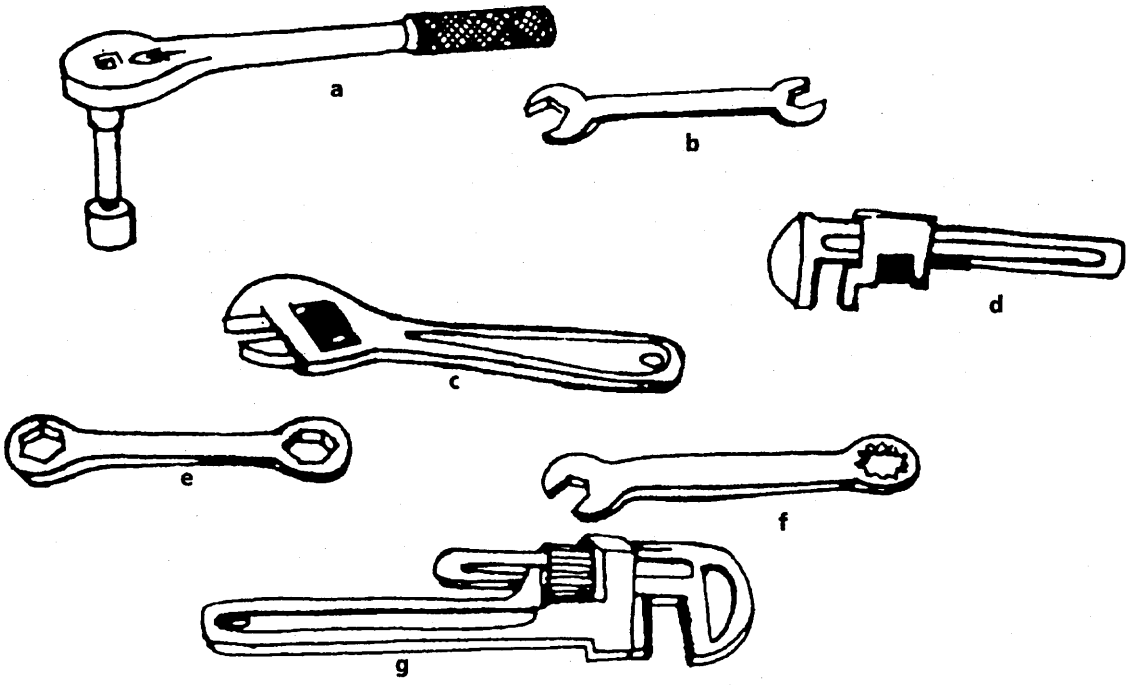


Figure 2

3. Look at figure 2. Write the name of each tool on the lines provided below. After the name write whether it is "fixed" or "adjustable".

a _____ _____

b _____ _____

c _____ _____

d _____ _____

e _____ _____

f _____ _____

g _____ _____

4. Complete the following statements. Write the missing words or phrases in the spaces provided. Refer to figure 2.

a. The tool in figure 2a is composed of a _____, an _____, and a _____.

b. The tool in figure 2b is an _____.

c. The tool in figure 2c is a _____. It is best used with _____ nuts and bolts.

d. The tool in figure 2d is a _____. It is best used with _____ nuts and bolts.

e. The tool in figure 2e is a _____-point _____.

f. The tool in figure 2f is a _____. It has a _____ on one end, and a _____ on the other end.

g. The tool in figure 2g is a _____. It is mostly used by _____. It has _____ for holding _____ objects. It should not be used on nuts and bolts because it might _____ the surfaces.

UNIT TWO

PRECISION MEASURING AND POWER TOOLS

OBJECTIVES

1. Given a picture of an inside micrometer, outside micrometer and depht micrometer, the student will orally and/or in writing correctly identify each.

2. Given a picture of three kind of micrometers, the student will orally and/or writing identify the following parts:
   - hub
   - spindle
   - thimble
   - frame

3. Given a picture of a telescoping hole gage, split ball gage, surface gage and surface plate, the student will orally and/or in writing correctly identify each.

4. Given pictures of an electric hand drill, drill press, disc sander, electric bench grinder, pair of safety goggles and a face shield, the student will orally and/or in writing correctly identify each.

5. Given pictures of the power tools named above, the student will orally and/or in writing identify the following parts for each :
   - handle
   - trigger switch
   - chuck
   - chuck key
   - motor housing
   - worktable
   - feed handle
   - column
   - belt
   - abrasive wheel
   - eye shield
   - tool rest

UNIT TWO

PRECISION MEASURING AND POWER TOOLS

LESSON A

1. MICROMETERS

Measuring tools that will measure differences of one hundredth of an inch (0.01 inch), one thousandth of an inch (0.001 inch), or one ten-thousandth of an inch (0.0001 inch), are called precision measuring tools. The steel rule measures to one sixty-fourth of an inch (0.0156 inch); it is not considered a precision measuring tool.

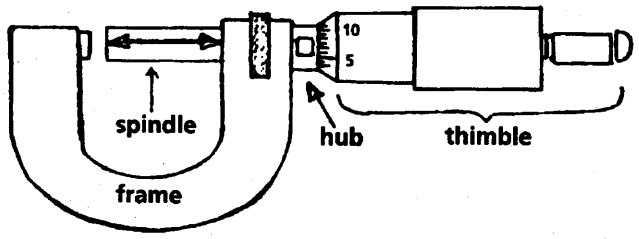


Figure 1.- outside micrometer

The precision measuring tool in figure 1 is an *outside micrometer*, it wil measure to 0.001 inch. When the *thimble* is turned, the *spindle* moves forward in the *frame*. The measurements are read from the reference line on the *hub*.

The hub of the micrometer is marked with a scale numbered from 0 to 10. Each numbered division represents, 100 (1/10) inch. Each numbered division is subdivided by four lines, each of which represents a space of .025. One complete rotation of the thimble moves the thimble a distance of .025, the distance from one subdivision to the next. The circumference of the thimble is marked with a scale numbered from 0 to 25; each of the divisions represents a space of .001. When reading a micrometer, the number from the scale of the thimble is added to the number shown on the hub.

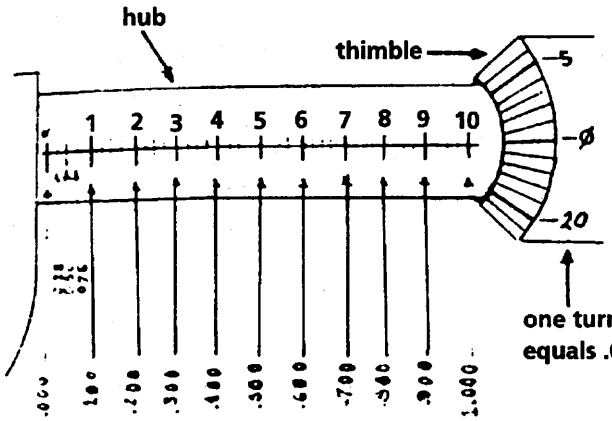


Figure 2.- Enlarged view of micrometer scale

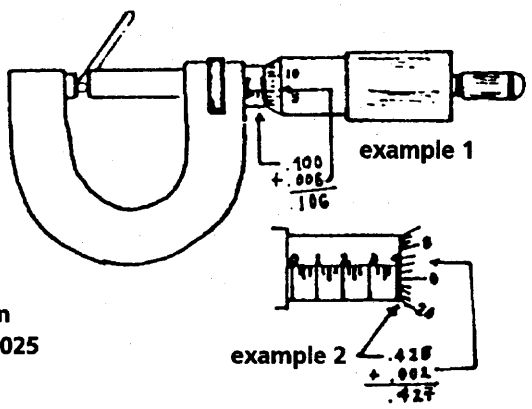


Figure 3.- Reading a micrometer

The measuring tool in figure 4 is an *inside micrometer*. It is used to measure the size of holes and slots. The same scale system is used on the inside micrometer as is used on the outside micrometer. The number shown on the scale must be added to the length of the micrometer frame. See figure 4b.

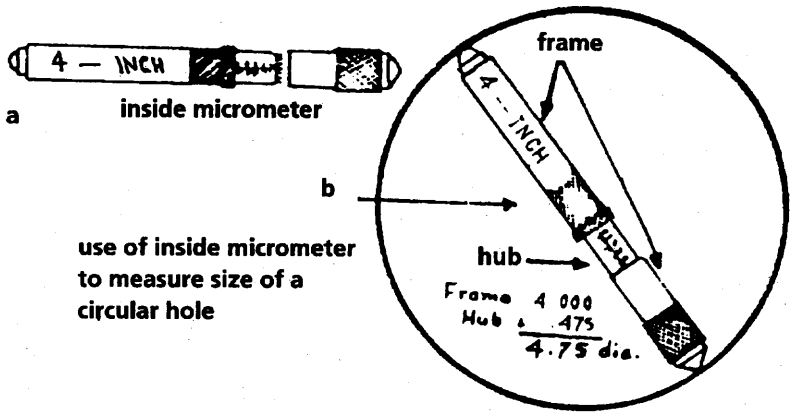


Figure 4.- Inside micrometer

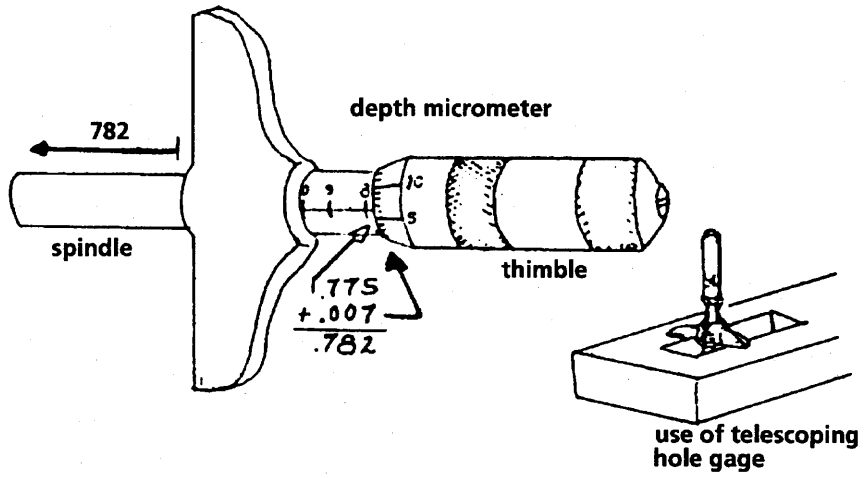


Figure 5.- Depth micrometer

The measuring tool in figure 5 is a *depth micrometer*. It is used to measure the depth of slots and holes. The scale is the same as the scale on the inside and outside micrometers except it is reversed. The scale is reversed because it shows how far the spindle extends to measure the depth of the hole.

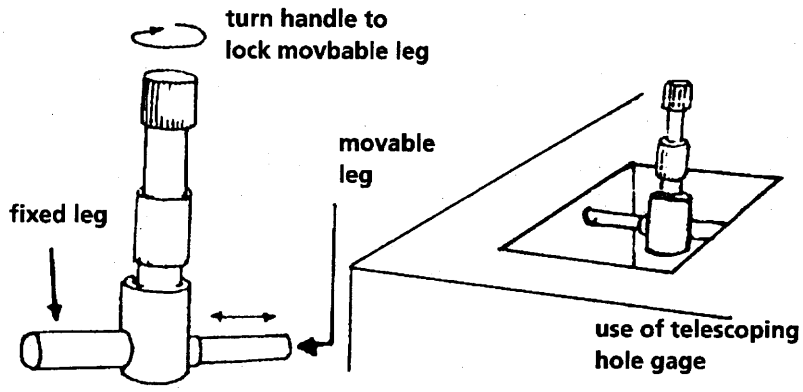


Figure 6.- Telescoping hole gage

2. GAGES

The measuring tool shown in figure 6 is a *telescoping hole gage*. Telescoping hole gages are usually used to measure holes that are too small to permit the use of an inside micrometer.

When the telescoping hole gage is inserted in the hole, the movable leg extends to contact one side while the fixed leg contacts the other side; the handle is then turned to lock the movable leg. The telescoping hole gage is removed and the distance between the ends of the legs is measured with an outside micrometer.

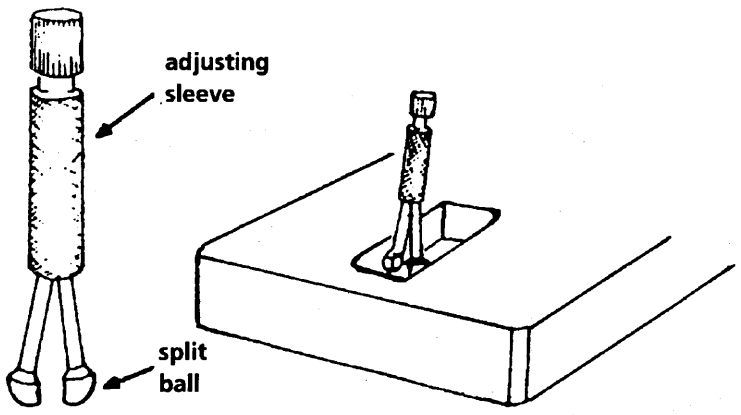


Figure 7.- Split ball hole gage

The measuring tool shown in figure 7 is a *split-ball hole gage*. It is used to measure holes too small to be measured by a telescoping hole gage. The *split-ball* is inserted into the hole and the adjusting *sleeve* is turned until the ball contacts both sides of the hole. The gage is then removed and measured with an outside micrometer.

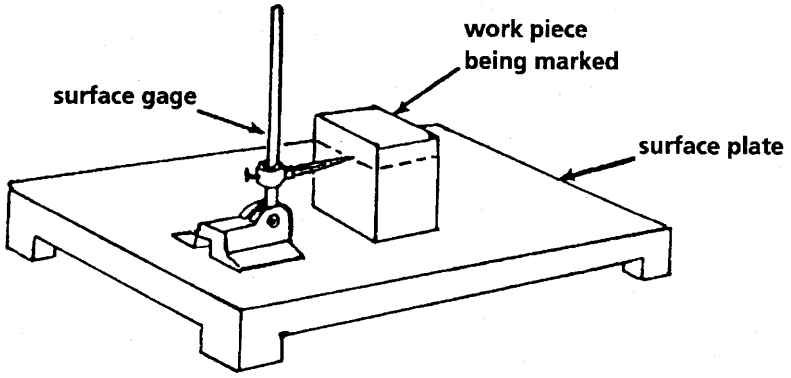


Figure 8.- Use of surface gage to mark work piece

Figure 8 shows a *surfaces plate* and a *surface gage*. They are used when precision marking or measuring must be done. A surface plate is a small iron (Fe) table. The top of the table is polished perfectly flat and level.

UNIT TWO

PRECISION MEASURING AND POWER TOOLS

CLASWORK ASSIGMENT : LESSON A

The following exercises should be completed in class with the instructor´s assistance:

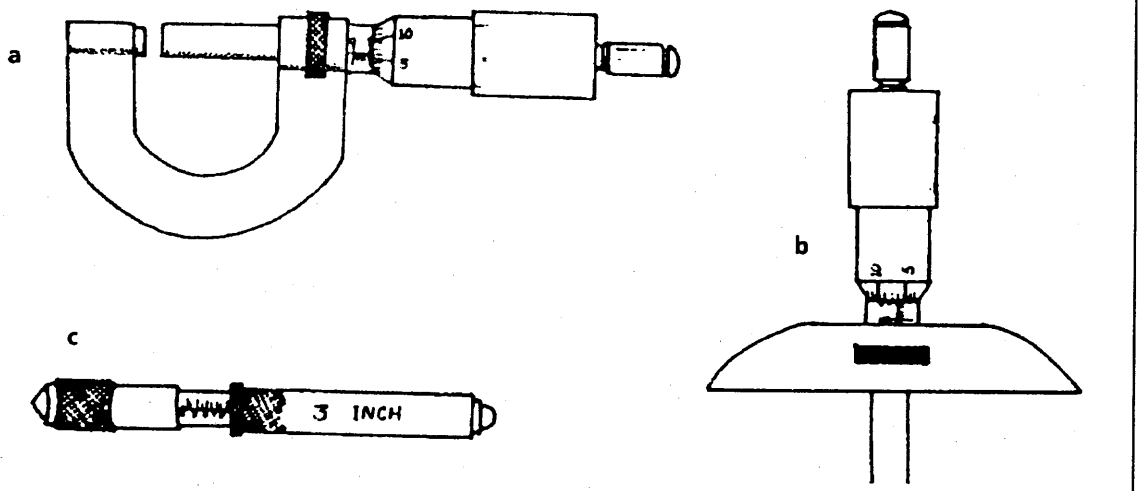


Figure 1

1. List the names of the measuring tools in figure 1 in the correct spaces below.

Tools a is a _____.

Tools b is a _____.

Tools c is a _____.

All of the tools in figure 4 are _____.

They are _____ measuring tools. They will measure _____ as small as 1/1000 of an inch.

Tool a is an _____ micrometer. The hub and thimble reading of tool a is _____ of an inch.

Tools b is a _____ micrometer. It is used to measure how _____ holes are. It uses the same scale as the outside micrometer but the _____ on the scale are reversed. Tool c is an _____ micrometer. It is used to measure the _____ of holes. The _____ is the same as the outside _____.

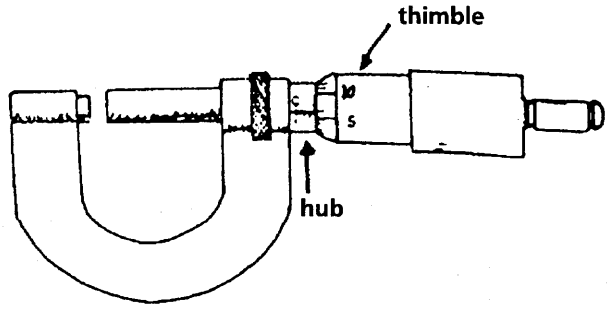


Figure 2

2. Write your answer to the questions in the spaces provided below.

The tool pictured in figure 2 is an _____.
The number exposed on the hub is _____. The line on the thimble that is nearest the reference line is line _____.
The hub and the thimble show a total reading of _____.

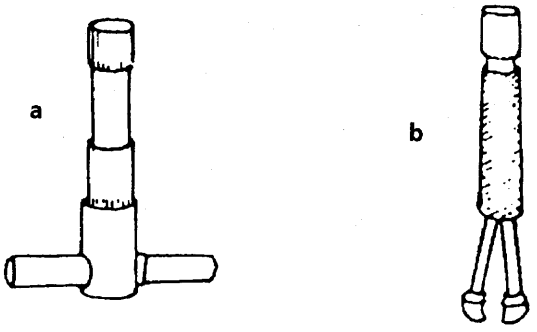


Figure 3

3. List the name of the tools in figure 3 in the correct spaces below.

Tools a is a _____. It is used to measure spaces _____ small to be measured by an _____ _____. Tool b is a _____ it is used to measure spaces too _____ to be _____ by a telescoping hold gage. Both tool a and tool b are locked to size and then measured by an _____.

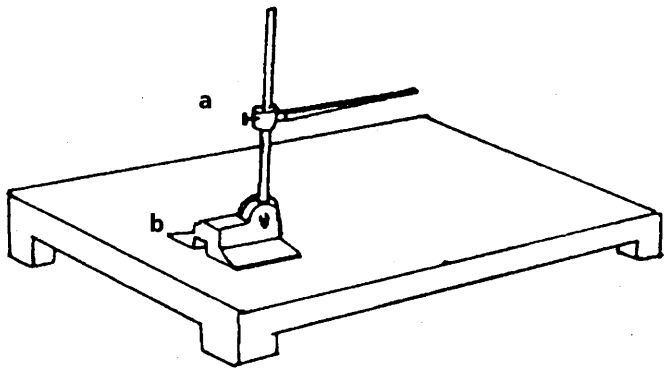


Figure 4

4. Write the names of the measuring tools in figure 7 in the correct spaces below.

Tools a is a _____.

Tools b is a _____.

Tools b, the _____, in an absolutely flat surface. Tool a, the _____, is used to measure or _____ objects when they are placed on the _____.

UNIT TWO

PRECISION MEASURING AND POWER TOOLS

LESSON B

1. ELECTRIC DRILL

Power tools are tools that use a motor to do the work that would be performed by a person. If you use a hand drill, and turn the drive handle by hand, you are using a hand-driven tool. If you use an electric drill, figure 1, below, that uses an electric motor to rotate the bit, you are using a power tool. Power tools are very useful as they can do many jobs quicker and easier than they can be done by hand.

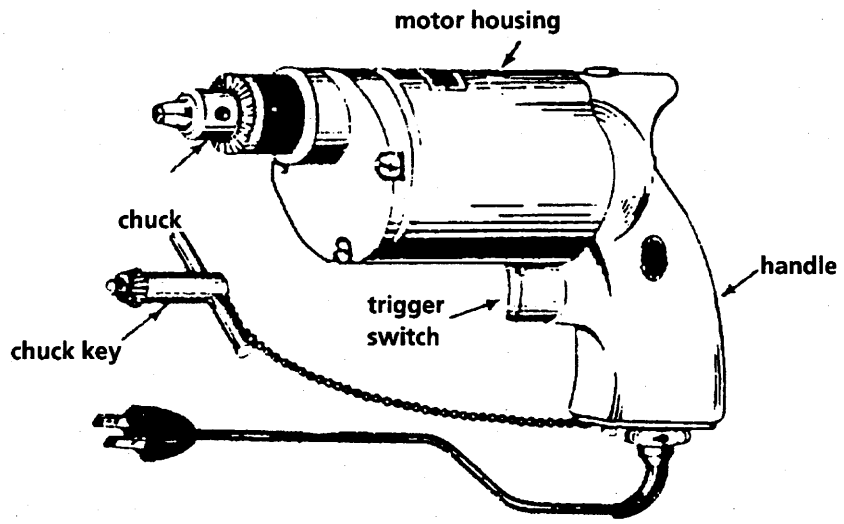


Figure 1.- Electric drill

The tool shown in figure 1 is an *electric drill.* The electric drill uses an electric motor to rotate the drill bit in the *chuck.* As the motor rotates the drill bit very rapidly it is necessary to use a *chuck key* to turn the chuck very tightly to hold the drill bit securely. The drill is turned on and off with a *trigger switch* at the front of the *handle.* The motor is contained in the motor *housing.* The electric hand drill is portable and can be taken from place to place.

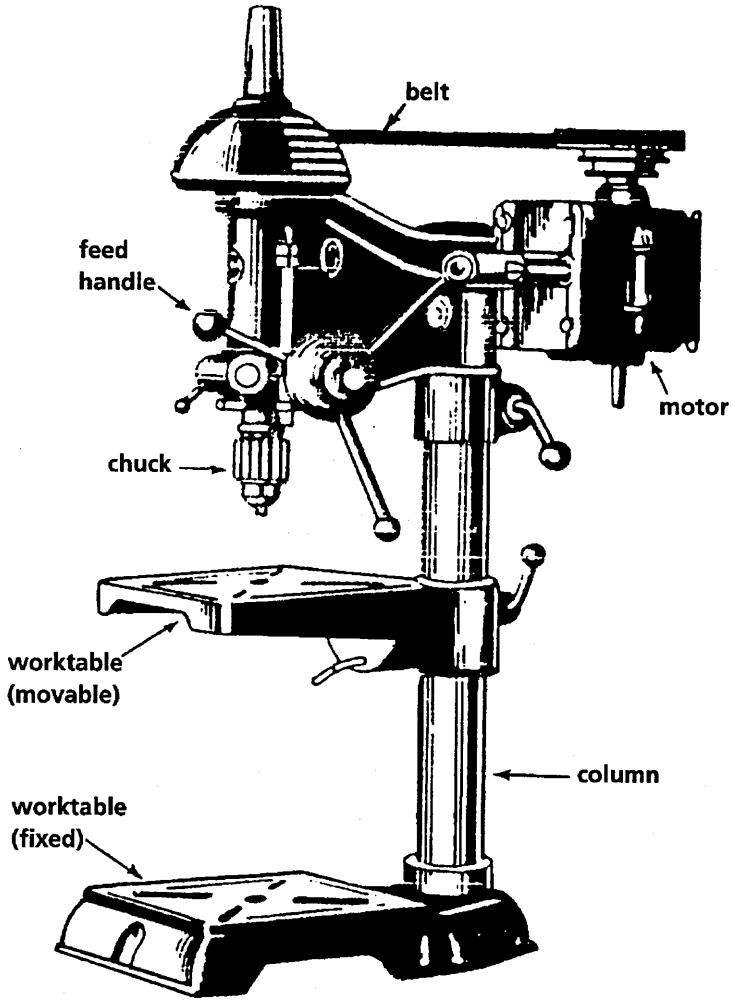


Figure 2.- Electric drill press

2. ELECTRIC DRILL PRESS

The tool shown in figure 2 is an electric *drill press*. The electric drill press is a large drill that is used for precision drilling or for heavy or large work. It is fixed in place and is not portable. The *motor* is mounted at the rear of the drill. The motor drives or rotates the *chuck* by means of a *belt*. The work to be drilled is placed on the *worktable*. The movable worktable can be moved up or down on the *column* and locked in place. The *feed handle* is used to lower the rotating drill bit to the work and to apply pressure so that the bit will cut.

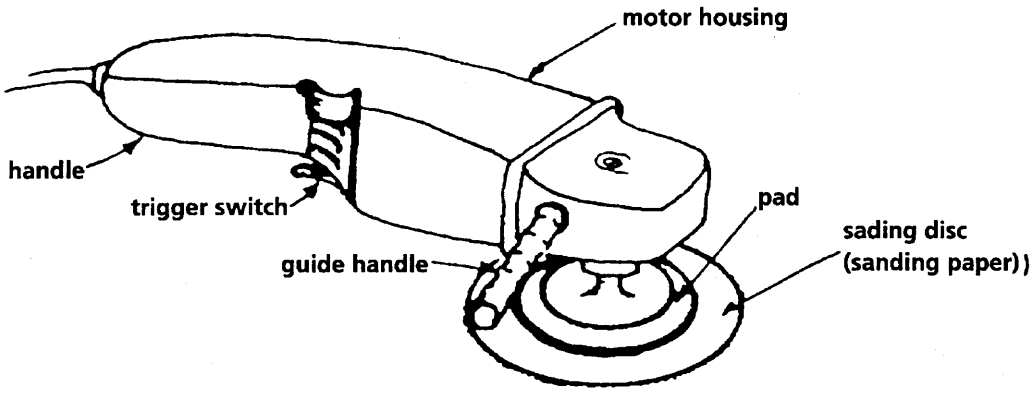


Figure 3.- Disc sander

3. DISC SANDER

The power tool shown in figure 3 is a *disc sander*. Sandpaper *sanding discs* are fastened to the pad. The motor revolves the pad at a high speed. The *handle* that contains the on-off switch is held in one hand and the guide handle is held in the other hand. Disc sanders are used when a large amount of sanding is to be done. They are mostly used to remove paint and to do rough sanding.

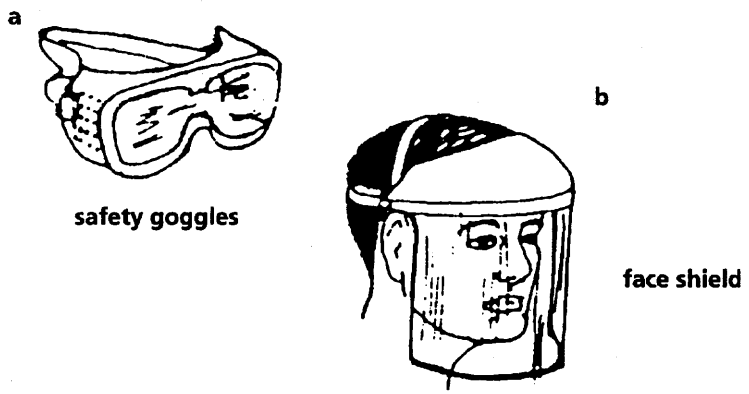


Figure 4.- Equipment to protect the eyes

4. EYE PROTECTORS

The eyes protectors shown in figure 4a are *safety goggles*. Safety goggles are made from strong glass or plastic that resists breaking. The goggles also cover the eyes from the sides and the top and bottom. Safety goggles or other eye protectors should be worn when working with power tools.

The eye protector shown in figure 4b is a *face shield*. The face shield is a transparent cover made from strong plastic that covers and protects the whole front and sides of the face. Face shields or other eye protectors should be worn when working with power tools.

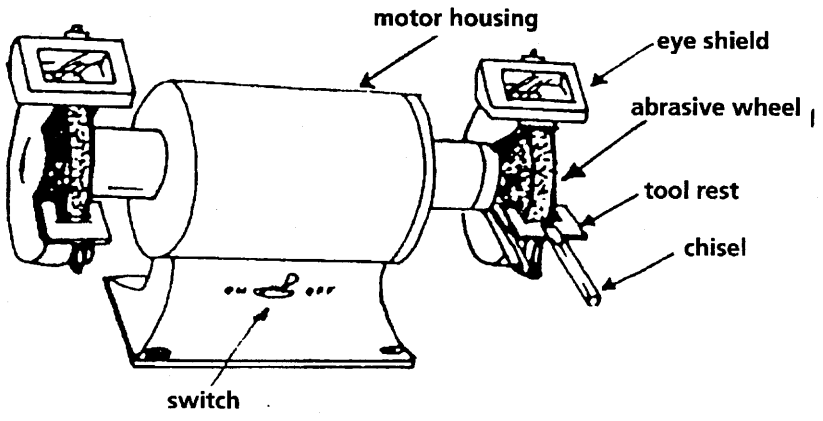


Figure 5.- Electric grinder

5. ELECTRIC GRINDER

The power tool shown in figure 5 is an *electric grinder*. The motor rotates two hard stone *abrasive wheels*. The hard stone abrasive wheels, which are turned very rapidly, are used to sharpen or shape metal objects. The metal objects are held on the *tool rest* and pushed into contact with the rotating wheel. The stone abrasive removes particles of the metal. The transparent eye shields are adjusted to prevent the small pieces of stone and metal from hitting the eyes. Safety goggles or a safety face shield must be worn when working with an electric grinder, whether or not the grinder has eye shields. Tools that use a rotating abrasive wheel to remove metal are called grinders. The process is called grinding.

UNIT TWO

PRECISION MEASURING AND POWER TOOLS

CLASSWORK ASSIGMENT : LESSON B

The following exercises should be completed in class with the instructor´s assistance

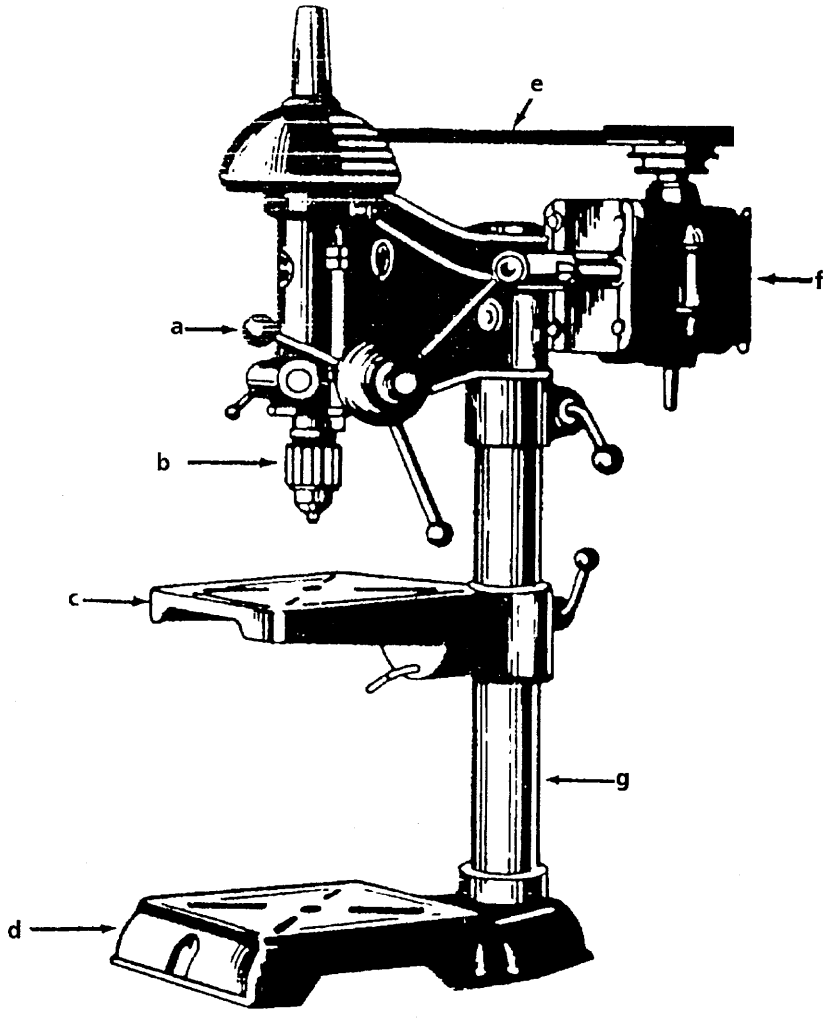


Figure 1

1. Look at figure 1 and 2. Figure 1 shows an _____ _____. Figure 2 shows an _____.

White the names of the parts indicated in figure 1 in the correct spaces below.

a is the _____

b is the _____

c is the movable _____

d is the fixed _____

e is the _____

f is the _____

g is the _____

Write the names of the parts indicated in figure 2 in the correct spaces below.

a is the _____

b is the _____

c is the _____

d is the _____

e is the _____

The _____ is a fixed tool. It is usually bolted to a bench and used for precision _____. The electric _____ is small and portable; it can be taken from job to job. Both the electric hand drill and the electric drill press use _____ motors to turn the chuck. The electric drill press uses a _____ to transfer power from the motor to the chuck.

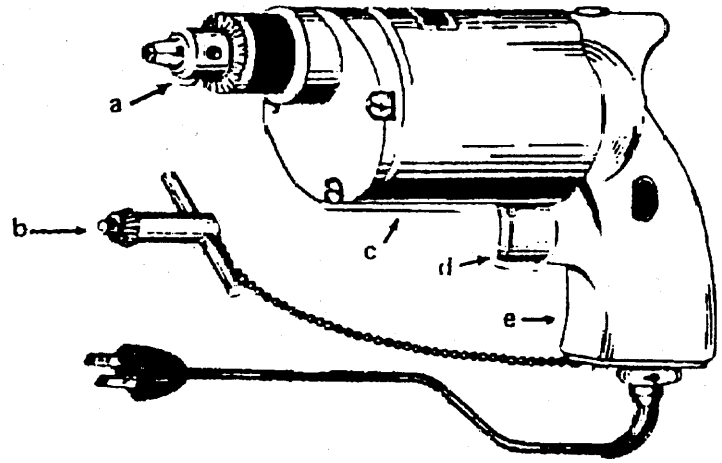


Figure 2

2. Look at figure 3. Write the names of the tool and the indicated parts in the spaces below.

The tool shown in figure 3 is a _____.

a is the _____.

b is the _____.

c is the _____.

d is the _____.

e is the _____.

f is the _____.

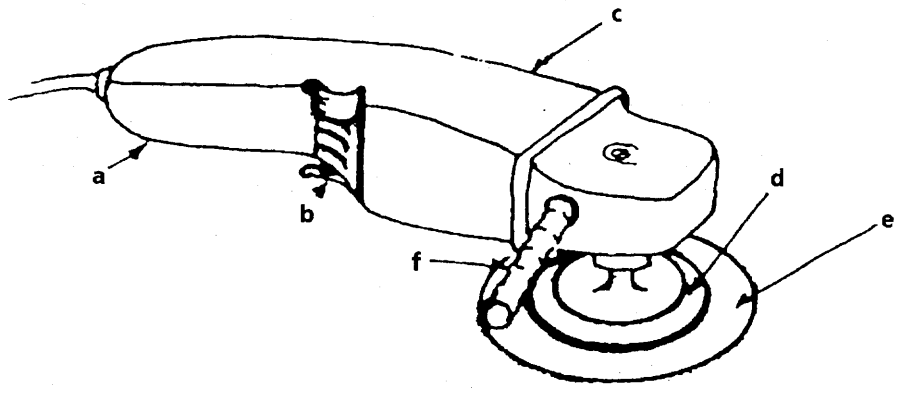


Figure 3

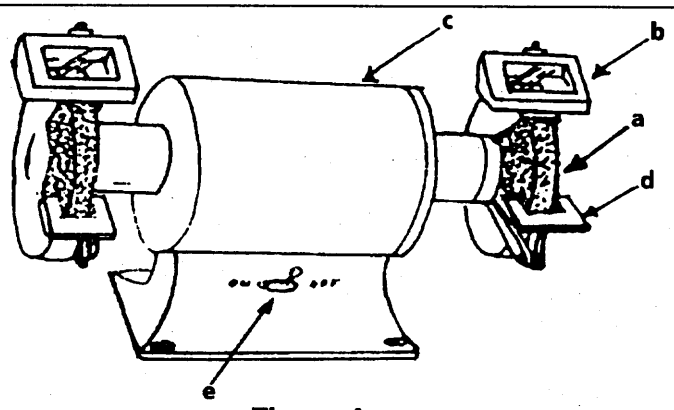


Figure 4

3. Look at figure 4. Write the names of the tool and the indicated parts in the correct spaces below.

The tool shown in figure 4 is an _____.

a is an _____.

b is an _____.

c is the _____.

d is a _____.

e is the _____.

The electric _____ uses rapidly rotating _____ wheels to sharpen or shape metal. When the _____ is pushed against the abrasive _____, the wheels remove _____ of the metal. The metal to be shaped or _____ is rested on the _____ _____. The _____ is lowered so the small particles will not be thrown in the _____. Even though the tools has eye shields, you should wear some type of _____ protectors. This should be done with all _____ tools and especially with the electric _____.

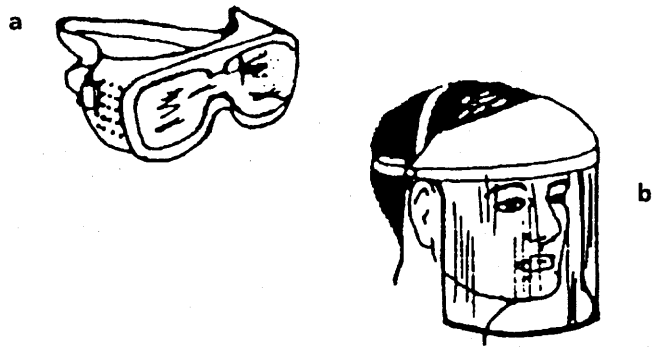


Figure 5

4. Write the names of the objects in figure 5 in the correct spaces below.

The items in figure 5 are _____.

a is a pair of _____.

b is a _____.

Safety _____ may be made of _____ or of _____. The face _____ is usually made of _____. Both of the eye _____ in figure 5 protect the eyes from the front and from both _____. Some type of _____ _____ should be worn whenever you work with _____ tools.

UNIT THREE

FASTENING DEVICES

OBJECTIVES

1. Given a picture of a machine bolt, a carriage bolt and a stove bolt, the student will orally and/or in writing correctly identify each.

2. Given pictures of bolts, the student will orally and/or in writing identify the following features:

- length
- diameter
- threads per inch
- head type
- nut shape
- hex head
- longer thread
- hex nut
- plain round body
- round head
- square nut
- squared shank
- slotted head

3. Given a pictures of safetying methods, soldering and welding equipment, the student will orally and/or in writing identify each.

4. Given a picture of a gas welding unit, the student will orally and/or in writing identify the following parts:

- tanks
- hoses
- regulator units
- torch unit
- welding helmet
- welding goggles

UNIT THREE

FASTENING DEVICES

LESSON A

1. BOLTS

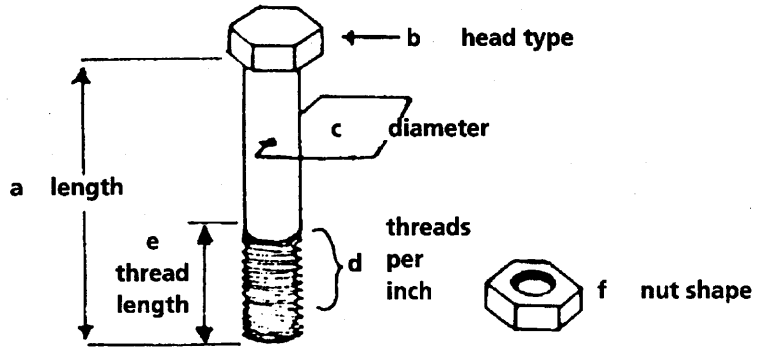


Figure 1.- Bolt features

Figure 1 illustrates a typical bolt. Bolts are straight rods that are threaded on one end and have a head on the other end. Bolts are usually secured by a nut. Bolts are described by their *length* (figure 1a), *head type* (figure 1b), *diameter* (figure 1c), the number of *threads per inch* (figure 1d), *the length of the thread* (figure 1e), and the *nut type* (figure 1f).

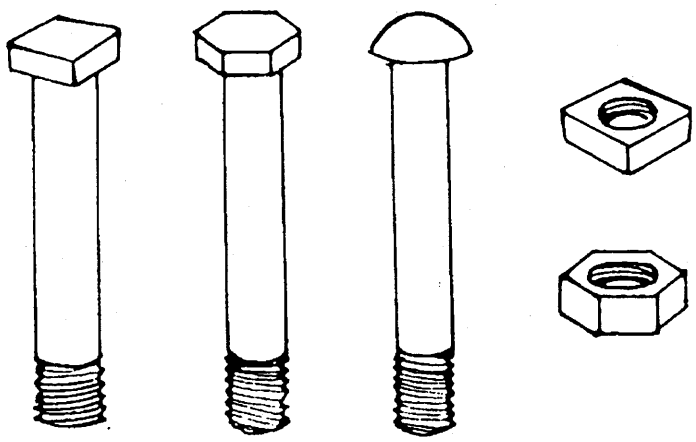


Figure 2.- Machine bolts

Figure 2 shows three *machine bolts*. One has a square head, one a hex head, and one a round head. They could be used with a square nut or a hex nut. But note that all of them have a simple straight shank and a relatively short thread. These last two features are characteristic of machine bolts. Machine bolts are inserted into drilled holes and locked with a nut from the opposite side.

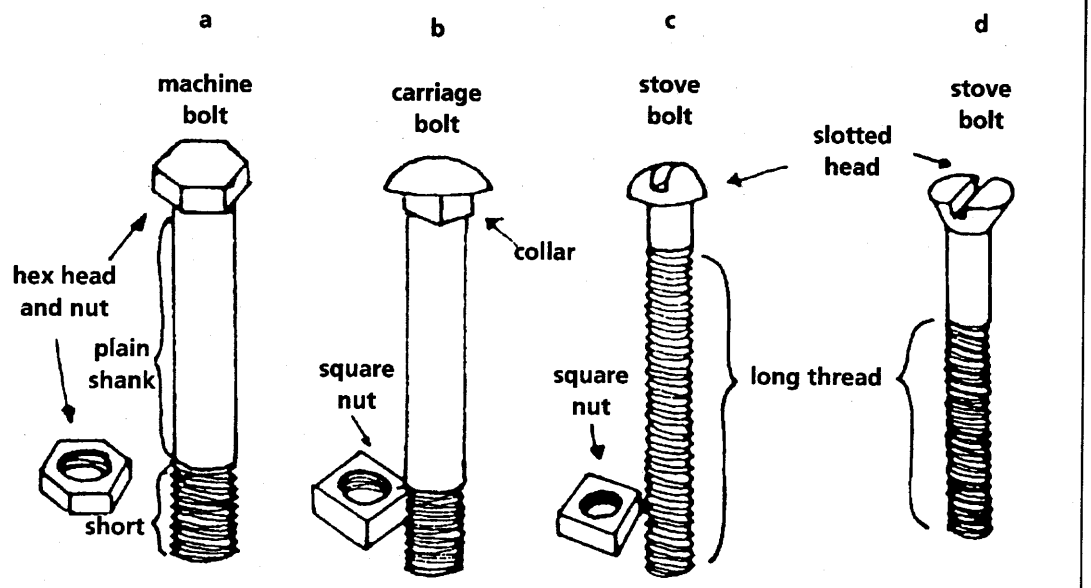


Figure 3.- Comparison of bolts

Figure 3 compares a typical *machine bolt* (figure 3a) with a *carriage bolt* (figure 3b) and a *stove bolt* (figure 3c). The machine bolt has the straight plain shank and short thread that was described. The *carriage bolt* (figure 13b) has a locking collar on the shank. The square locking collar wedges into the round hole and prevents the bolt from rotating when the nut is tightened. Square nuts are usually used when working with wooden pieces. The *stove bolt* (figure 3c) has a slotted head and a relatively long thread and is usually used with a square nut. The stove bolt is a general purpose bolt and is used with either wood or metal. The stove bolt may be made in different head types. See figure 3d.

2. NUTS AND WASHERS

Nuts are used to secure bolts. They may be any of several shapes such as square, hex, etc. Washers are often put on the bolt between the nut and the surface of the material. In general, a washer is a flat, round disc of metal with a bolt-size hole in the center. Washers are used for many purposes.

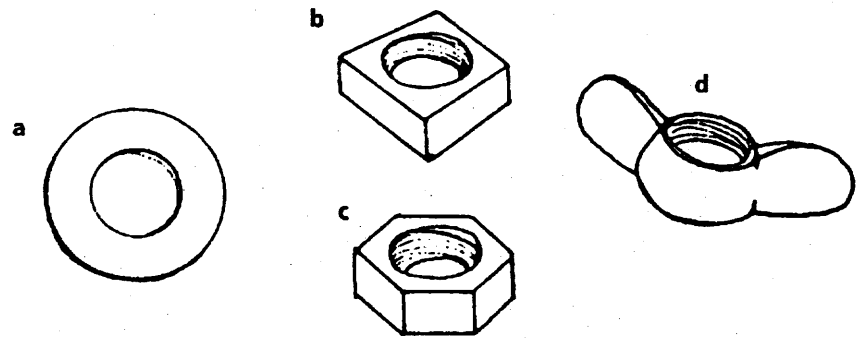


Figure 4.- Flat washer and nuts

Figure 4a shows a plain *flat washer.* It is usually put on the bolt under the nut. When it is used on bolts in wood, it performs three functions; it protects the surface from damage by the nut; it provides a smooth surface for the nut to turn on; and it distributes the pressure of the nut over a larger area. Sometimes washers are also put under the head of a bolt for the same reasons.

Figure 4b and 4c are nuts; b is a *square nut* and c is a *hex nut.* Hex nuts and square nuts are tightened with wrenches.

Figure 4d shows a *wing nut.* A wing nut has a flat projection on each side so it can be tightened and loosened easily with the fingers. Wing nuts are used when it is necessary to remove the nut frequently and when it is not necessary to apply a large amount of pressure to the nut.

UNIT THREE

FASTENING DEVICES

CLASSWORK ASSIGMENT : LESSON A

The following exercises should be completed in class with the instructor´s assistance

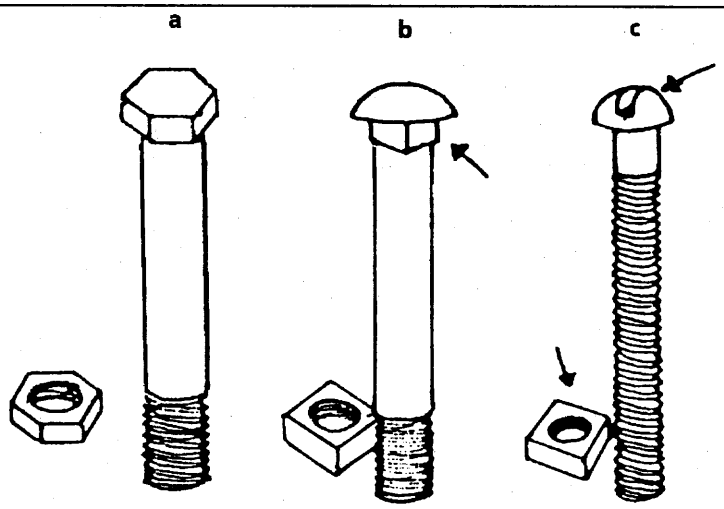


Figure 1

1. Look at figure 1. Write the names of the fasteners in the spaces below.

a is a _____ _____

b is a _____ _____

c is a _____ _____

All of the fasteners in figure 1 are _____. They are inserted in _____ through the material and locked with a _____.

Bolt a, the _____, can be used with wood or _____. Bolt b, the _____, is made especially for use with _____. The carriage _____ has a square _____ under the head. The _____ collar wedges in the hole so that the bolt won´t _____ when the nut is tightened. Bolt c is called a _____ bolt. It is a _____ purpose bolt; it can be used in wood or _____. It has a _____ head.

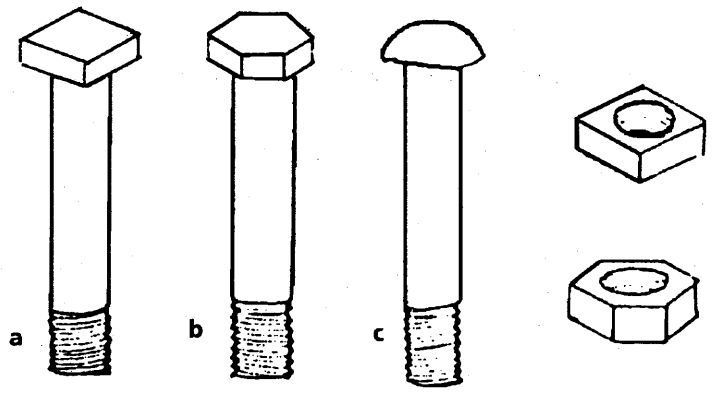


Figure 2

2. Look at figure 2. Write the names of the fasteners in the spaces below.

All trhee bolts are _____ bolts.

a is a _____.

b is a _____.

c is a _____ .

Bolt _____ Is the most common type

A _____ nut or a _____ nut may be used

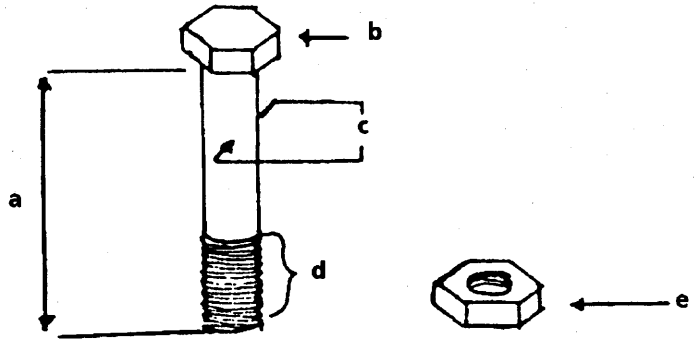


Figure 3

3. Look at figure 3. If showx the measurements used tio describe bolts. write the measurements n the spaces bellow.

a. refers to _____

b. refers to _____

c refers to _____.

d refers to _____.

e refers to _____.

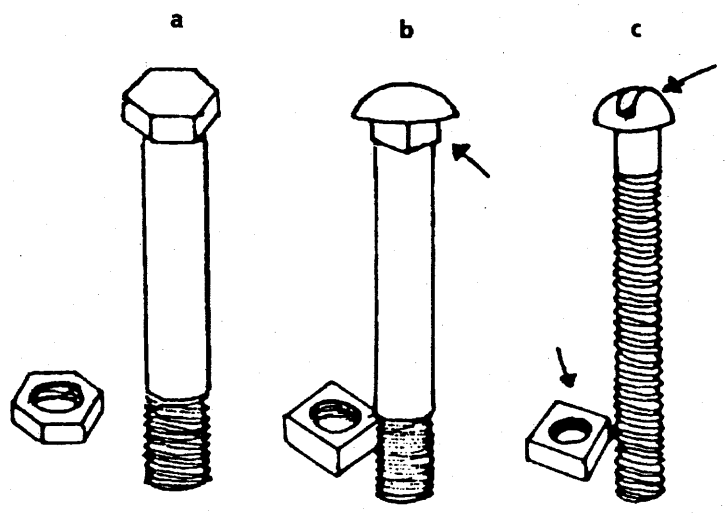


Figure 4

4. Look at figure 4. Write the missing words in the space below.

a is a _____. It has a _____ head and a _____ nut, it has a plain round _____ and a relatively _____ thread length.

b is a _____. It normally has a _____ head. Below the head is a _____ that wedges it in the hole. It has a relatively _____ thread length and usually has a _____ nut.

c is a _____. It has several types of heads but they are all _____ to engage a screwdriver. The thread. length is relatively _____.

They normally use a _____ nut.

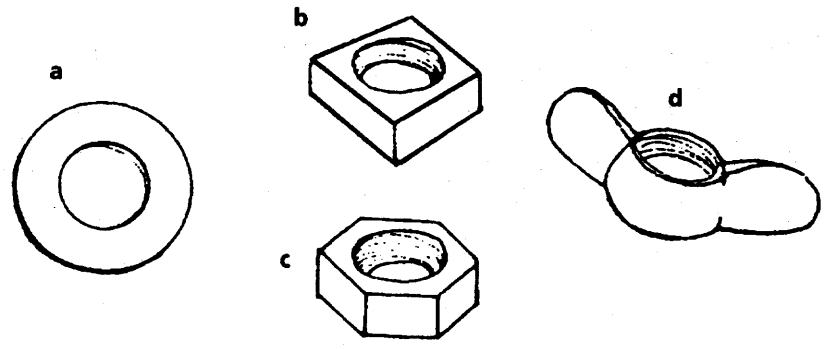


Figure 5

5. Look at figure 5. Write the names of the objects in the spaces below.

a is a _____.
b is a _____.
c is a _____.
d is a _____.

The _____ washer is put on the bolt between the material and the _____. The _____ nut and the _____ nut are tightened with wrenches but the _____ nut is turned with your fingers.

UNIT THREE

FASTENING DEVICES

LESSON B

1. COMMON SAFETYING METHODS

It is often necessary to secure a bolt or cap screw so that it cannot turn or become loose. Yet, the method used must be simple enough that the bolt or screw can be removed when it is necessary. These methods of semi-permanently securing nuts and bolts are called *safetying methods*. The three most common methods are the use of a *cotter pin, safety wire*, or a setscrew.

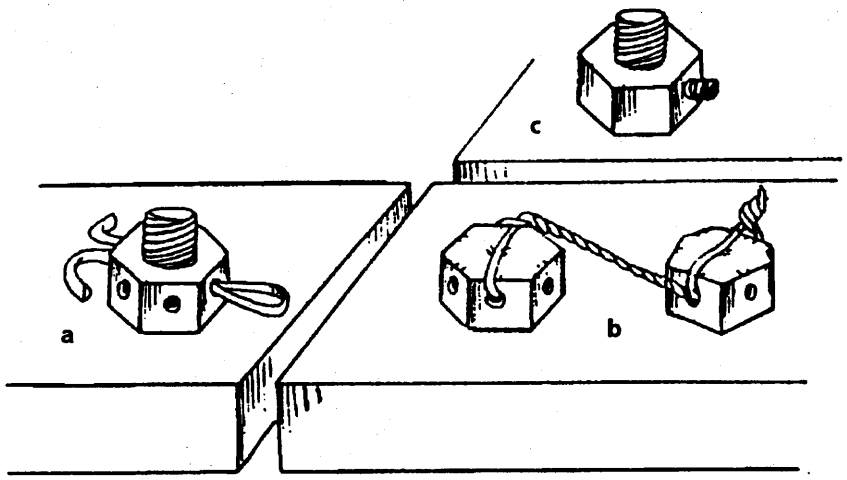


Figure 1.- Safetying methods

Figure 1a shows the use of a *cotter pin* to secure or safety a nut. The pin is inserted through the hole in the nut and bolt, then the ends are bent to hold it in place.

Figure 1b shows the use of *safety wire*. Safety wire is a strong wire that is inserted through holes in nuts and bolts and then twisted so the nut or bolt cannot turn.

Figure 1c shows the use of a *setscrew* to secure a nut. A setscrew may engage a slot in the bolt, as in figure 1c, it may be used to force a lead (Pb) ball into the bolt threads, or it may be a pointed end setscrew that locks the nut by pressure.

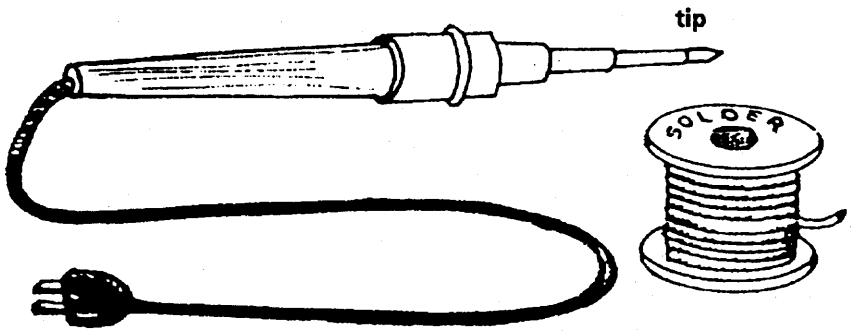


Figure 2.- Soldering iron and solder

2. ELECTRIC SOLDERING

Figure 2 shows a *soldering iron* and a roll of *solder*. Metals are soldered together much in the same way that pieces of wood are glued together. The soldering iron is heated by electricity, if it is an electric soldering iron as in figure 2, or by a flame, if it is a simple soldering iron. The hot *tip* of the soldering iron is used to melt the solder so that it covers or joins the pieces that are to be fastened together. When the solder cools it becomes hard. If the soldering has been done correctly, the hard solder will hold the pieces together. Solder does not make a strong connection, but it is a rapid, simple way to join metals. Solder is often used to join together electrical parts the wires in radios, televisions and other electrical equipment. The solder is a good conductor of electricity. Figure 4 shows a soldering gun. Soldering guns are a form of soldering irons. They are more convenient to use when a large number of small soldering jobs are to be done. See figures 3 and 4.

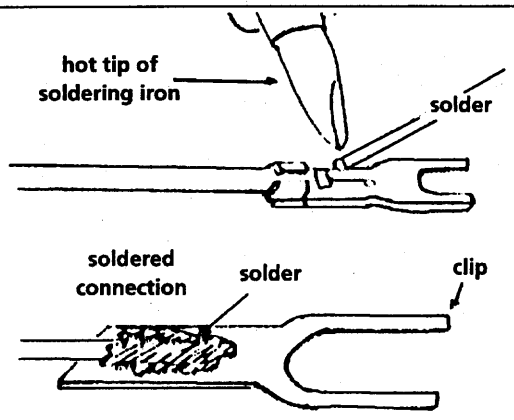


Figure 3.- Soldered connection

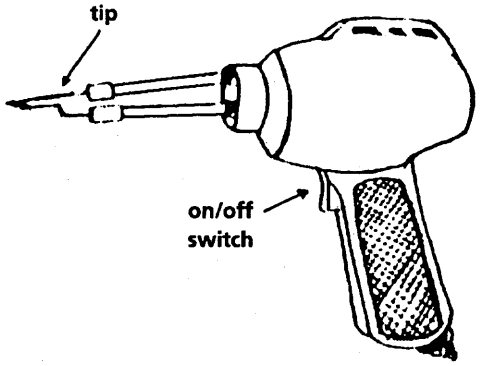


Figure 4.- Soldering gun

3. WELDING

Welding is completely different from any of the metal fastening methods we have discussed so far. In all of the other systems, the two pieces are held together by a fastening method but they still remain as two pieces. Welding uses an extremely hot flame to melt the pieces together so that when they cool they are one piece at that place; they are no longer two separate pieces of metal. The high temperature required by welding are produced by burning the gases, and directing the flame at the parts to be welded. The gases are stored in metal tanks. A regulator is attached to the tanks to control the flow of gas. The gas moves through hoses to the torch unit. The gases are combined at the torch unit and burned at the tip. See figure 5.

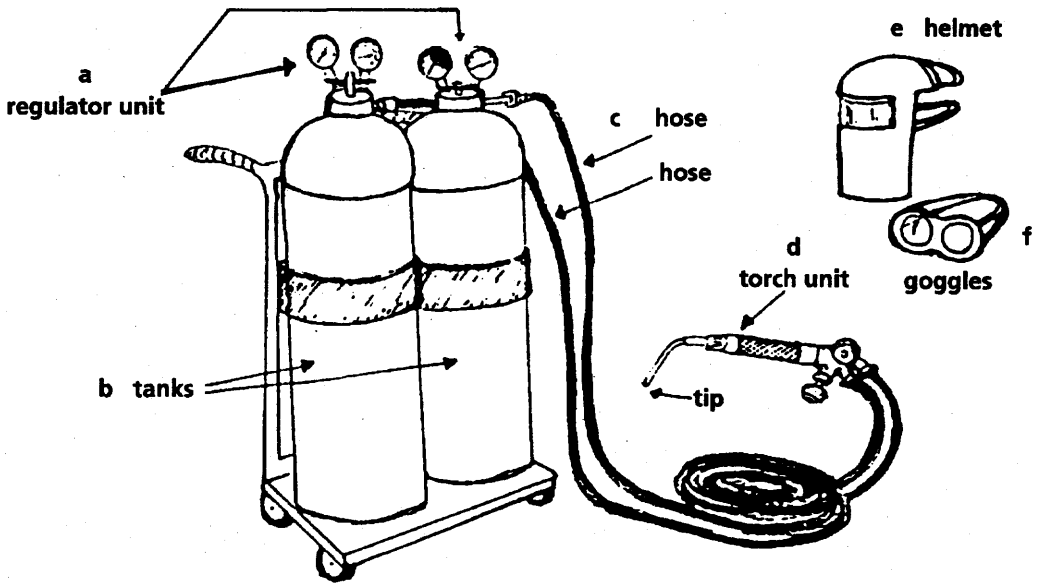


Figure 5

Welding is a dangerous process due to the hot, bright flame and the high temperature used. The welder and all people around can not look at the flame unless their eyes are protected by very dark glasses, either in the form of *goggles* or in a *welding helmet* or face shield. The bright flame of the welding torch will produce permanent damage to the eyes unless they are protected. In addition, the metal pieces and sparks from the flame are very hot and can produce bad burns unless gloves and protective clothing are worn.

There is another system of welding called *arc welding* that uses electrical current to produce the heat for welding. It produces the same dangers as a hot, bright flame, very high temperatures, and the additional dangers associated with electrical equipment.

UNIT THREE

FASTENING DEVICES

CLASSWORK ASSIGMENT : LESSON B

The following exercises should be completed in class with the instructor´s assistance:

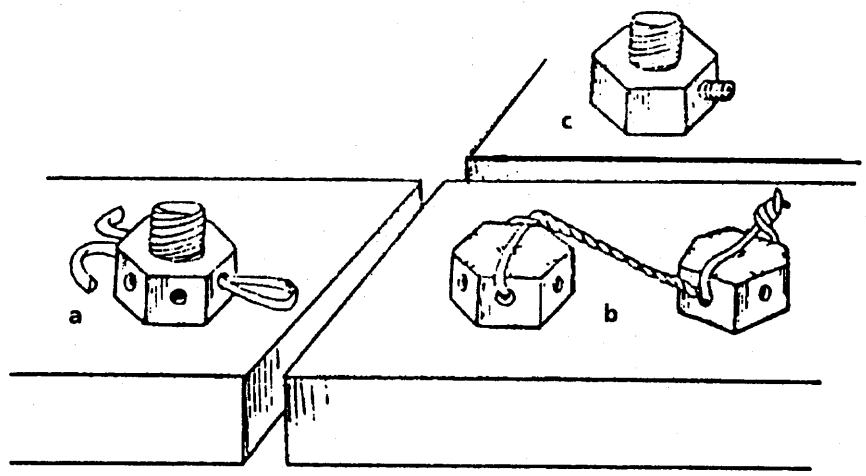


Figure 1

1. Look at figure 1. Write your answer in the space below.

Bolt a is secured by a _____.

Bolt b is secured by _____.

Bolt c is secured by a _____.

These bolts are _____. When a bolt is safetied, it is _____ so it can not turn or become loose. One method of _____ a bolt, as in figure 1a, is to use a _____ pin. Another way to secure or _____ a bolts is to use safety _____, as in figure 1b. The wire is _____ through the bolts and _____ so that the bolts can´t turn. In figure 1c the bolt is _____ by a _____ _____. All of these methods are considered semi _____. They secure the bolt or nut, but they can be _____ if it is necessary to turn the nut or bolt.

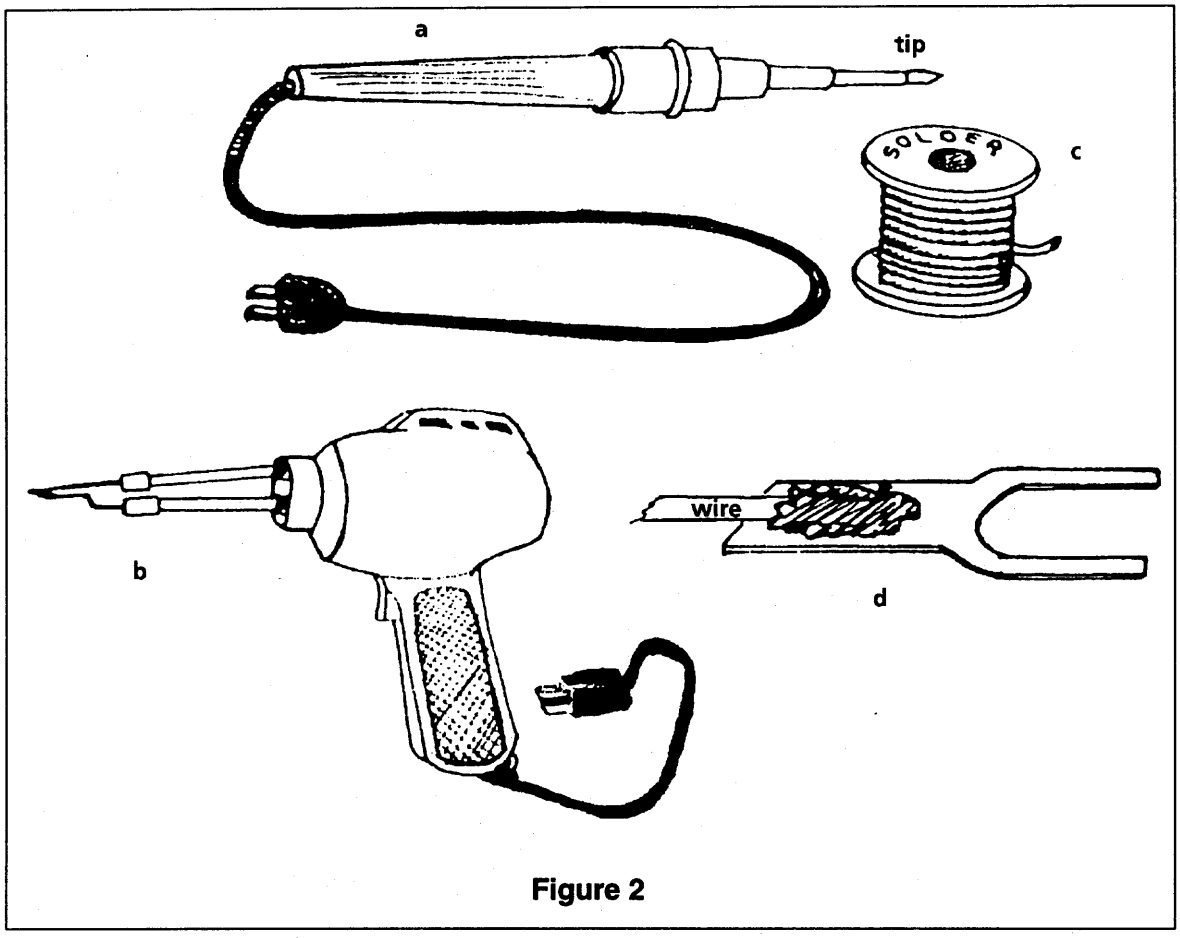


Figure 2

2. Look at figure 2. Write your answer in the spaces below.

a shows an electric _____ _____

b shows an electric _____ _____

c shows a roll of _____

The connection in d is fastened by _____.

It is a _____ connection.

The soldering _____ or _____ is used to melt the _____ so it covers or _____ the pieces. When the solder _____ and becomes hard, the pieces are held together. Soldering _____ is very similar to _____ wood. A soldered _____ is not very _____, but it does make a good electrical _____, Many _____ parts are soldered in Tvs, radios, and other electronic equipment.

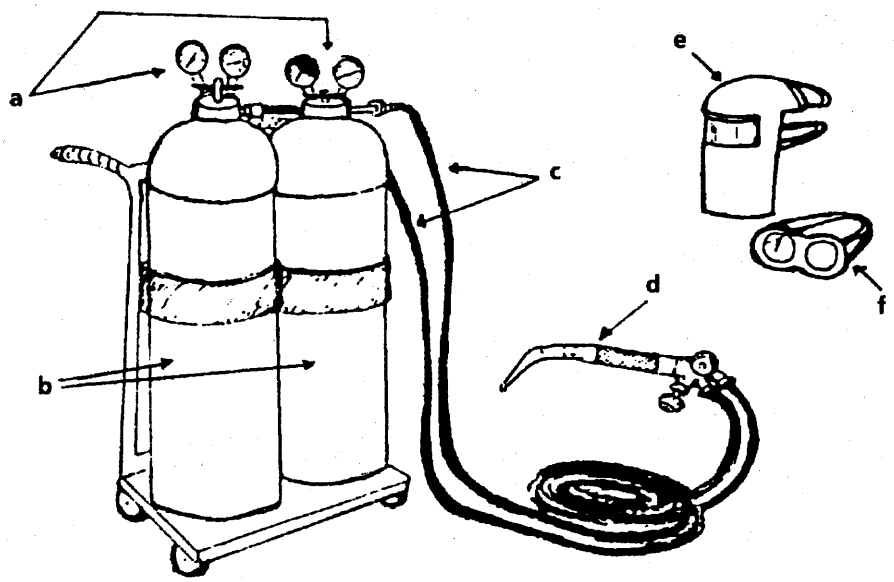


Figure 3

3. Look at figure 3 and write your answer in the spaces below.

Figure 3 shows typical equipment used for _____.

a indicates the _____.

b indicates the _____ _____.

c indicates the _____.

d indicates the _____ _____.

e indicates the _____ _____.

f indicates the _____ _____.

Welding is somewhat _____. The hot _____ flame can permanently damage your _____ unless your wear a welding _____ or a pair of welding _____ _____.

No one should ever look at a _____ flame unless his _____ are protected by dark glasses. Because the _____ are high, you can receive bad burns from the sparks or the hot _____.

UNIT FOUR

HYDRAULICS

OBJECTIVES

1. Given a cross-section picture of a hydraulic press, the student will orally and/or in writing correctly identify the following features :

- pump cylinder
- pump piston
- check valve
- lines
- work cylinder
- work piston
- release valve reservoir

2. Given an enlarged picture of a check valve, the student will orally and/or in writing identify the following parts:

- ball
- seat
- spring
- direction of flow
- inlet
- outlet

3. Given a picture of a complete hydraulic pump, cylinder and piston, the student will orally and/or in writing correctly identify the following features:

- cylinder
- piston
- handle (lever)
- pivot (fulcrum)
- reservoir
- downstroke
- upstroke

UNIT FOUR

HYDRAULICS

LESSON A

1. FLUID PRESSURE

Liquids have a variable form and a fixed volume. Due to the variable form, liquids exert pressure in all directions, not just in the direction of the applied force as a solid does. See figures 1 and 2.

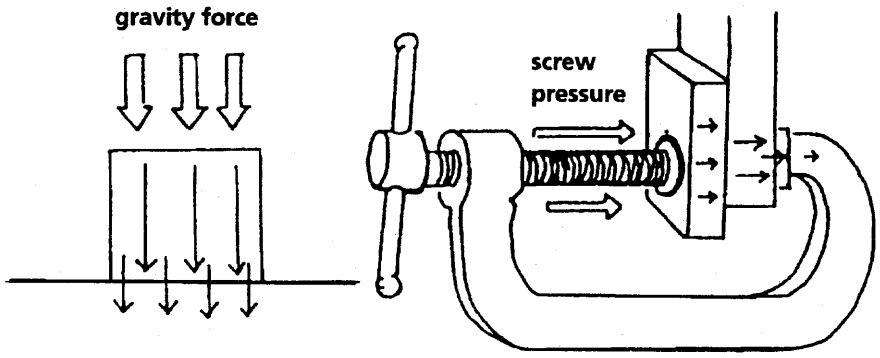


Figure 1.- Solids : transmission of force

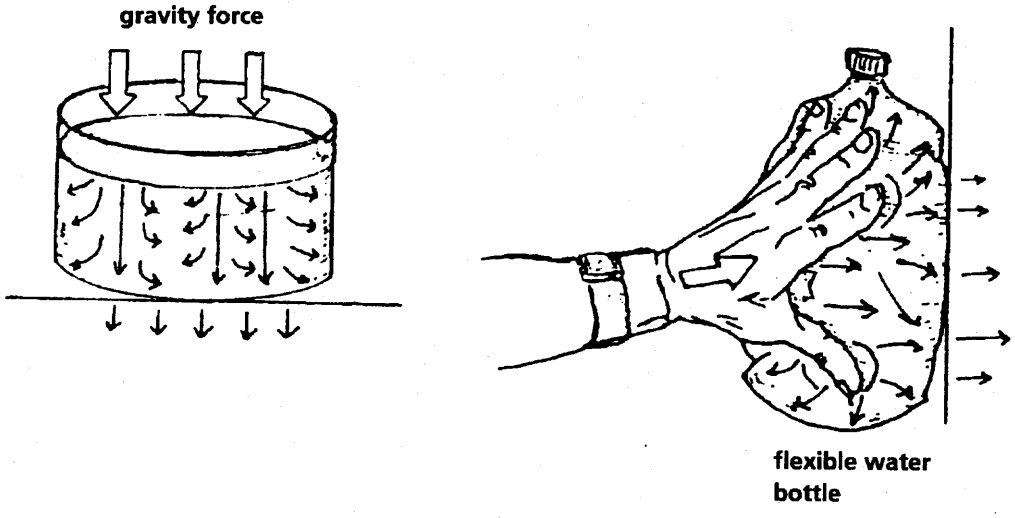


Figure 2.- Liquids : transmission of force

In addition to their characteristics in trasmitting force, liquids cannot be compressed. In figure 2 above, the man is applying force to the water bottle.

The volume of water is not variable, it is fixed; the water cannot be forced into a smaller container or space. The force or pressure that is being applied is transmitted to all parts of the flexible bottle. If the man pushes harder, the internal pressure in the bottle will increase. If he pushes very hard, the internal pressure, in PSI, will be more than the strength of the walls of the container and the container will break.

2. HYDRAULIC MACHINES

Machines that use the characteristics of fluids to perform work are called *hydraulic machines*. We will look at several of these machines to see how they operate. Figure 3 illustrates the basic features of most of these machines.

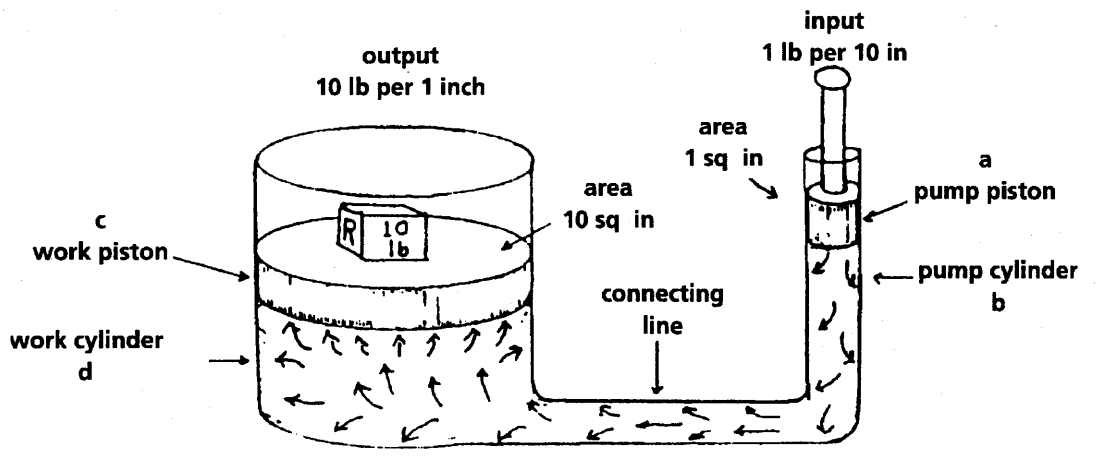


Figure 3.- Basic hydraulic machine elements

Look at figure 3. The small *cylinder*, b, with an area of 1 inch is called the *pump cylinder*, the piston, a, is called the *pump piston*. If a 1-pound force, 1 PSI, is applied to the 1-inch area of the pump piston face, this force is transmitted throughout the fluid, at a pressure of 1-pound per square inch. The fluid pushes against the *cylinder walls*, the sides of the *connecting line*, and the walls of the large *work cylinder*, d, with a force of 1 PSI. But these walls are strong and resist the pressure. The fluid cannot be compressed and the walls will not move. However, the force is also transmitted to the *work piston*, c. It is not fixed, it is movable.

The 1-pound force per square inch pushes on each square inch of the face of the work piston. The work piston face has an area of 10 square inches. It is pushed with a 10-pound force; 1-pound for each square inch of area. This force is enough to raise the 10-pound resistance of the weight. If the pump piston is pushed 10 inches, and the area is 1 inch, it will cause 10 cubic inches of fluid to move. When the 10 cubic inches of fluid move to the large work cylinder, they only lift the work piston 1 inch, because the area of the face of the work piston is 10 square inches. See figure 4.

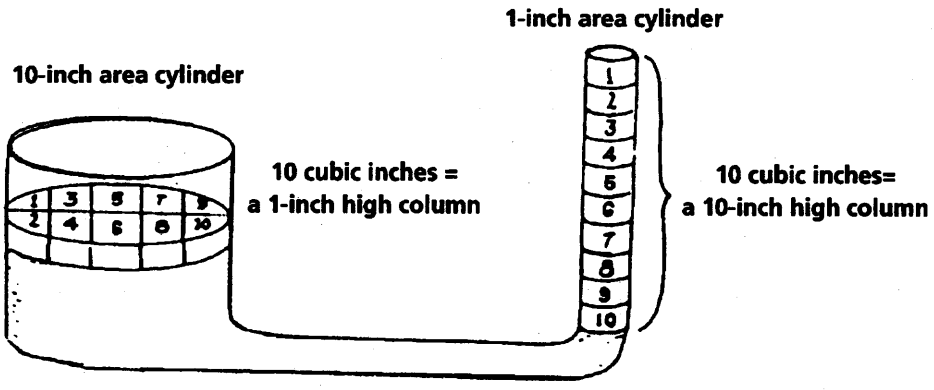


Figure 4.- Distribution of cubir inches by area

The hidraulic machine in figures 3 and 4 conforms to our normal formula:

Input (W = F x D) + Output (w = f x d)

Input		Output
(10 in-1b = 1 1b x 10 in)	=	(10 in-1b = 10 1b x 1 in)
Work Force Distance		work force distance

The input force, F, is the 1-pount applied to the pump piston, the input distance D, is the distance the pump piston causes the fluid or liquid to move in the pump cylinder.

The output force, f, is force transmitted to the work piston, and the output distance, d, is the distance the fluid or liquid moves in the work cylinder. The input work, W, and the output, w, must be the same. In this type of machine W and w are nearly equal because there is very little loss to friction.

The machine in figure 3 and 4 is too simple. If we remove our hand from the pump piston, the machine will operate in reverse, the weight on the work piston will force the pump piston to rise. Also, if we wished to lift the 10-pound resistance weight 4 inches, our pump cylinder would have to be at least 40 inches long. We need to add some more pieces to our machine. We will add then one at a time, so you can see the function of each part of the *system*.

UNIT FOUR

HYDRAULICS

CLASSWORK ASSIGMNET : LESSON A

The following exercises should be completed in class with the instructor´s assistance :

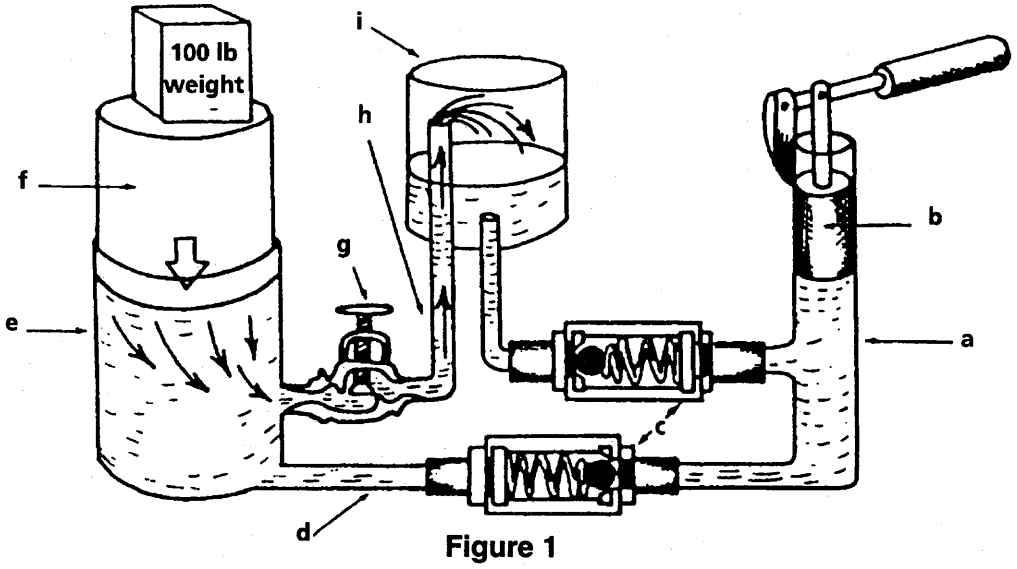


Figure 1

1. Look at figure 1 above. Write the correct name of each part in the spaces provided below.

a indicates the _____.

b indicates the _____.

c indicates the _____.

d indicates the _____.

e indicates the _____.

f indicates the _____.

g indicates the _____.

h indicates the _____.

i indicates the _____.

The machine in figure 1 is a _____ machine.

Fluids or liquids have a fixed _____ but variable

_____, they transfer _____ in all

directions. Liquids cannot be _____ into a smaller space.

_____ machines use the characteristic of _____

to perform work.

UNIT FOUR

HYDRAULICS

LESSON B

1. HYDRAULIC MACHINE COMPONENTS

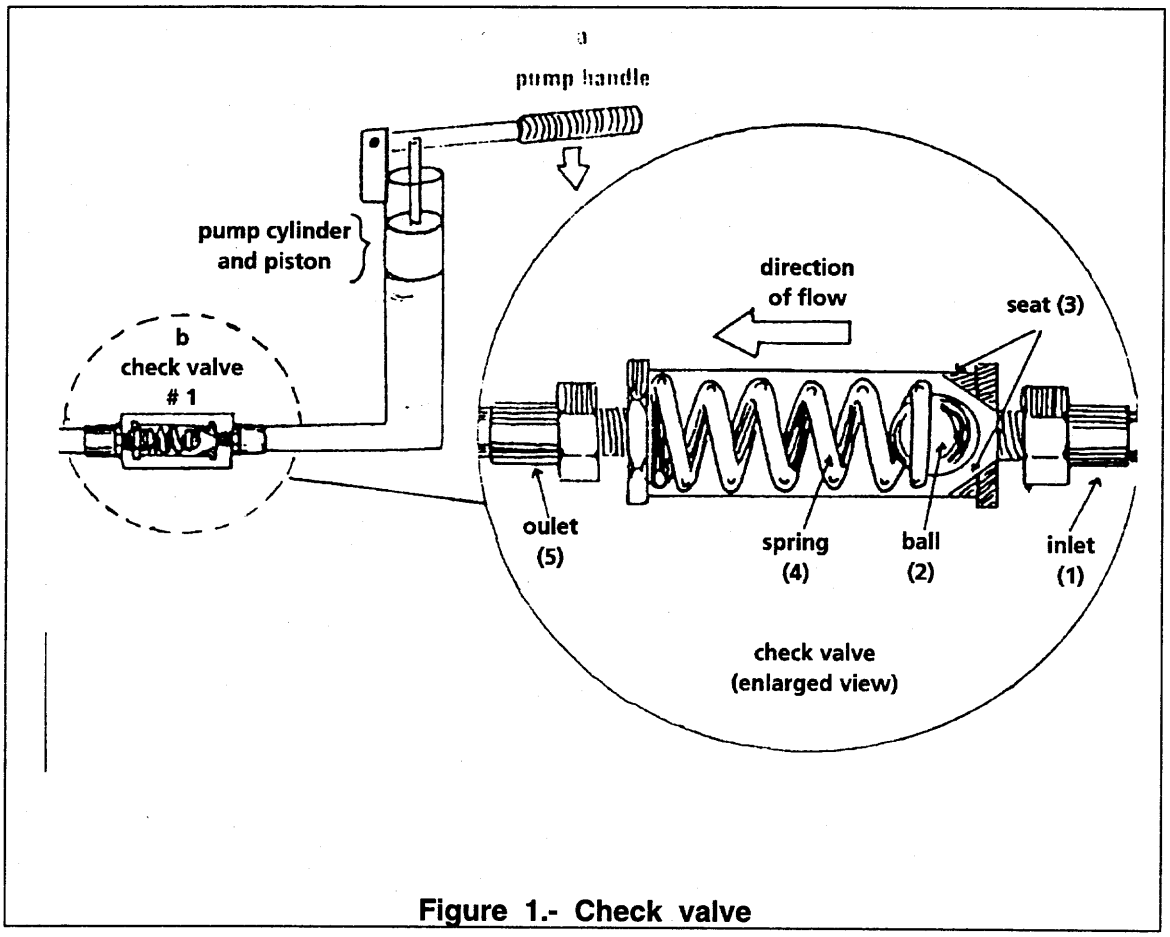


Figure 1.- Check valve

Look at figure 1. We have added a *pump handle*, a, and a *check valve*, b. The pump handle is a simple class 2 lever that increases the force applied to the pump piston. The check valve is a mechanical device that lets the fluid move in only one direction. When the pump handle is lowered, the piston forces the fluid against the check valve. Look at the enlarged view of the check valve. The fluid at the *inlet* (1) pushes the *ball* (2) away from the *seat* (3) because the force of the fluid is stronger than the force of the small *spring* (4).

The fluid under pressure from the piston, moves in the inlet, around the ball, and out the *outlet* (5) into the line to the work cylinder. When pressure is removed from the pump handle and piston, the pressure of the spring (4) and the weight on the work piston, acting through the fluid, move the ball back into the seat so that it closes the inlet opening. The fluid in the work cylinder cannot return to the pump cylinder. The check valve controls the fluid so it can only move in one direction to the work cylinder, and cannot return to the pump cylinder.

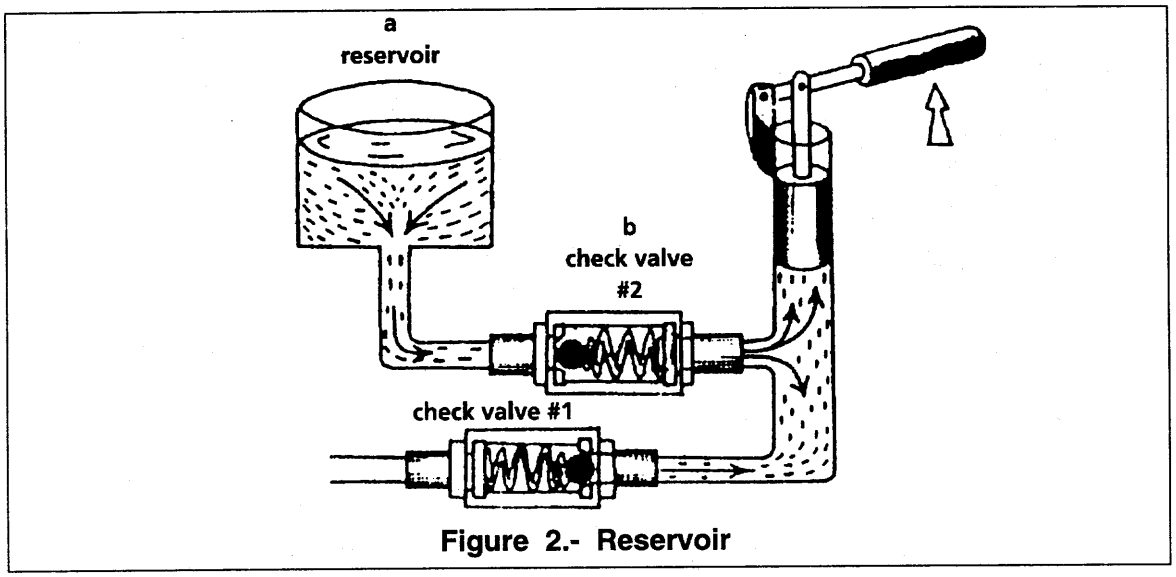


Figure 2.- Reservoir

Now look at figure 2. We have added a *reservoir*, a, or tank to hold additional fluid, and a second check valve, b, that faces in the opposite direction. The reservoir and check valve 2 are used to replace the fluid that was pushed through check valve 1. When the pump handle is raised, the space in the cylinder is increased, but the fluid cannot expand; it has a fixed volume. Additional fluid must enter the cylinder. Check valve 1 prevents the fluid from the work cylinder from returning, but check valve 2, which is reversed, allows fluid to be pulled in from the reservoir, a. The fluid from the reservoir refills the pump cylinder so the piston unit can be operated again. Figure 3 shows how the *downstroke* produces positive pressure that forces check valve 1 open while holding valve 2 closed. In figure 4, the *upstroke* pulls valve 2 open while holding valve 1 closed. With this system, twenty 1-inch downstrokes move 20 inches of fluid; a 20 inch long cylinder is not needed.

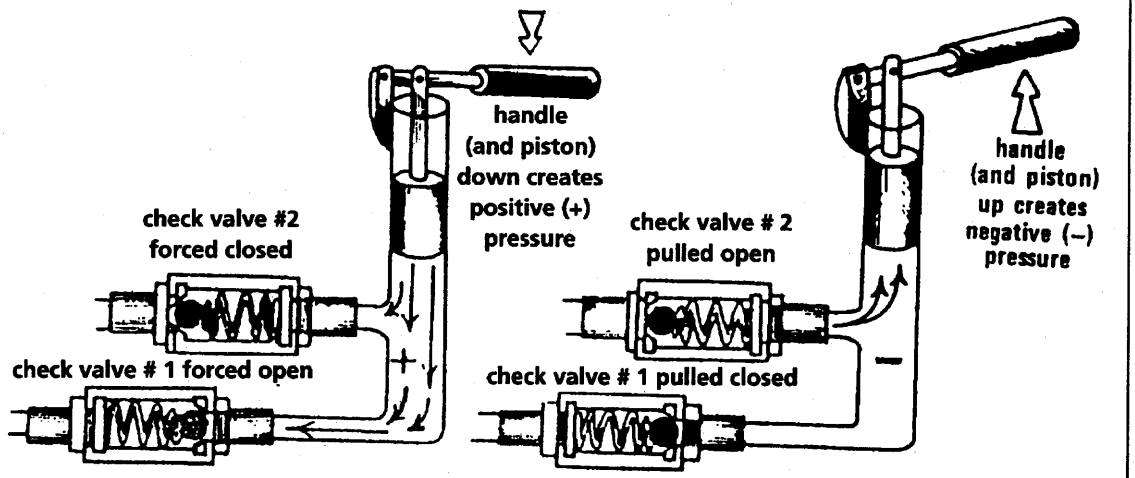


Figure 3.- Double valve system positive pressure

Figure 4.- Double valve system negative pressure

Now look at figure 5; we have drawn in the work cylinder and work piston, which you are familiar with. We have also added the *release valve* and the *return line*. The two check valves are used to allow the fluid to be pulled from the reservoir and forced the pump cylinder into the work cylinder where it is used to raise the work piston. We now need to provide a way to lower the work piston. The two check valves cannot be used as they operate in one direction only. We need a *release* valve, which is just a simple valve that is opened and closed by turning a screw-in, screw-out handle. When it is necessary to lower the work piston, the release valve is opened. The weight of the piston and the resistance weight will push the fluid through the opened release valve, through the return line, and back into the reservoir. When it is desired to raise the work piston again, the release valve is screwed closed so the fluid cannot leave the work cylinder.

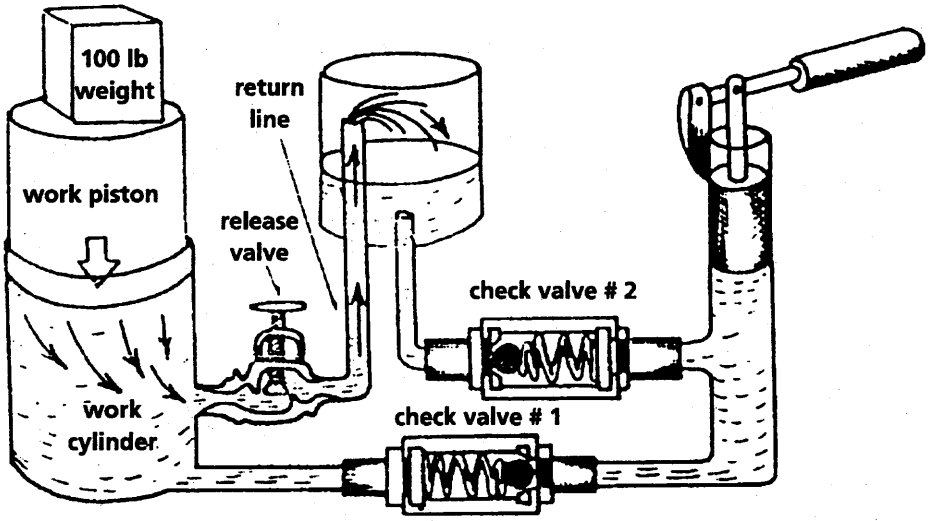


Figure 5.- Release valve

2. CALCULATIONS

The theoretical mechanical advantage of hydraulic machines such as the one we have been looking at, is calculated by the formula :

$$TMA = \frac{a}{A}$$

a = area of face of the work piston.

A = area of face of the pump piston.

UNIT FOUR

HYDRAULICS

CLASSWORK ASSIGMENT : LESSON B

The following exercises should be completed in class with the instructor´s assistance :

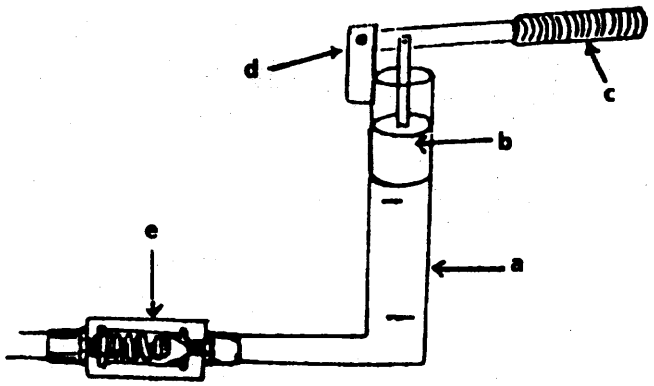


Figure 1

1. Look at figure 1. Write your answers in the spaces provided below.

Figure 1 shows the _____ cylinder and _____ piston. c, the handle, is a class _____ lever. The _____ or pivot is indicated by the letter _____. When the handle is lowered, the pump _____ is forced down. This cause the fluid in the pump_____, a, to be forced through the connecting line to e, which is a _____ valve; it is called a check _____ because it only allows the fluid to pass in _____ direction.

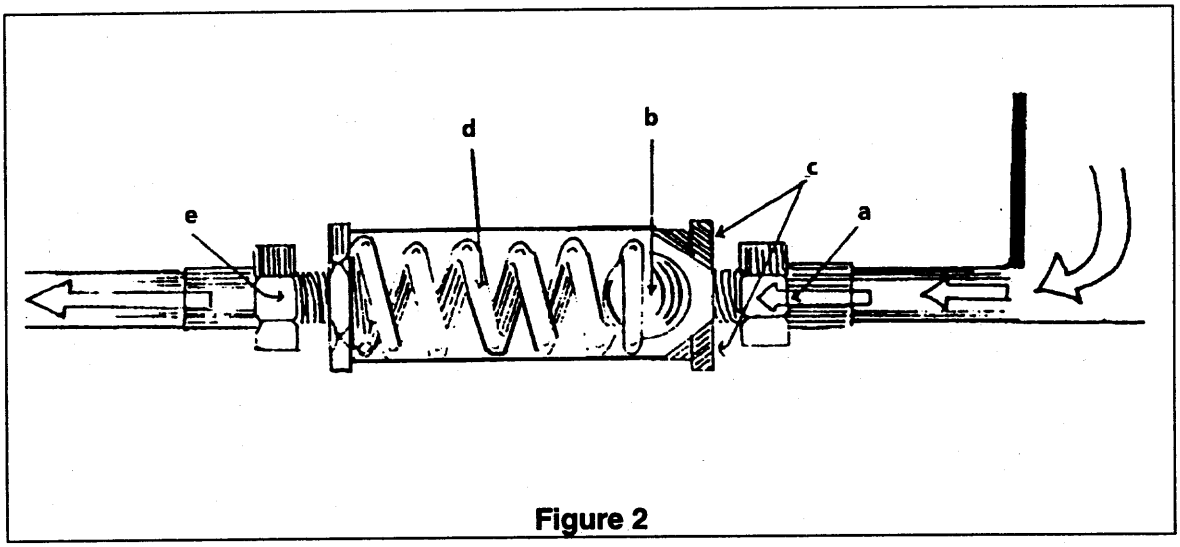


Figure 2

2. Look at figure 2. It shows a _____ valve. a indicates the _____ where the fluid enters. This forces b, the _____, to move away from c, the _____. d is a _____, it holds the ball against the seat. When the ball is forced out of the _____, the _____ can pass through the check _____ and out e, which is called the _____.

The formula to determine the theoretical _____ advantage of a hydraulic machine is :

$$TMA = \frac{a}{A}$$

In this formula :

TMA stands for _____.

a stands for _____.

A stands for _____.

UNIT FIVE

DRIVE SYSTEMS

OBJECTIVES

1. Given a picture of a sleeve coupling, the student will orally and/or in writing correctly identify the following features:

- sleeve
- slit
- clamp
- lock screw
- lug

2. Given a picture of a cylinder-piston unit joined by a connecting rod to a crankshaft, the student will orally and/or in writing identify the following components :

- cylinder
- piston
- wrist pin
- connecting rod
- crankshaft
- crankpin
- throw

3. Given pictures of an Oldham, Hooke-type and ring & trunion universal joints, the student will orally and/or in writing identify the following features :

- end disc
- center disc
- slot
- spring
- yoke
- ring
- trunnion
- bushing
- pivot pin
- cross piece

UNIT FIVE

DRIVE SYSTEMS

LESSON A

1. CRANKSHAFTS AND CRANKS

Power systems make the power available either in the form of a rotating shaft or a reciprocating shaft. The selection of a particular power system is mainly determined by factors such as size, weight, space available, fuel type, system type (combustion/non-combustion) etc. The types of shaft movement, rotating or reciprocal, are not particularly important, as either movement can be mechanically changed to the other movement. This is accomplished by using a crank, or, as it is called in machines, a *crankshaft*. See figure 1.

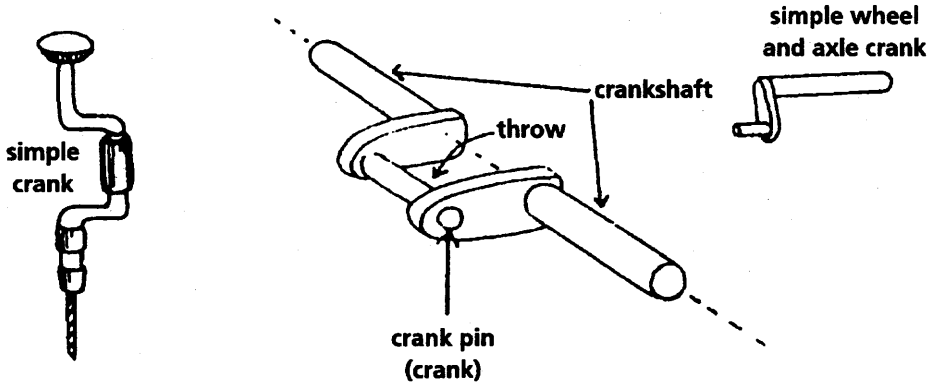


Figure 1.- Crankshaft

The *crankshaft* is a form of the simple wheel-and-axle machine called the crank, which we have already studied. The *shaft* or crankshaft is the axle part. The *throw* is the distance from the line of the axle to the axle to the *crank pin*. The throw is actually the radius of the circle that the crank or crank pin rotates in. In previous units we have seen this in the form of the brace and in the form of a lifting machine. It is used in many engines to change reciprocal motion to rotating motion, or, in some cases, to change rotating motion to reciprocating motion.

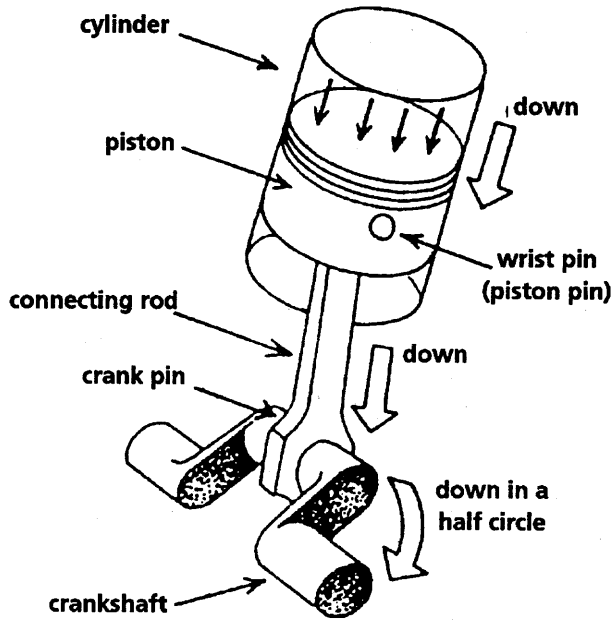


Figure 2.- Changing reciprocal movement to rotating movement

When the crankshaft is used to change reciprocating motion to rotating motion, it functions as is shown in figure 2. When the expanding gases force the piston out, it pushes against the *connecting rod*. The connecting rod, which is attached to the piston by the *wrist pin* at one end and to the crank pin at the other end, pushes against the arm or throw of the crankshaft. This force causes the crankshaft to turn. The reciprocating motion is changed to rotating motion as the crankshaft turns.

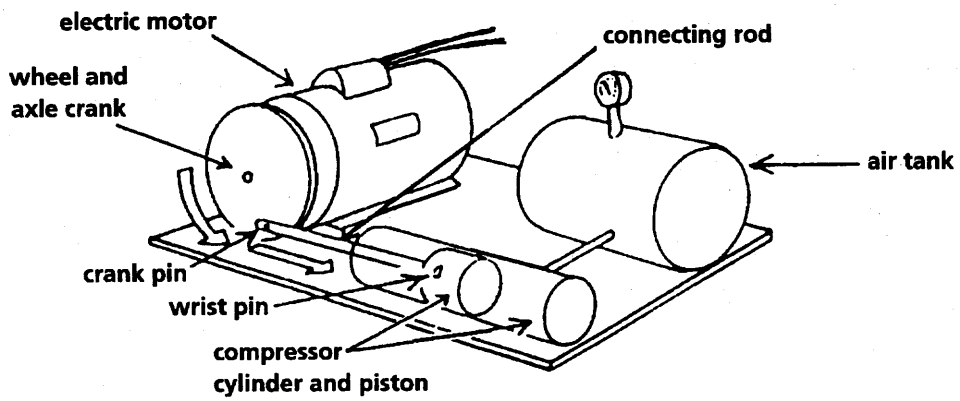


Figure 3.- Changing rotating motion to reciprocating motion.

When a crankshaft, or in this case a wheel-and-axle crank, is used to change rotating motion to reciprocating motion, it often functions as shown in figure 3. The electric motor rotates a wheel which has a crank pin attached to the outside edge. As the wheel rotates, the crank pin pushes the connecting rod, which in turn forces the piston into the cylinder. As the piston moves forward, it compresses the gases in the cylinder. This system, or a very similar system, is used in the compression units of most refrigerators and other cooling equipment.

UNIT FIVE

DRIVE SYSTEMS

CLASSWORK ASSIGMENT : LESSON A

The following exercises should be completed in class with the instructor´s assistance:

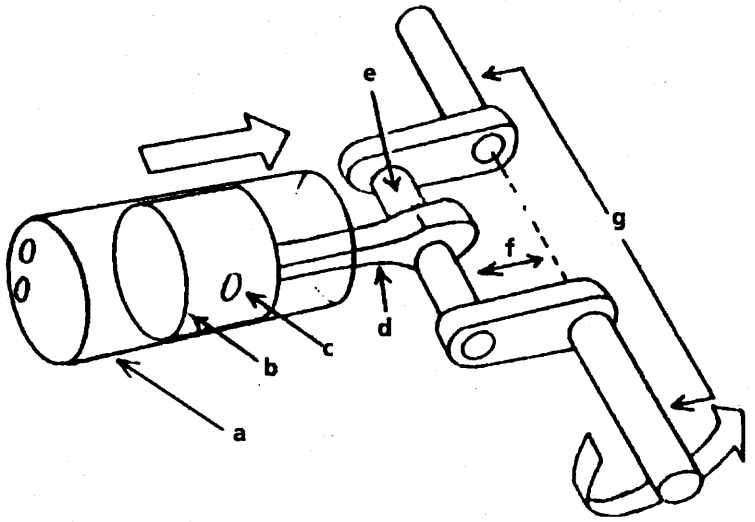


Figure 1

1. Look at figure 1. Write your answers in the spaces provided.

Figure 1 shows a _____-piston and _____ shaft unit.

a indicates the _____.

b indicates the _____.

c indicates the _____.

d indicates the _____.

e indicates the _____.

f indicates the _____.

g indicates the _____.

When the gases in the cylinder are heated, they _____ and push against the _____ face. When the piston moves, the _____ rod pushes against the _____ pin. This force causes the crank pin to rotate the _____ shaft.

UNIT FIVE

DRIVE SYSTEMS

LESSON B

1. COUPLINGS

A *coupling* is a device that holds two parts together. One purpose of couplings is to connect the rotating or reciprocating shaft of a power system to other parts of a machine. The choice of which coupling to use is usually determined by the angle between the two shafts that are to be connected. If the drive shaft and the driven shaft are in line (on the same axis), a *sleeve coupling* can be used. See figure 1.

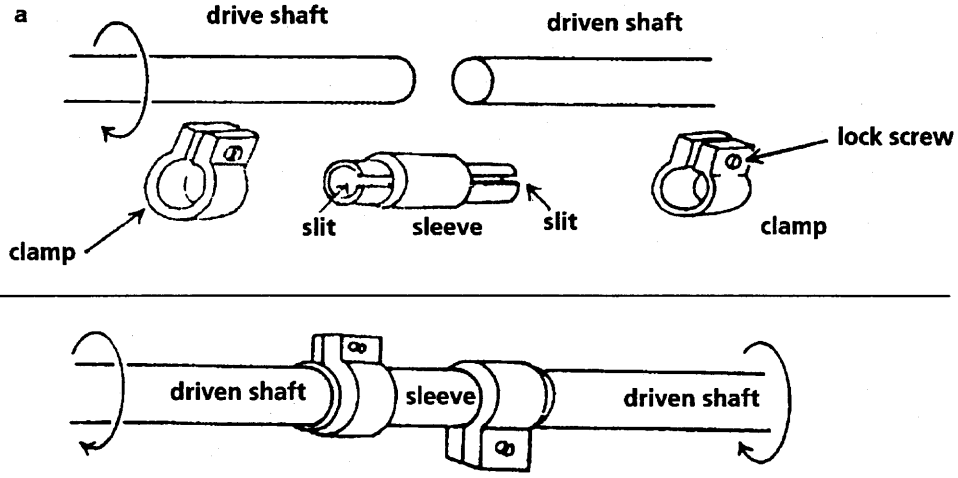


Figure 1.- Use of sleeve coupling

The sleeve of the sleeve coupling is a hollow metal cylinder that is fitted on the ends of the drive and driven shafts. Each end has a small slit so the sleeve can be tightened by the *clamps* that lock the ends of the sleeves to the two shafts. The clamps are turned so that an equal amount of weight will be located on opposite sides of the shaft. The coupling joins the two shafts so the rotation of the drive shaft will be transferred to the driven shaft.

If the two shafts are not exactly in line and the angle of difference is small, an *Oldham coupling* can be used. It consists of two *end discs*, and a *center disc*. The center disc has projections called *luge* that fit into *slots* in the end disc.

One end disc is locked on the drive shaft and the other is locked on the driven shaft. The center disc is put between the two so that the lugs on one side engage the slots in the drive-shaft disc. The small spring pushes the center disc against the drive disc and allows a small of movement to adjust for the two shafts not being in line. See figure 2.

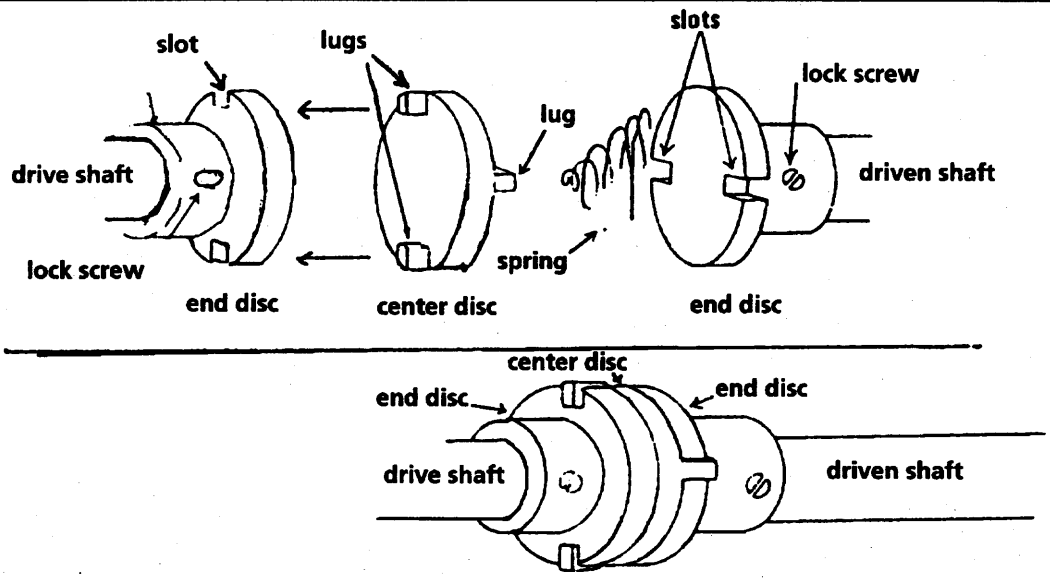


Figure 2.- Oldham coupling

When the angle between the drive shaft and the driven shaft is fairly large a universal coupling or U-joint is used. Figure 3 shows a Hooke-type universal joint. It is very similar to the universal joint used with socket wrenches.

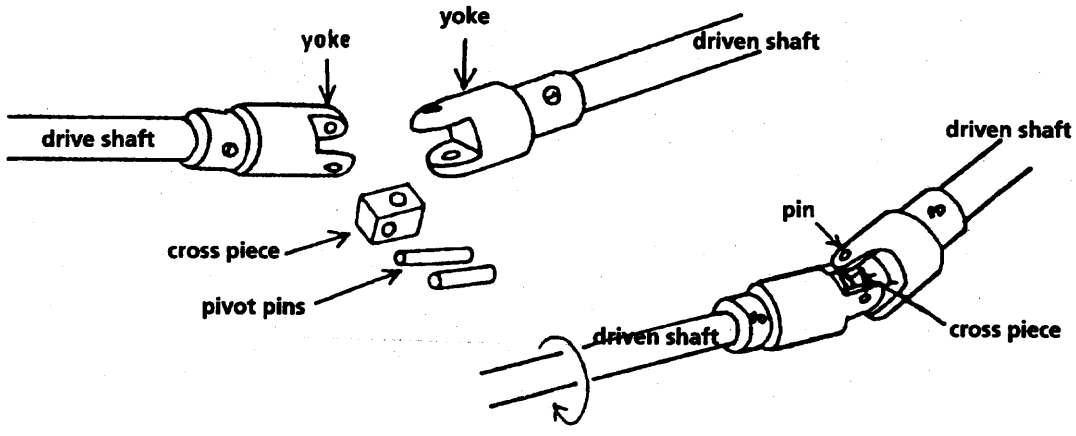


Figure 3.- Hooke type universal joint

Another commonly used unviersal joint is the *ring and trunnion* type. It is frequently used on the drive shaft of automobiles. It is similar to the Hooke type except it uses a *ring with* four projections called *trunnions* to fill the hole and lock it in the yoke. See figure 7.

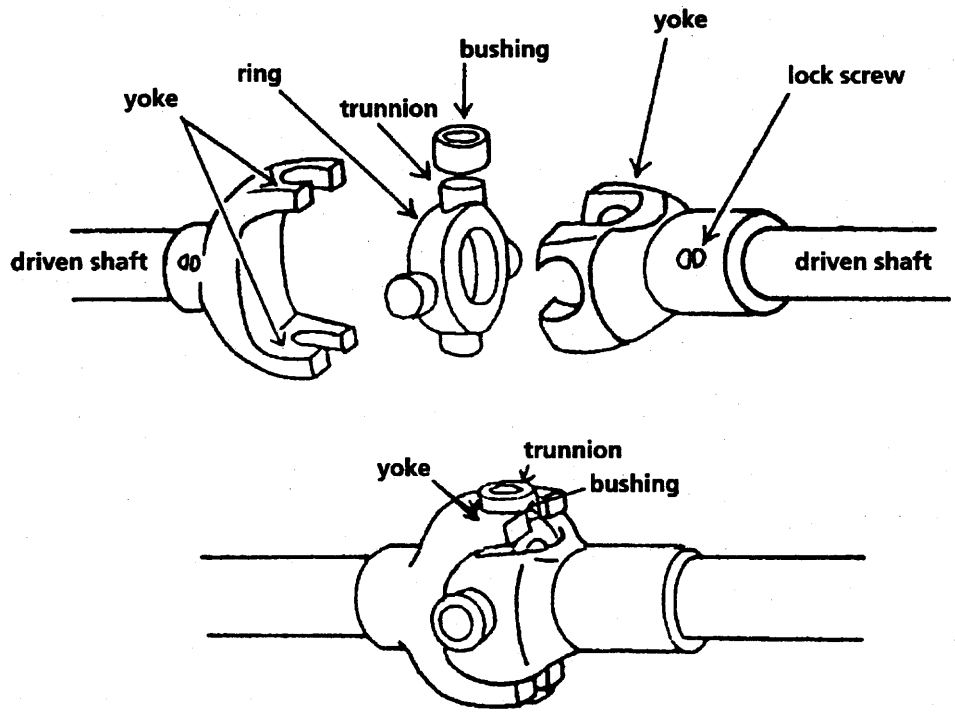


Figure 4.- Ring and trunnion universal joint

UNIT FIVE

FASTENING DEVICES

CLASSWORK ASSIGMENT : LESSON B

The following excercises should be completed in class with the instructor´s assistance:

1. Look at figure 1. Write your answers in the spaces provided.

   Figure 1 shows a _____ coupling. It is used to join the _____ shaft to the _____ shaft.

   It is only used when the shafts are in _____.

   a indicates the _____.

   b indicates the _____.

   c indicates the _____.

   d indicates the _____.

   e indicates the _____.

   f indicates the _____.

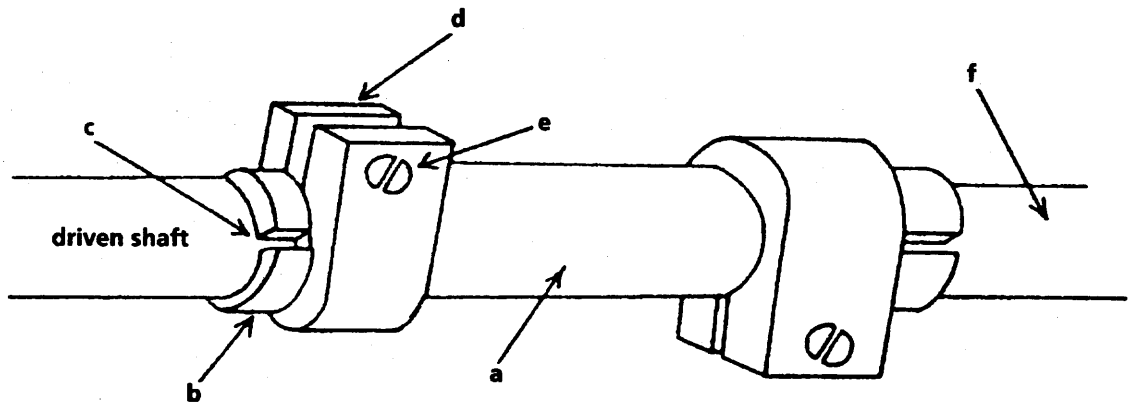


Figure 1

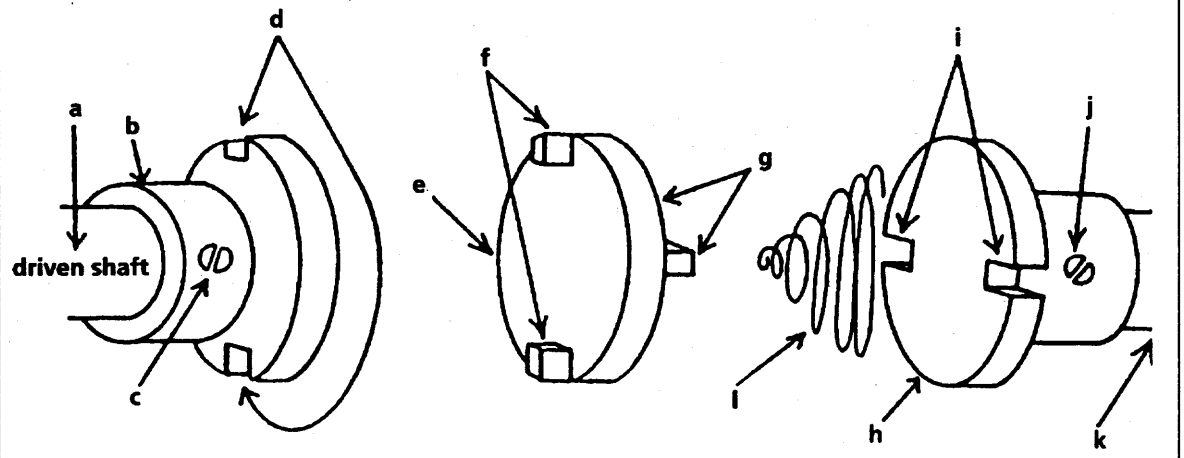


Figure 2

2. Look at figure 2. Write your answers in the spaces provided.

Figure 2 shows an _____ coupling. It is used when the shaft are not exactly in _____ but the angle of difference is very _____. It is composed of two _____ disc and a _____ disc. The _____ on the center disc fits into the slots on the _____ disc.

a indicates the _____ shaft.

b indicates the _____ disc.

c indicates the _____ _____.

d indicates the two _____ on the end disc.

e indicates the _____ disc.

f indicates the two _____ that fit into the end disc slots.

g indicates the two _____ that fit into the other end disc.

h indicates the second _____ disc.

i indicates the two _____ in the second end disc.

j indicates the _____ _____.

k indicates the _____ shaft.

l indicates the _____.

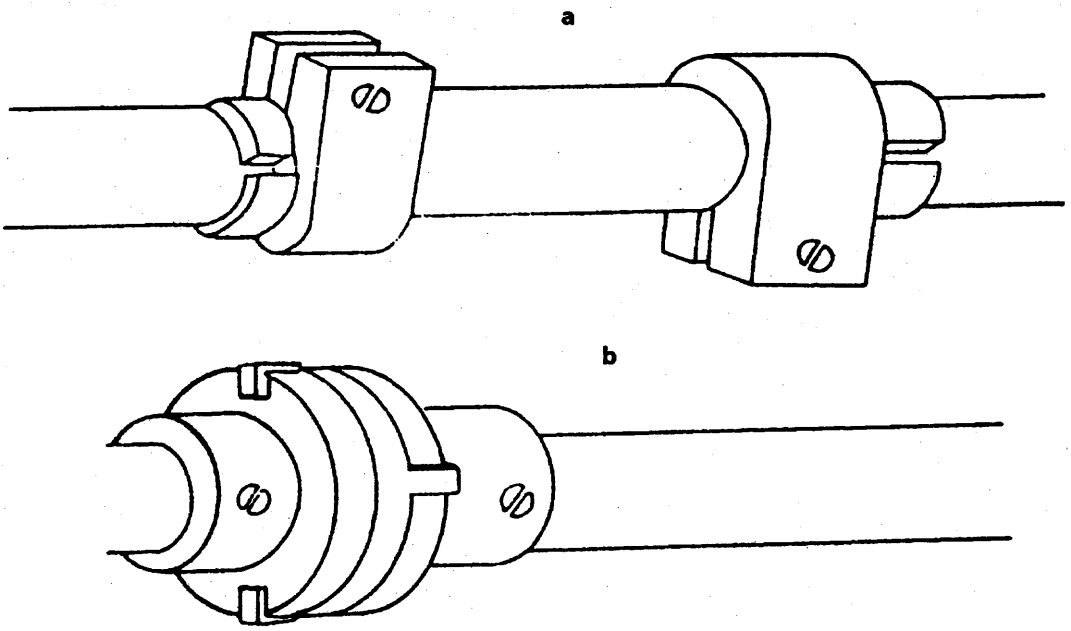


Figure 3

3. Look at figure 3. Write your answer in the spaces provided.

a is a _____ coupling.

b is a _____ coupling.

They are used to _____ the drive _____ to the _____ shaft.

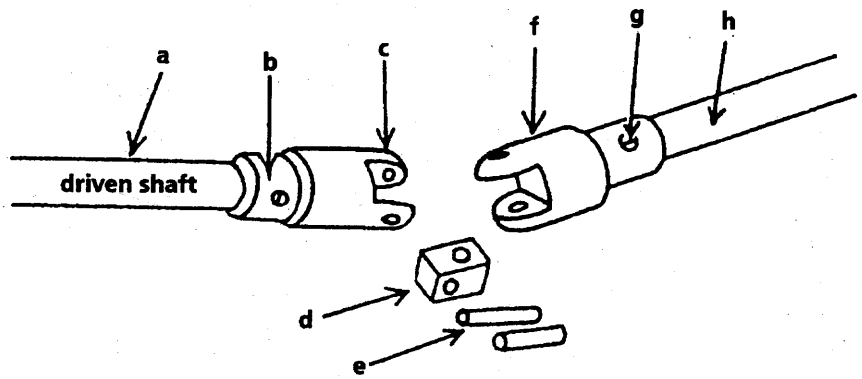


Figure 4

5. Look at figure 4. Write your answers in the spaces provided.

Figure 4 shows a _____ type _____ joint.

a indicates the _____ shaft.

b indicates the _____.

c indicates the _____.

d indicates the _____ _____.

e indicates the _____ _____.

f indicates the _____.

g indicates the _____.

h indicates the _____ shaft.

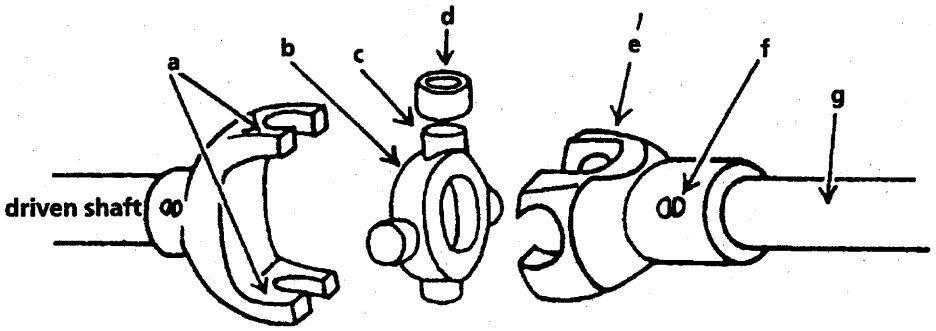


Figure 5

6. Look at figure 5. Write your answers the spaces provided.

Figure 5 shows a _____ and _____ type _____ joint.

a indicates the _____.

b indicates the _____.

c indicates one of the _____.

d indicates the _____.

e indicates _____.

f indicates _____.

g indicates _____.

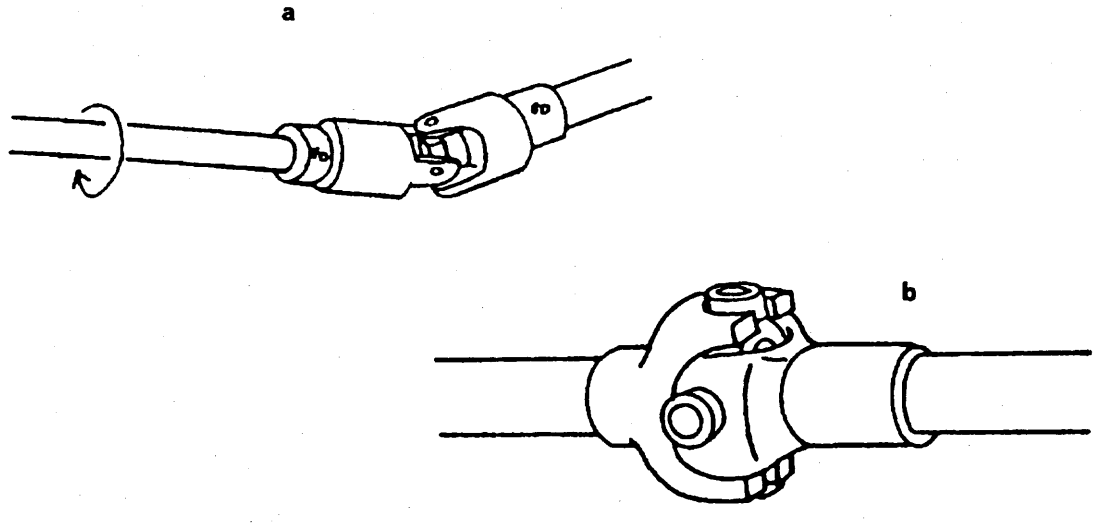


Figure 6

7. Look at figure 6. Write your answers in the spaces provided.

Figure 6 shows two _____ joints. They are also called _____ joints. The upper one is a _____ type _____ joint; the bottom one is a _____ and _____ type universal _____.

UNIT SIX

BEARINGS

OBJECTIVES

1. Given the question "What are the two types of bearings ?" the student will orally and/or in writing identify the two types of bearings as sliding type bearings and antifrictional bearings.

2. Given a composite picture of examples of the sliding type bearings below, the student will orally and/or in writing identify each by name:
- a reciprocal motion guide bearing
- a journal bearing (split shell type)
- a journal bearing (bushing type)
- a thrust bearing

3. Given pictures of a radial load ball bearing, a radial load cylindrical roller bearing, needle bearing and a taper roller bearing, the student will orally and/or in writing correctly identify the following features:

- inner ring ball race	- inner ring	- shell
- outer ring ball race	- outer ring	- cone
- ball	- roller	- cage
- separator	- separator	- cup

4. Given the task of state the meaning of the following terms, the student will orally and/or in writing correctly state each :
- lubricants
- wear
- worn
- worn out
- axial thrust
- radial load
- thrust bearing

UNIT SIX

BEARINGS

LESSON A

1. BEARINGS, GENERAL

Friction occurs when two moving surfaces are in contact with each other. The friction reduces efficiency, that is some of the input work is used up overcoming the friction. Friction also produces heat and causes *wear.* Wear is the slow destruction of surfaces caused by friction. As the moving surfaces slide against each other, very small particles are broken or pulled off the surfaces in contact. When this occurs the dimensions of the parts change and we say the parts are *wearing.* When the process continues so that the parts no longer fit correctly, we say the parts are *worn* or *worn-out.* As you can see in figure 1, a complex machine has many moving parts that are in contact with each other. It is important to prevent or reduce the friction at the places of contact or *friction points.* This keeps the machine efficient and reduces the wear of the parts. The two main methods of reducing friction at these points is the use of *lubricants*, such as oil or grease, or the use of *bearings.*

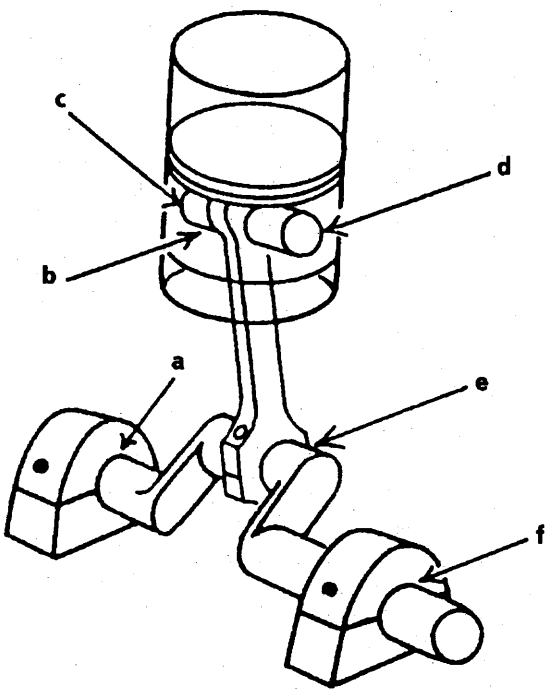


Figure 1.- Friction points

Bearings perform several functions. Bearings at points a and f in figure 1 support the crankshaft, that is they hold the weight of it and receive any pressure applied to the crankshaft. Bearings at point c support the connecting rod, and they also act as a guide to keep it from moving from side to side on the crank pin. The bearings reduce friction because they are lubricated and they are made from metals that slide easily on other metals. And last, bearings reduce wear; the special bearing metals are usually softer than the parts they support and guide. When wear takes place as the result of the friction that does occur, it is the bearing that becomes worn, not the part it supports and guides. It is much more economical to replace the bearing than it is to replace the part.

2. SLIDING TYPE (PLAIN) BEARINGS

The simplest of the two types bearings is the sliding type. It is also called a *friction, guide* or *plain bearing.*

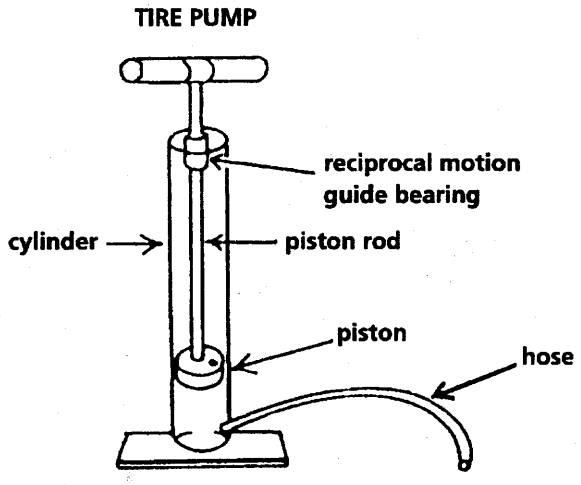
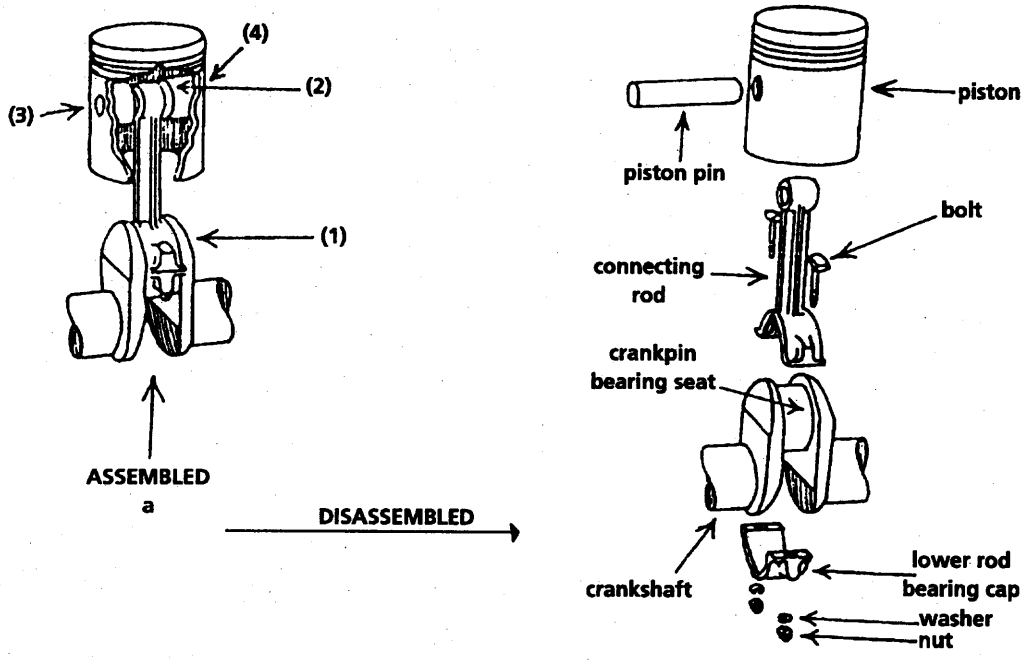


Figure 2.- Reciprocal motion sliding type bearing

There are three types of sliding bearings in use. Figure 2 illustrates a *reciprocal motion bearing.* The bearing at the top of the pump cylinder guides the piston rod as it is moved in and out of the cylinder. Although this is a simple usage, more complex units operate in the same way.

Figure 3 illustrates the second type of sliding bearings. They are *journal bearings* or *bushings.* A journal bearing guides and supports rotatings shafts. Figure 3a shows the three main friction points where these bearings are used on a piston-connecting rod-crank pin unit; (1), where the connecting rod is attached to the crank pin; (2), where the other end of the connecting rod is attached to the piston pin; and (3) and (4), where the piston pin passes through the sides of the piston. Figure 3b shows an enlarged view of these parts. Bearing (1), the journal bearing for the crank pin, is made in two pieces. After the bearing halves have been put on the crank pin, the connecting rod is put over it and bolted together. Bearing (2) is in the form of a bushing. It is inserted in the hole at the end of the connecting rod and then the piston pin is inserted through the bushing. Bearings (3) and (4) are in the form of bushings which are slipped over the ends of the piston pin to support it in the holes in the piston. In each case the journal bearings are put between the one rotating or moving part and the other part.



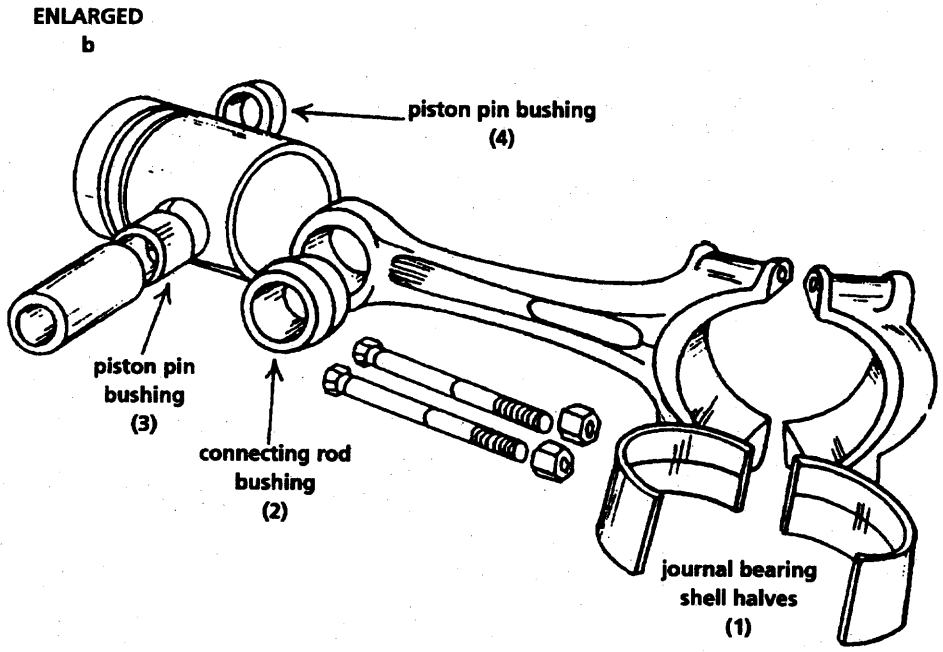


Figure 3.- Journal bearings (bushing and liners)

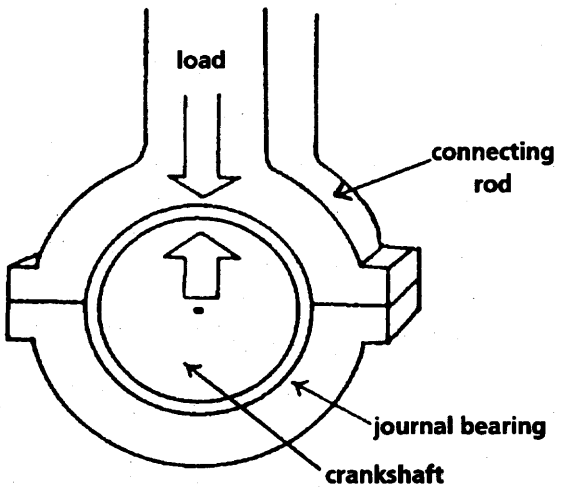


Figure 4.- Radial load

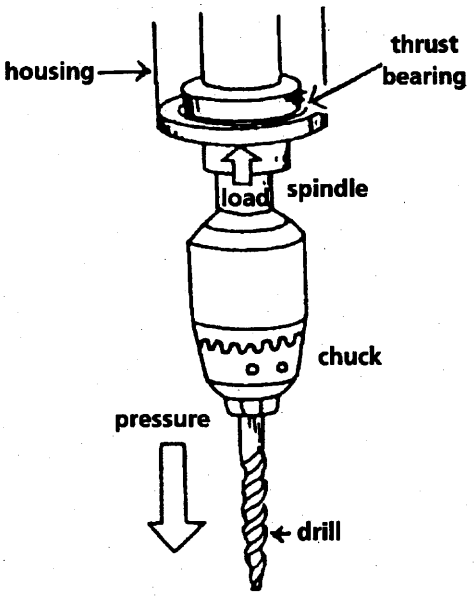


Figure 5.- Thrust load

Journal bearings receive a *radial load*. The pressure or load on the bearing is toward the center of the shaft or pin in line with the radius, as in figure 4. The third use of sliding bearings is to support *thrust loads* as in figure 5. When a drill is used, the drill bit is pushed against the material that is being drilled, this puts pressure in line with the length of the shaft. This *axial* pressure is called thrust. Bearings that resist this pressure and limit axial movement are called *thrust bearings*. It is often necessary to use both radial load journal bearings and axial load thrust bearings on the same shaft. See figure 6.

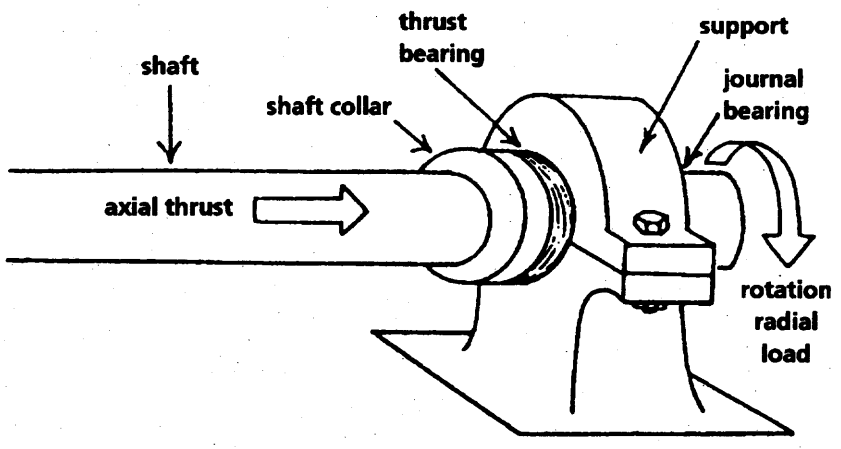


Figure 6.- Use of thrust and journal bearings

UNIT SIX

BEARINGS

CLASSWORK ASSIGMENT : LESSON A

The folowing exercises should be completed in class with the instructor´s assistance:

1. What is the major cause of worn parts ?

_____

_____

2. How can friction be reduced ?

_____

_____

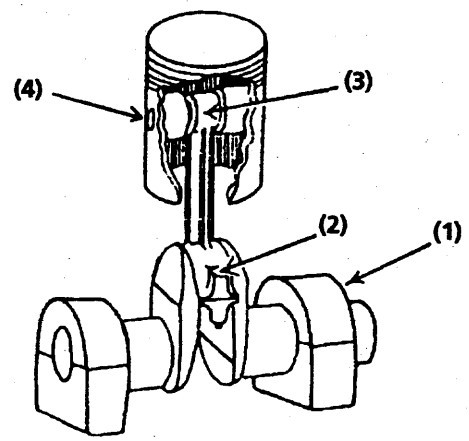


Figure 1

3. Look at figure 1. Write your answers in the spaces provided.
   The numbers indicate places where moving parts contact other parts.

   These are called _____ points.
   (1) is where the _____ is supported by the _____
   (2) is where the _____ is attached to the _____
   (3) is where the _____ is attached to the _____
   (4) is where the _____ is attached to the _____

4. The two basic types of bearings are _____ (plain) bearings and _____ bearings.

5. Look at figure 2. Write your answers in the spaces provided.

The tool shown in figure 2 is a _____ pump.

It is used to inflate _____.

a indicates the _____.

b indicates the _____.

c indicates the _____.

d indicates the _____.

e indicates the _____.

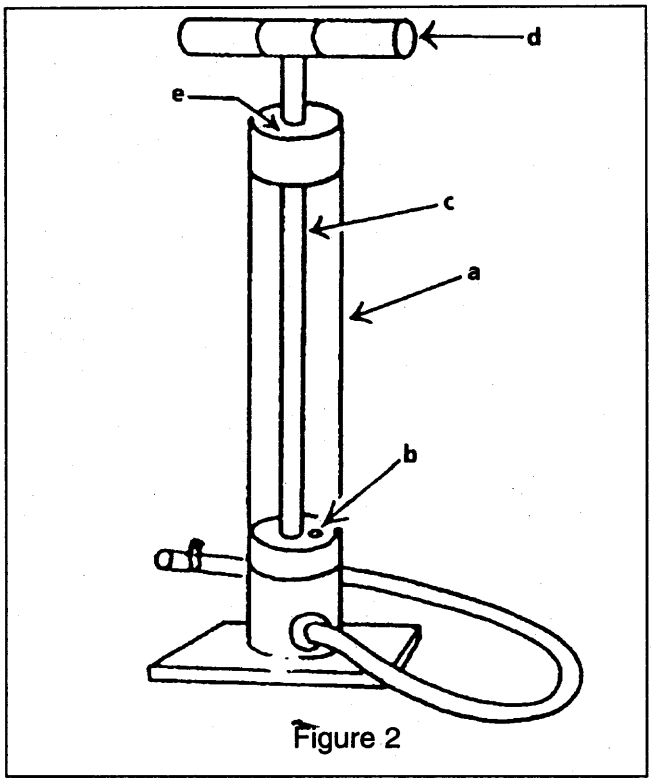


Figure 2

Bearing e is a _____ motion _____. It guides the _____ rod (c) when it is raised and lowered.

6. Bearings that support and guide revolving shafts are called _____ bearings. Some of them are made in _____ pieces or halves. Others, called _____, are made in the shape of a ring. Journal _____ are inserted between the _____ parts.

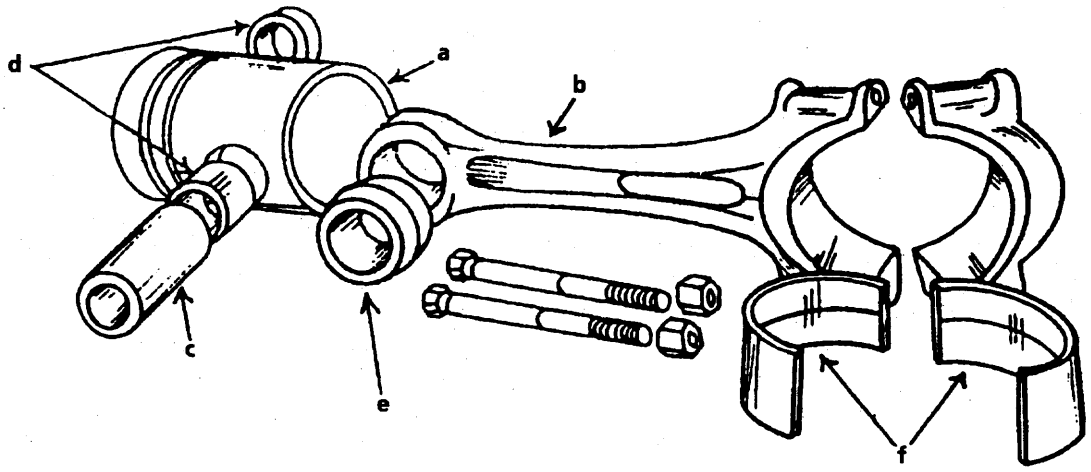


Figure 3

7. Look at figure 3. Write your answers in the spaces provided.

Figure 3 shows a _____ and _____ rod units.

a indicates the _____

b indicates the _____ _____.

c indicates the _____ _____.

d indicates the _____ that support the _____ _____ where it passes through the sides of the _____. They are a type of _____ bearings.

e indicates the _____ that goes between the _____ _____ and the _____ _____.

f indicates the two halves of the _____ _____ where it is attached to the _____.

UNIT SIX

BEARINGS

LESSON B

1. ANTIFRICTIONAL TYPE (ROLLER OR BALL) BEARINGS

As we learned in an earlier unit, rolling friction is much less than sliding friction. Bearings that use rollers or balls to provide a rolling contact are called *antifrictional* (against friction) *bearings*. They are used when it is desired to reduce friction as much as possible.

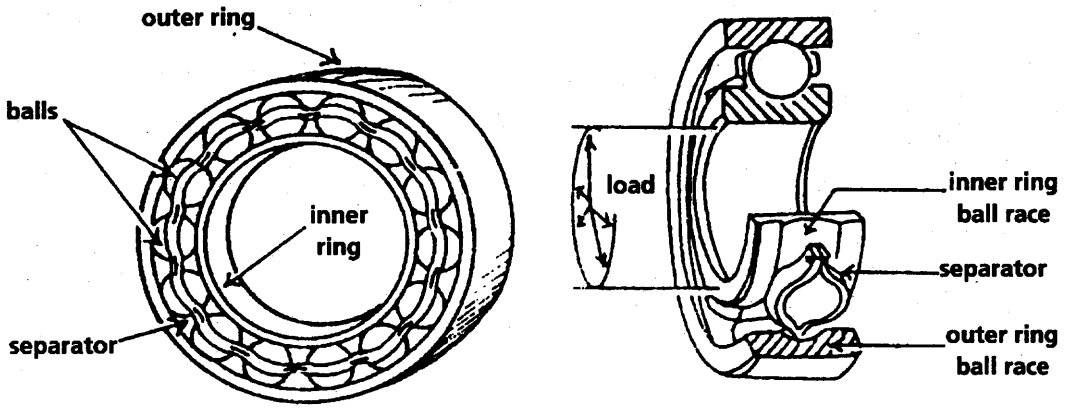


Figure 1.- Simple ball bearing

Figure 1 illustrates one of the four major types of antifrictional bearings. It is a *ball bearing*. The balls are usually held in correct spacing by a device called a *separator*. They roll between two grooved rings called *races*. The ball bearing shown in figure 1 is a radial load type. The ball bearing shown in figure 2 is a thrust load type.

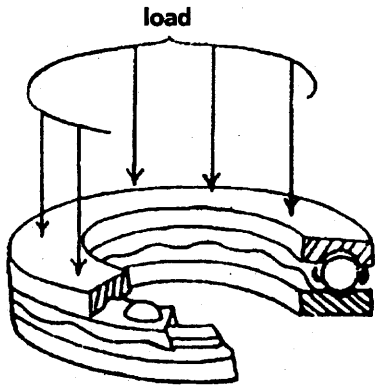


Figure 2.- Ball thrust bearing

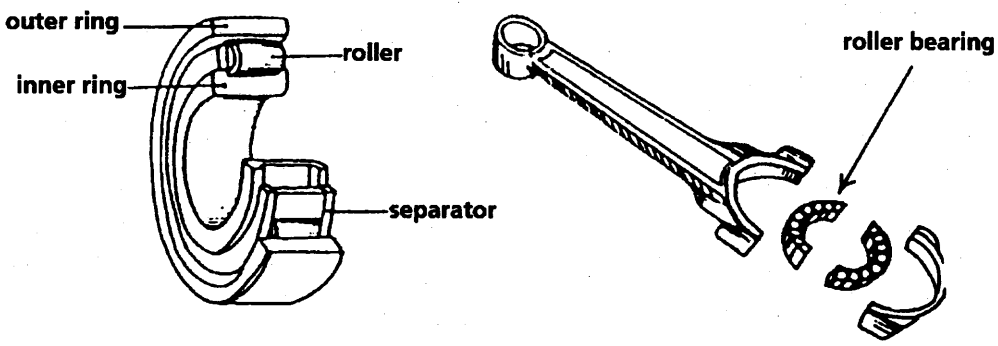


Figure 3.- Cylindrical roller bearings

Figure 3a illustrates the second type of antifrictional bearings. It is a *cylindrical roller bearing*. It is similar to the ball bearing except that small cylinder-shaped *rollers* are used instead of balls. Figure 3b shows an example of cylindrical roller bearing usage with a special two-piece bearing.

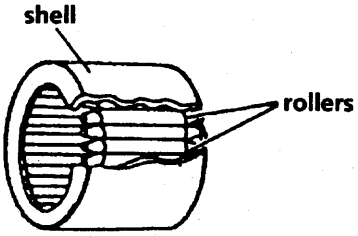
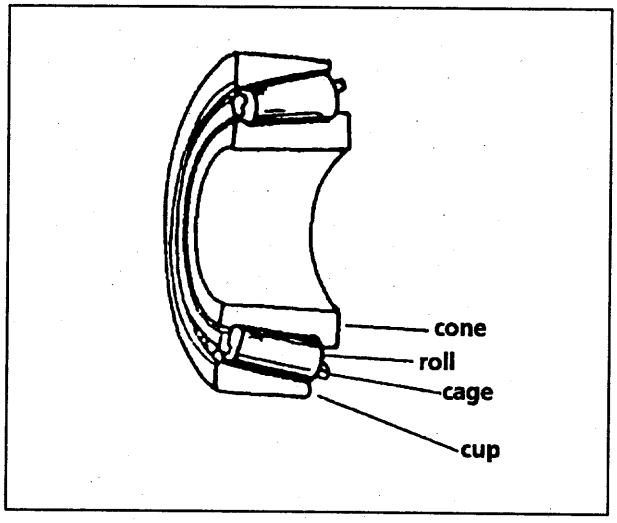


Figure 4.- Needle roller bearings

Figure 4 shows the third type of antifrictional bearing. It is a *needle bearing*. The rollers are long, thin, pointed cylinders. The outer part, which encloses the rollers, is called the *shell*.



8. Figure 5 illustrates the fourth type of antifrictional bearing. It is a *taper roller bearing*. It is similar to the simple roller bearing but the roller is tapered and is called a *roll*. The separator is called a cage. The inner rings is called the *cone* and the outer ring is called the *cup*. The taper roller bearing can be constructed so it will resist both radial and thrust loads at the same time.

UNIT SIX

BEARINGS

CLASSWORK ASSIGMENT : LESSON B

The following exercises should be completed in class with the instructor´s assistance:

1. Look at figure 1. Write your answers in the spaces provided.
   The shaft in figure 1 has an _____ pressure load.
   Axial pressure is called _____. Bearings that resist axial pressure or thrust are called _____ bearings.

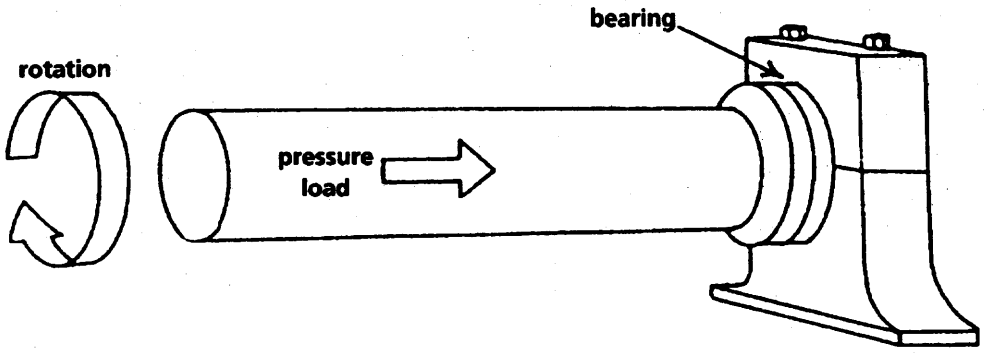


Figure 1

2. Figure 2 illustrates a type of anti-_____ bearing called a _____ bearing.
   a indicates the _____.
   b indicates the _____.
   c indicates the _____.
   d indicates the _____.
3. Figure 3 illustrates a type of _____ bearing called a _____ _____ bearing.
   a indicates the _____.
   b indicates the _____.
   c indicates the _____.
   d indicates the _____.

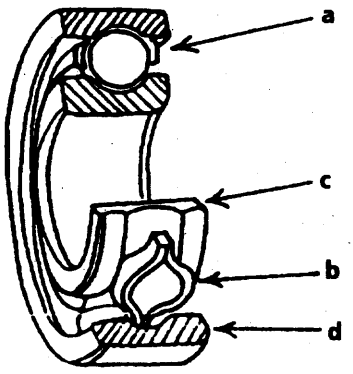


Figure 2

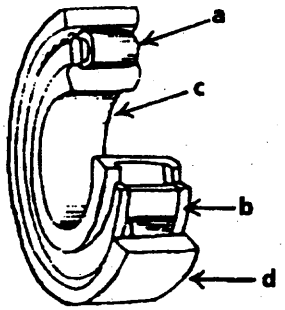
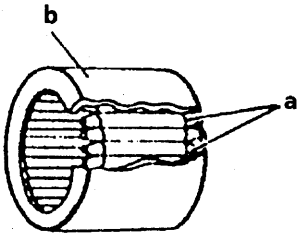


Figure 3

4. Figure 4 illustrates a type of antifrictional bearing called a _____ _____

   a indicates the _____.
   b indicates the _____.

5. Figure 5 illustrates a type of antifrictional bearing called a _____ _____ bearing. The construction is similar to the cylindrical roller bearing but the names of the parts are different.
   a indicates the _____.
   b indicates the _____.
   c indicates the _____.
   d indicates the _____.



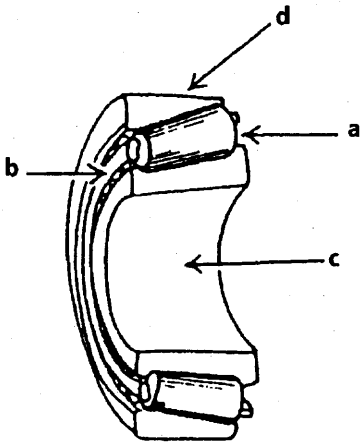


Figure 5

6. Antifrictional bearings have less _____ than _____ bearings. The friction from _____ contact is less than the friction from sliding _____. This reduces the _____ very much. If friction is reduced, the _____ and _____ caused by friction is also reduced.

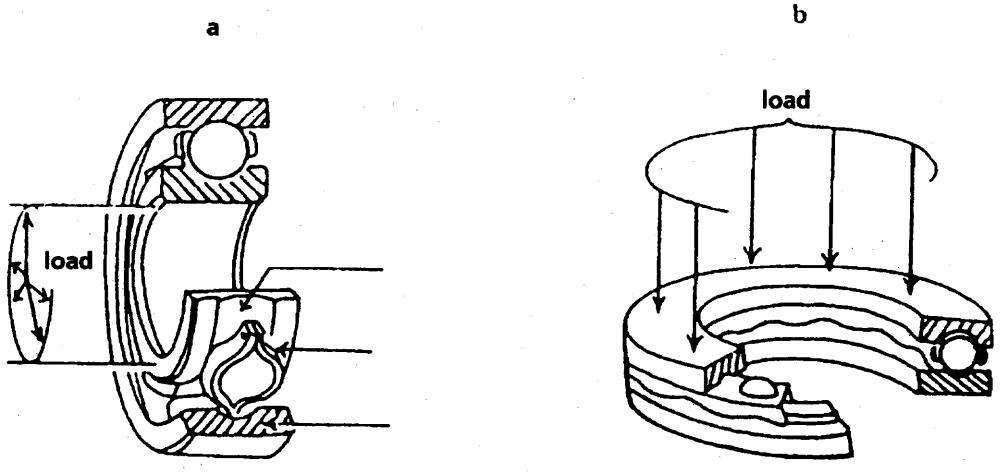


Figure 6

7. Look at figure 6. Write your answers in the spaces provided.

Bearing a is a _____ bearing used with _____ loads.
The pressure load is toward the _____ of the shaft.
Bearing b is a _____ bearing used with _____
loads. The pressure load is _____, or towards the length of the shaft. Axial pressure is also called _____.

UNIT SEVEN

GEARS

OBJECTIVES

1. Given a composite picture of a gear on a splined shaft and gear keyed to a shaft, the student will orally and/or in writing correctly identify each method of attachment.

2. Given a picture of pair of straight spur gears, a pair of helical spur gears and a pair of herringbone spur gears, the student will identify each.

3. Given a picture of a pair of plain bevel gears and a pair of miter gears, the student will correctly identify each.

4. Given the terms below, the student will orally and/or in writing state the meaning of each :

- splined shaft
- key
- keyed shaft
- key slot
- mesh
- leading edge
- trailing edge
- bevel gears
- miter gears
- pinion
- rack gear
- worm gear
- worm wheel

UNIT SEVEN

GEARS

LESSON A

1. ATTACHING GEARS TO SHAFT

Gears are simple machines. They are widely used in complex machines; probably more so than the other simple machines. The fact that they can transmit power from one rotating shaft so another shaft makes them extremely useful. Most complex machines utilize rotating shafts to increase or decrease speed or power as the rotation is transferred from the drive gear to the driven gear.

One of the most common methods of attaching a gear to a shaft is to use a *splined shaft.* A splined shaft has slots cut axially around the shaft. The teeth left between the slots are called *splines.* The splined shaft fits into the *splined center hole* of the gear. This arrangement provides a strong method of transmitting power from the shaft to the gear. See figure 1.

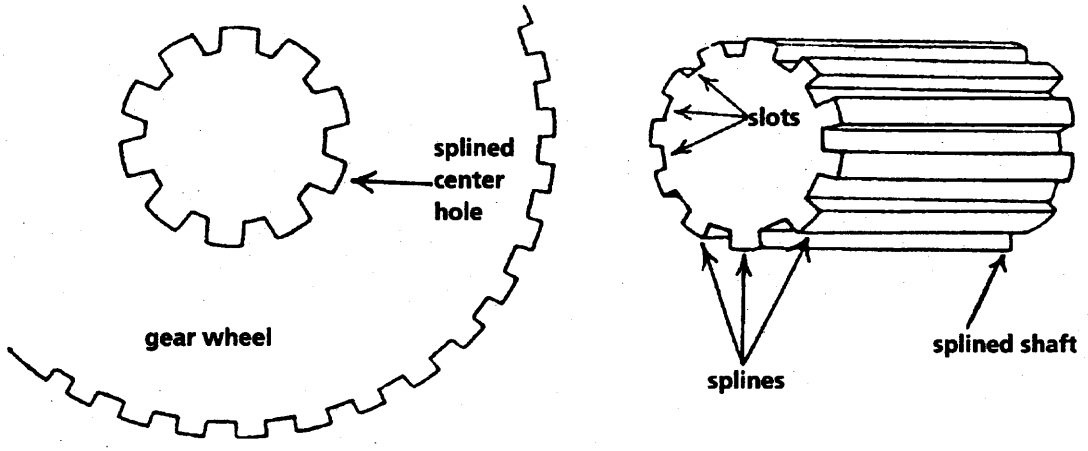


Figure 1.- Splined shaft and gear

A second common method of attaching gears to shafts is to use a *keyed shaft*. We learned about the use of keys, such as the Woodruff key and the square key, in the section on hand tools. Figure 2 illustrates the use of a Woodruff key. The key is placed in the slot on the shaft, and then the gear wheel is put on the shaft so the top of the key enters the slot in the center hole.

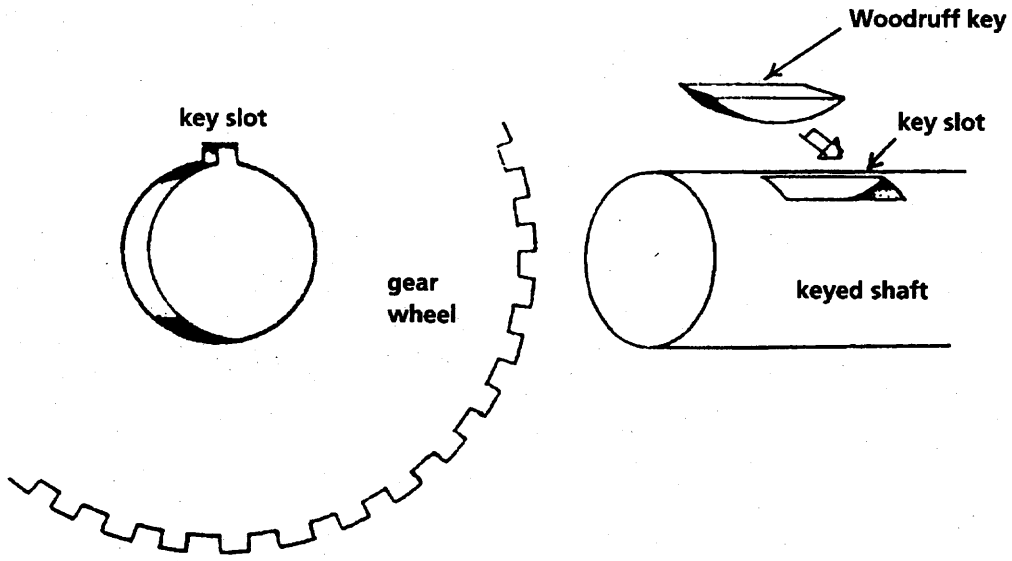


Figure 2.- Keyed shaft

2. SPUR GEARS

The simplest form of gears is the *spur gear*. Spur gears are used to transmit motion from one shaft to another, parallel, shaft. See figure 3.

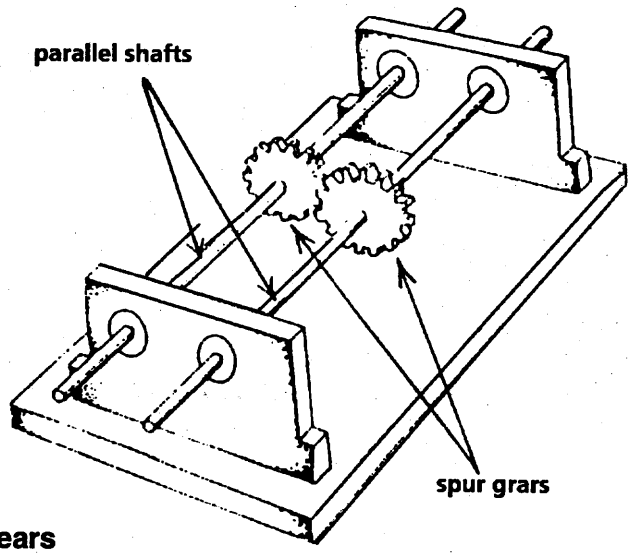


Figure 3.- Spur gears

The spur gears in the figure 3 are *straight spur gears*. They are called straight spur gears because the teeth that are cut into the gear are parallel to the axis of rotation. See figure 4.

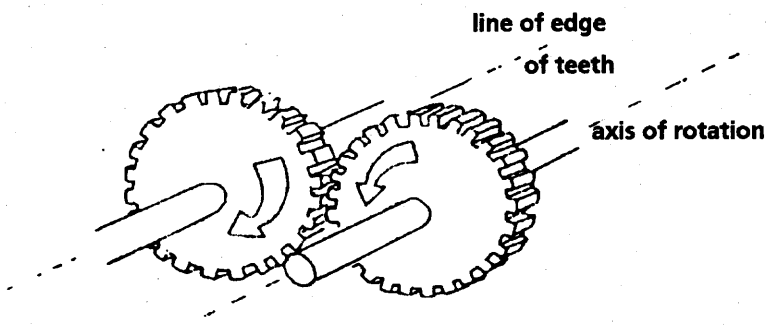


Figure 4.- Straight spur gears

Straight spur gears are somewhat noisy and do not run completely smoothly. This is because the teeth *mesh of engage* one by one without a smooth transition from one tooth to the next.

Helical spur gears are quiter and smoother. The teeth of helical spur gears are cut at a slant; not straight across the gear. One end of the tooth, the *leading edge*, engages the opposite tooth, then as the gear turns there is more contact until the teeth are fully engaged. As the gear continues to turn, the contac becomes less until the only contact is by the other end of the tooth, called the *trailing edge*. Just as the contact of the trailing edge is finished, the leading edge of the next tooth begins to engage. The gears are in contact mesh with a smooth transition from tooth to toth. See figure 5.

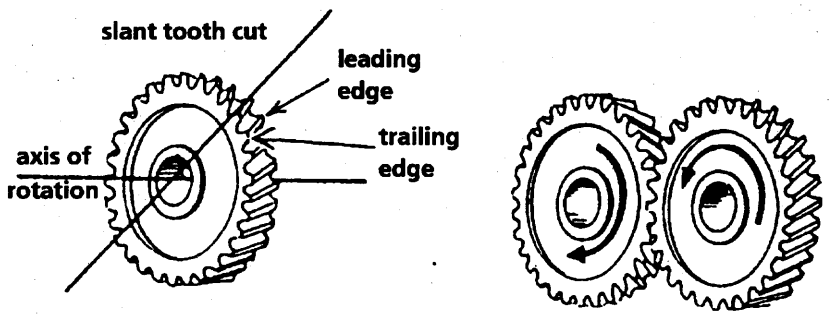


Figure 5.- Helical spur gears

While helical spur gears run quietly and smoothly, they do have one fault. They create thrust pressure on the shaft because some of the force on the slanted teeth is to the side. It is necessary to use thrust bearings at the end of the shaft.

The thrust caused by helical spur gears can be avoided by using *herringbone spur gears.* Herringbone geras have two opposing sets of helical teeth on each gear. The thrust from one set is opoosed by the thrust from the other set. Herringbone gears are mainly used in heavy equipment when large amounts of force must be transmitted by the gears.

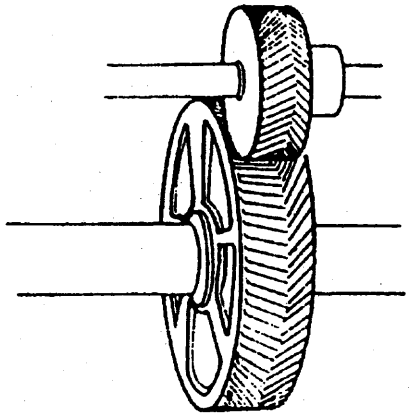


Figure 6.- Herringbone gear

UNIT SEVEN

GEARS

CLASSWORK ASSIGMENT : LESSON A

The following exercises should be completed in class with the instructor´s assistance:

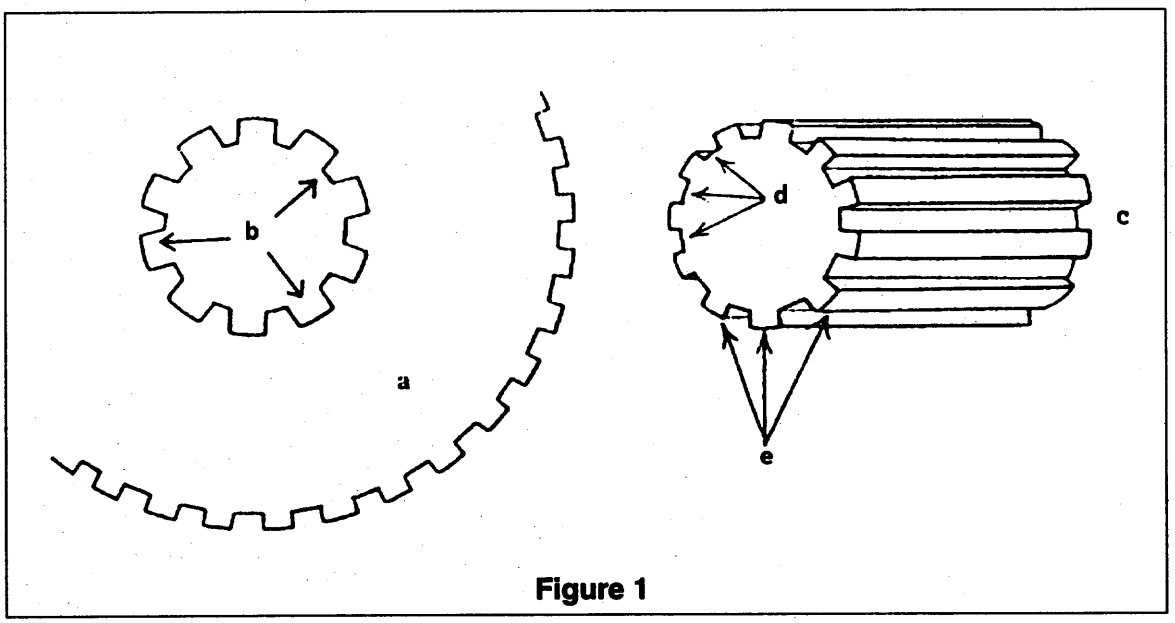


Figure 1

1. Look at figure 1. fill in the blanks below.

a indicates the _____ wheel.

b indicates the _____ center hole.

c indicates the _____.

d indicates the _____ cut into the shaft.

e indicates the teeth on the shaft; they are called _____.

The _____ shaft is one of the main ways of attaching a _____ to a shaft. The _____ on the shaft fit the _____ in the center _____ of the gear. This provides a strong method of transmitting _____ and rotation from the shaft to the gear.

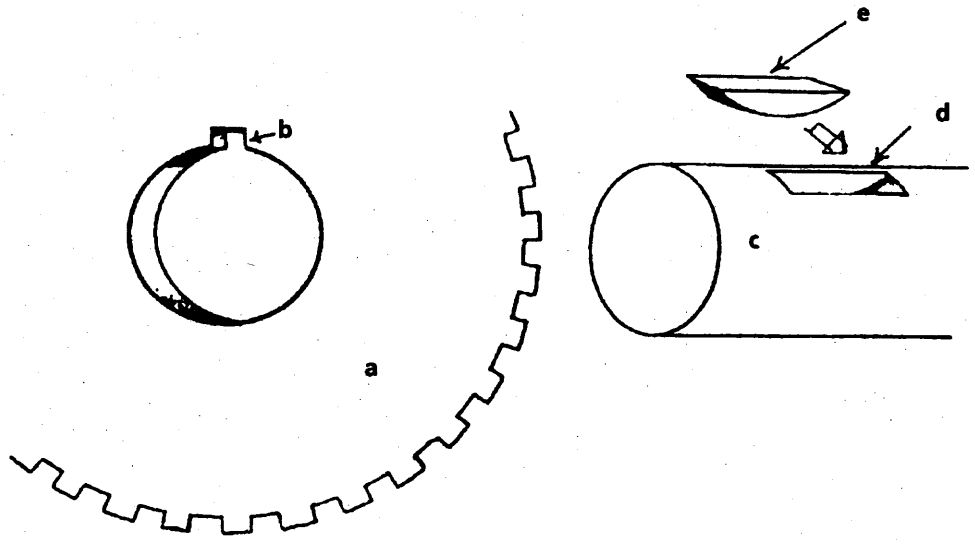


Figure 2

2. Look at figure 2. Fill in the blanks below.

a indicates the _____.

b indicates the _____ _____.

c indicates the _____.

d indicates the _____ _____ in the shaft.

e indicates the _____.

Another method of attaching a gear to a shaft is to use a _____. They key fits into a _____ in the shaft. The gear also has a _____. The gear is put on the _____ so that the key fits into the _____ in the gear. When the _____ rotates, the key transfers the power to the gear.

3. The gears shown in figure 3 are _____ _____ gears, we know they are spur _____ because the _____ are parallel. They are called straight spur gears because the _____ are cut _____ to the shaft.

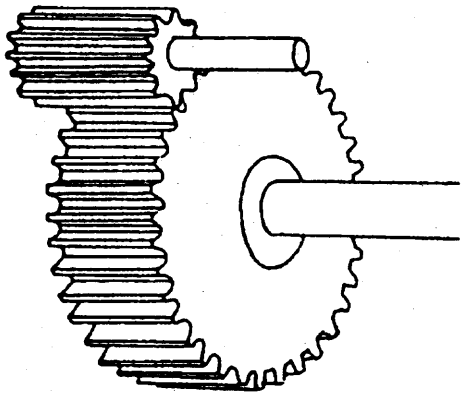


Figure 3

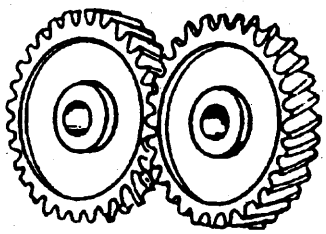


Figure 4.

4. The gears shown in figure 4 are _____ spur gears. The teeth are cut at a _____. The front edge that engages first is called the _____ edge. The opposite edge is called the _____ edge. Helical gears run quietly, but they create axial pressure, or _____. The shaft need _____ bearings to resist the thrust.

5. The gears shown in figure 5 are _____ gears. They have two sets of _____ teeth. The thrust from one set of teeth is opposed by the _____ from the other set of _____. Herringbone gears are often used when large amounts of _____ must be transmitted by gears.

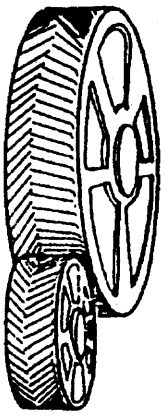


Figure 5

UNIT SEVEN

GEARS

LESSON B

1. BEVEL GEARS

Spur gears are used to transmit motion between parallel shafts. Bevel gears are used to transmit motion between shafts that are not parallel. When the angle between the two shafts is 90* and the gears are beveled or cut at 45*, they are called miter gears. See figure 1.

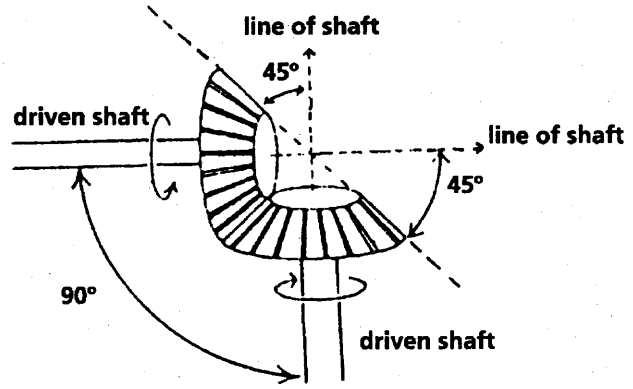


Figure 1.- Miter gears

Bevel gears used when the angle between the shafts is more or less than 90° are called *plain bevel gears*. See figure 2.

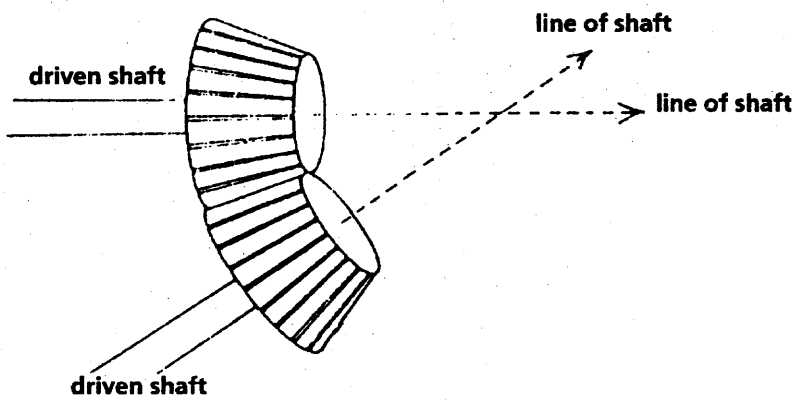


Figure 2.- Plain bevel gears

Bevel gears teeth can be cut at a slant to form *helical* or *spiral bevel gears*. See figure 3.

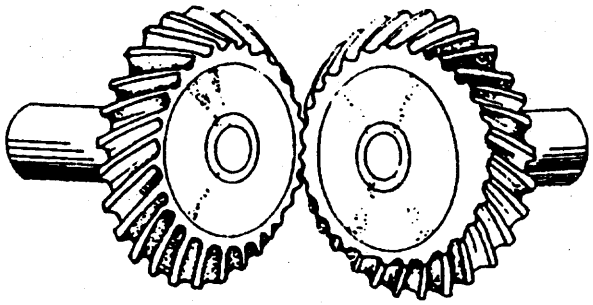


Figure 3.- Spiral bevel gears.

2. PINION GEARS

When a small gear engages a large gear, the small gear is called a *pinion*. Figure 6 from lesson A, shows two *external* (teeth on the outside) herringbone gears. The small one is the pinion. Figure 4 shows a pinion engaging an *internal* (teeth on the inside) gear. In this case, the inside gear or pinion has external teeth that engage the internal teeth of the large gear.

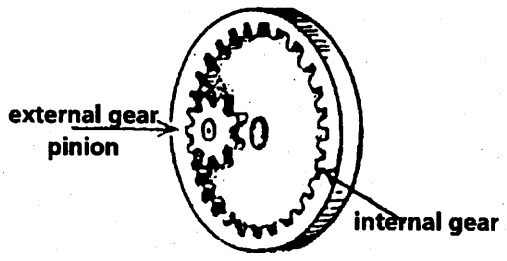


Figure 4

3. SPECIAL GEAR COMBINATIONS

Pinions are also used with *sector gears*. A sector gear is a partial gear that is used to control short movements. See figure 5.

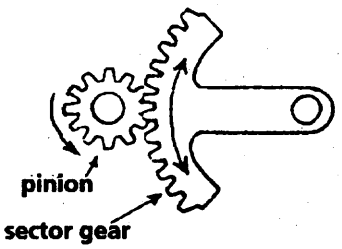


Figure 5

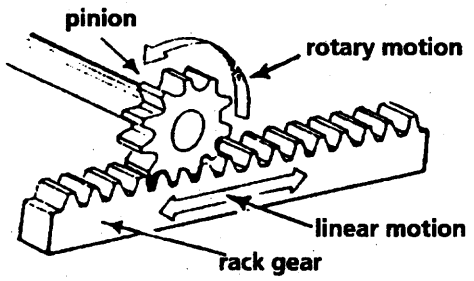


Figure 6

Figure 6 shows a *rack and pinion* gear system. The rack is a flat piece with teeth. The *rack gear* converts the rotary motion of the pinion gear to linear or reciprocal movement.

4. WORM AND WORM WHEEL (WORM GEAR)

A *worn wheel* is a toothed wheel that is turned by the thread on a shaft called a *worn*. It is also called a *worn gear*. The worm gear is a combination of a screw and a spur gear. See figure 13 and 14. The mechanical advantage of a worm gear is very high.

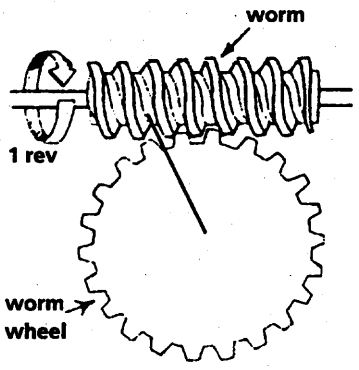


Figure 7

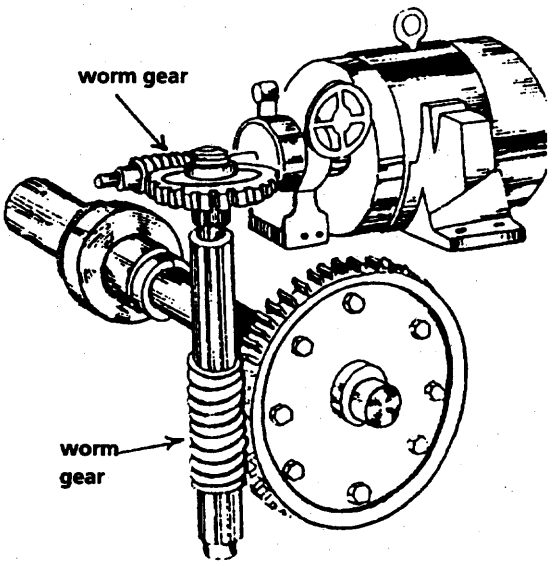


Figure 8

UNIT SEVEN

GEARS

CLASSWORK ASSIGMENT : LESSON B

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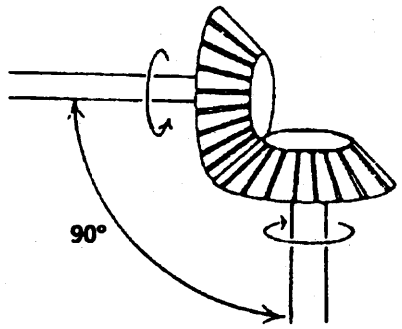


Figure 1

1. The gears shown in figure 1 are _____ gears. They are a type of bevel gear. Miter gears are used when the shafts are at _____ degree angle.

2. The gears shown in figure 2 are _____ bevel gears. They are used to transfer power between non-parallel shaft.

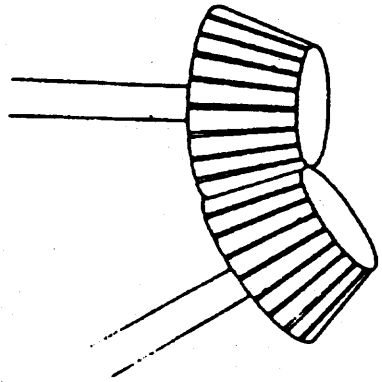


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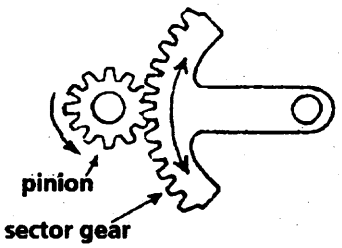


Figure 5

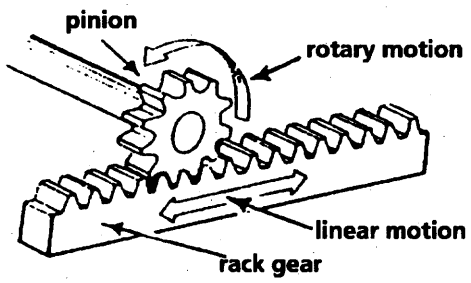


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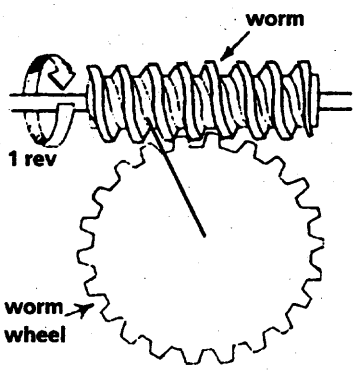


Figure 7

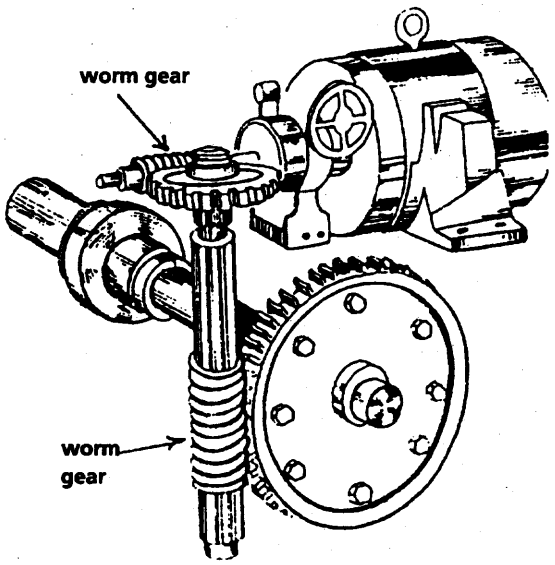


Figure 8

UNIT SEVEN

GEARS

CLASSWORK ASSIGMENT : LESSON B

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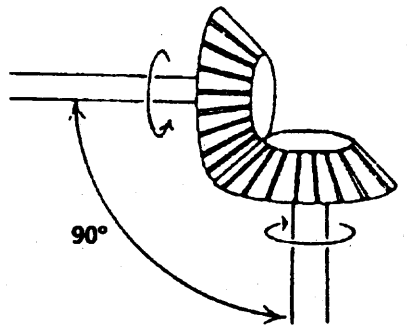


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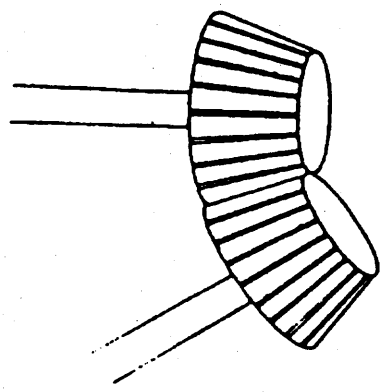


Figure 2

3. The gears shown in figure 3 are _____ or spiral bevel gears. The gears shown in figure 1 and 2 are _____ bevel gears.

4. Figure 4 shows the two kinds of gears. Gear a has teeth on the outside; it is an _____ gear. Gear b has teeth on the inside; it is an _____ gear.

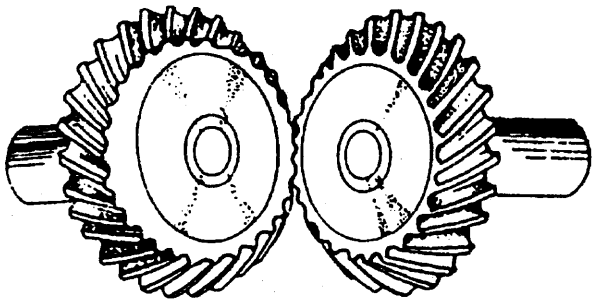


Figure 3

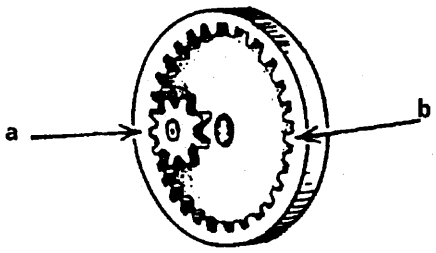


Figure 4

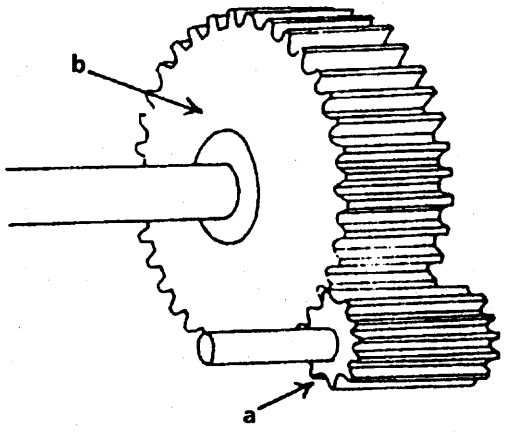


Figure 5

5. The two gears in figure 5 are not the _____ size. When two meshed gears are not the same size, the small gear is called a _____. Gear _____ is the pinion. In figure 4, the gear is smaller; it is the _____.

6. Figure 6 shows the use of a pinion to move a _____ gear. A sector gear is used when the movement is _____.

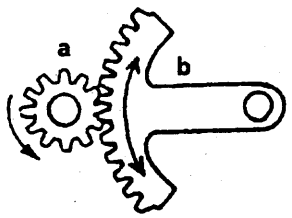


Figure 6

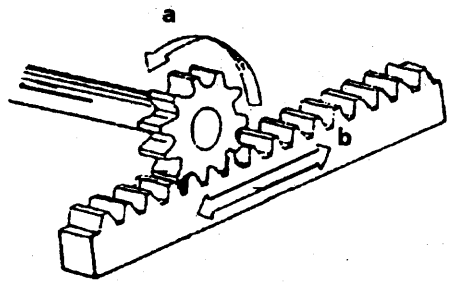


Figure 7

7. The unit shown in figure 7 is a _____ and _____. It is used to change the _____ movement of the pinion to a _____ or reciprocal movement. a indicates the _____, b indicates the _____.

8. The unit shown in figure 13 is a _____ wheel or _____ gear. It is a combination of a _____ and a _____.

a indicates the _____ gear.

b indicates the _____ screw.

A worn gear has a very _____ mechanical advantage.

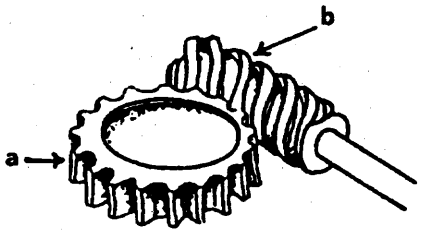


Figure 8

UNIT EIGHT

SPRINGS

OBJECTIVES

1. Given a picture of an elliptic leaf spring, a half-elliptic leaf spring, and special flat spring, the student will orally and/or in writing identify each by name.

2. Given a picture of a spiral flat spring and a volute spring, the student will orally and/or in writing identify each by name.

3. Given a picture of a helical compression spring and helical tension (extension) spring, the student will identify each by name.

4. Given a picture of a helical cone spring, a double cone spring and a keg spring, the student will orally and/or in writing identify each by name.

5. Given a picture of a helical torsion spring and a torsion bar unit, the student will identify each by name.

6. Given the following terms, the student will orally and/or in writing correctly state the meaning of each:

- wind / wound
- unwind / unwound
- coil
- buckling
- tension
- extension
- cone
- keg

UNIT EIGHT

SPRINGS

LESSON A

1. FLAT SPRINGS

Springs perform many functions in complex machines. If you are familiar with the different types of springs, you will usually know what function a spring is peforming.

Figure 1 shows an *elliptic* or *flat spring* unit. This type unit is frequently used on heavy trucks. It is composed of curved flat fieces of steel or other metal. The pieces are called *leaves.*

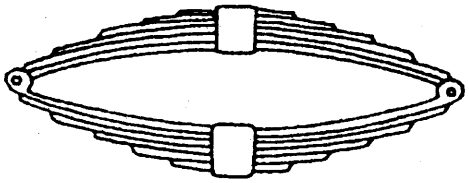


Figure 1.- Elliptic leaf spring

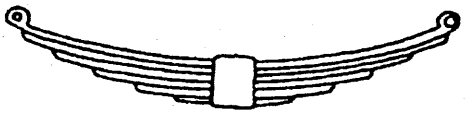


Figure 2.- Half-elliptic leaf spring

Figure 2 shows a *half-elliptic* leaf spring. It is used where it is not necessary to use the elliptic spring. It is frequently used in light trucks and automobiles. The elliptic and half-elliptic leaf springs are put between the axles and the frame of a vehicle so that vibrations and impacts are not transferred from the wheels to the frame of the vehicle. See figure 3.

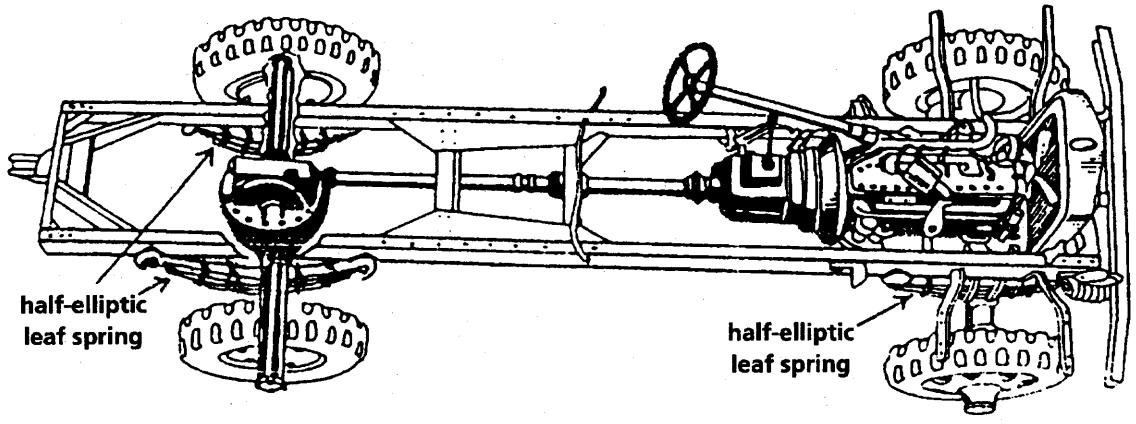


Figure 3.- Use of half-elliptic leaf springs

Flat pieces of metal are formed in various other shapes to act as springs. They are called special *flat springs*. See figure 4.

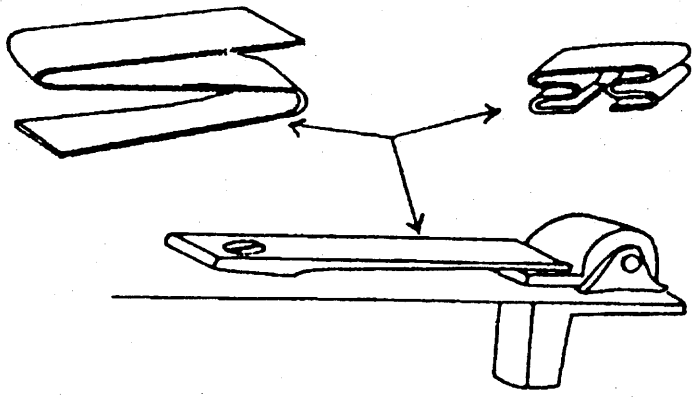
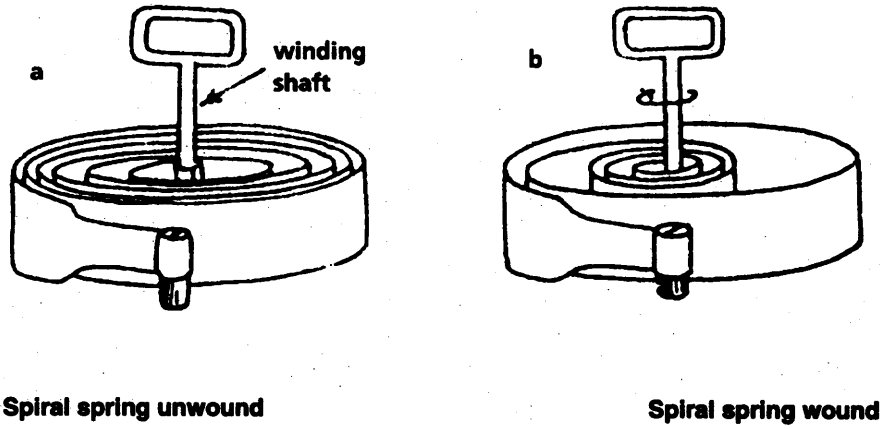


Figure 4.- Special flat springs

2. SPIRAL SPRINGS

Spiral springs are formed in horizontal circles. See figure 5. They are also called *clock springs* or *power springs* because originally they were used to provide the power to operate clocks and watches. The spring shown in figure 5a is *unwound*; that is the spirals are open and large. When you wind the spring, or when it is *wound up*, the inner spirals are close and small as in figure 5b. The spring provides power when it unwinds to form open and large spirals.



Spiral spring unwound

Spiral spring wound

Figure 7.- Spiral (clock or power) spring

UNIT EIGHT

SPRINGS

CLASSWORK ASSIGMENT : LESSON A

The following exercises should be completed in class with the instructor´s assitance :

1. Look at figure 1. Fill in the blanks below.

Figure 1a shows an _____ spring. It is composed of _____ pieces of steel or other metal called _____. Figure 1b shows a _____ _____ spring. Ellictic leaf spring are often used in _____ and light trucks. Figure 1c is a _____ _____ spring.

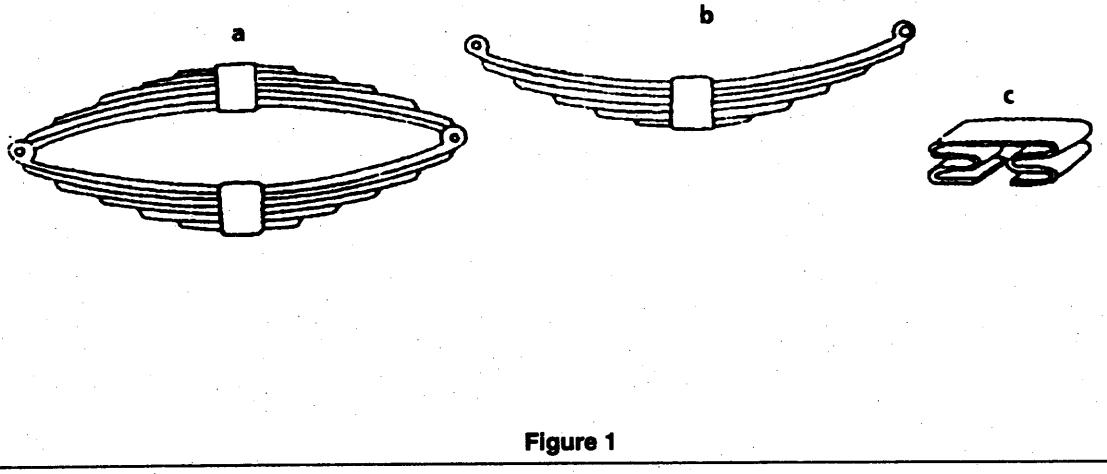


Figure 1

2. Look at figure 2. Fill in the blanks below.

Figure 2a shows a _____ spring; it is also called a clock _____ or a _____ spring. The spring shown can be _____ by turning the winding _____. Right now it is _____; the coils are open and _____. When it is wound, the coils are _____ and tight. Figure 2b shows a _____ spring. It is a type of _____ spring. It is very strong and resists bending or _____ sideways.

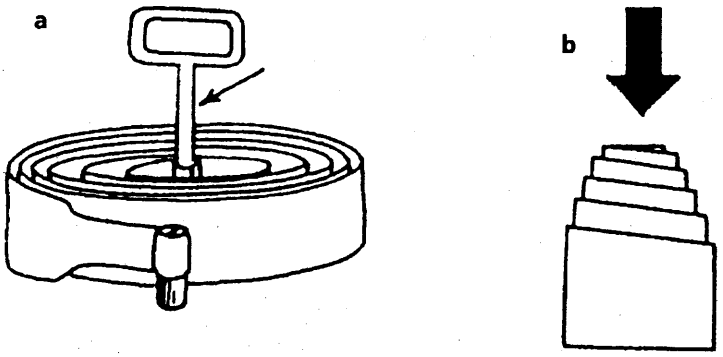


Figure 2

UNIT EIGHT

SPRINGS

LESSON B

1. HELICAL (COIL) SPRINGS

Helical or coil springs are formed in vertical circles. They are usually made of round spring wire; but one type, the *volute spring* shown in figure 1a, is made of flat metal. The volute spring is strong and resists bending or *buckling* to the sides. Volute springs are usually used to resist *compression* forces. See figure 1b.

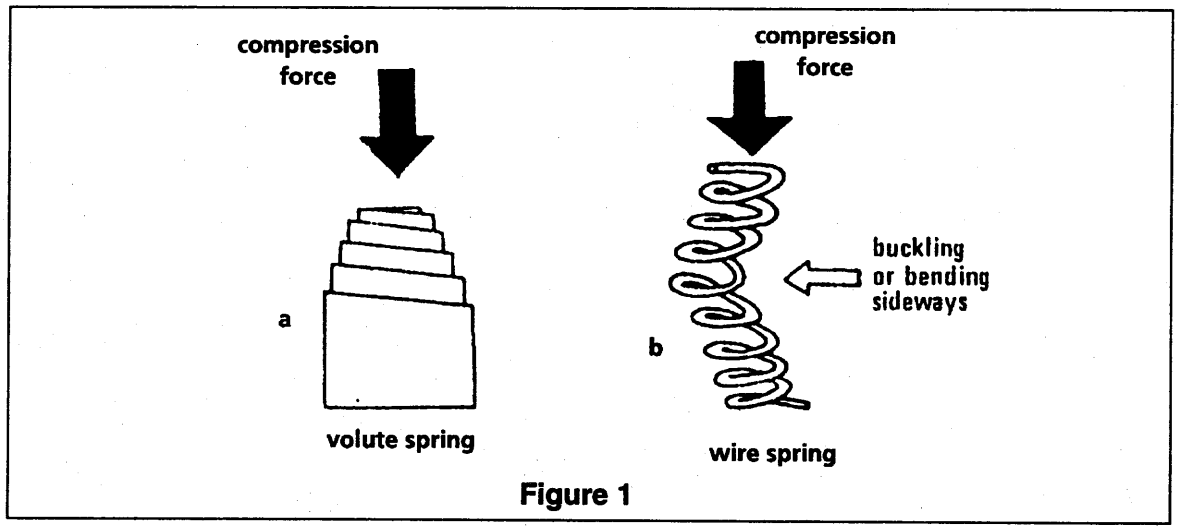


Figure 1

Compression springs are used to hold pieces apart ; they resist forces that would shorten the lenght of the spring. The coils are separated by spaces. *Tension* or *extension* springs are used to hold pieces together ; they resist forces that would lengthen the spring. The coils are wound close to each other. See figure 2a and 2b.

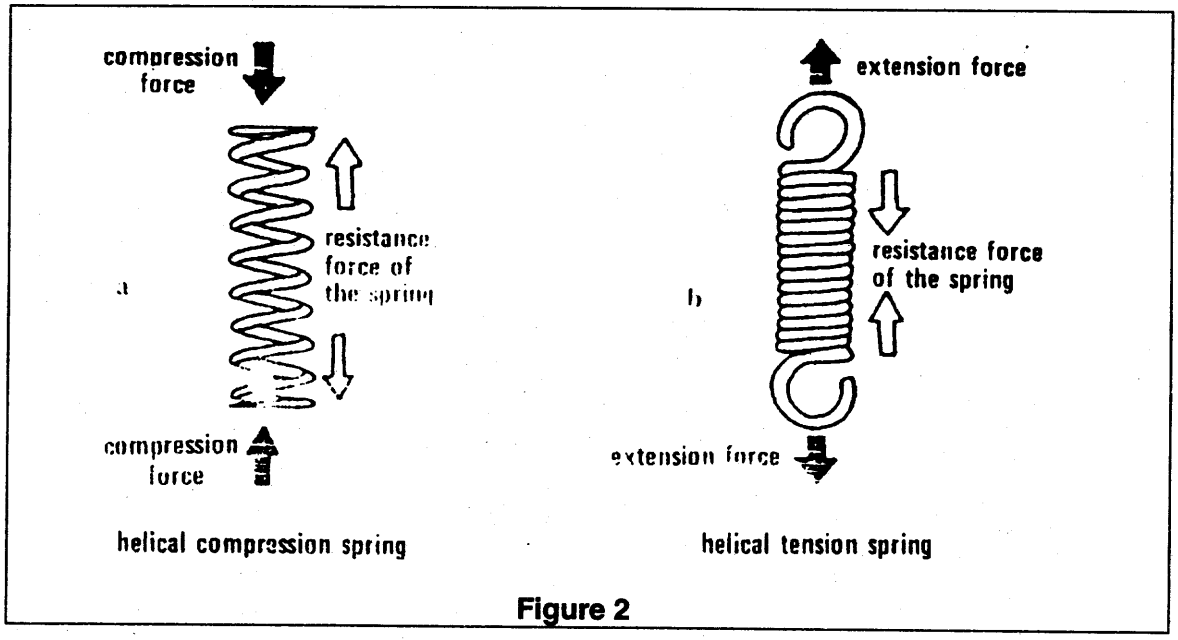


Figure 2

The helical springs shown in figure 2 have a cylindrical shape. Other helical springs have special shapes. Figure 3 shows the *cone* or *valve spring,* the *double cone* spring, and the *keg* spring. The double cone spring consists of two cones joined at the small ends, the keg spring consist of two cones joined at the large ends. The springs shown are compression springs.

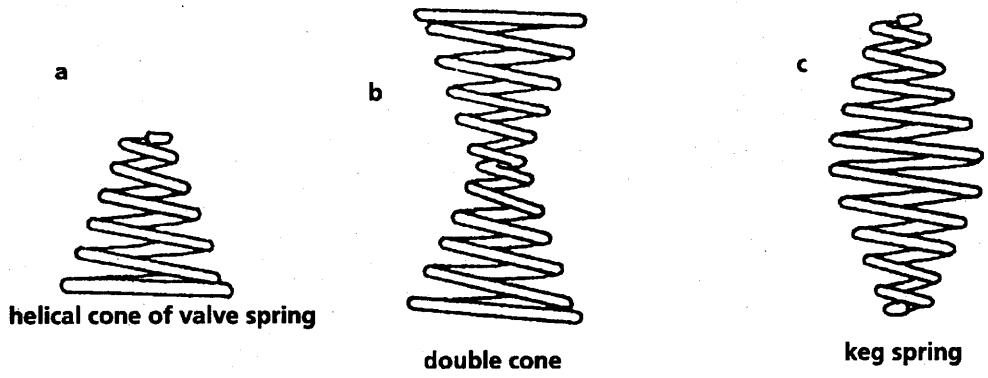


Figure 3

Figure 4 shows a helical coil *torsion spring.* Torsion springs resist twisting or turning force. A compression spring resists being shortened and a tension spring resists being lengthened. A torsion spring resists being coiled or wound tighter. It is often used to close doors or to hold the

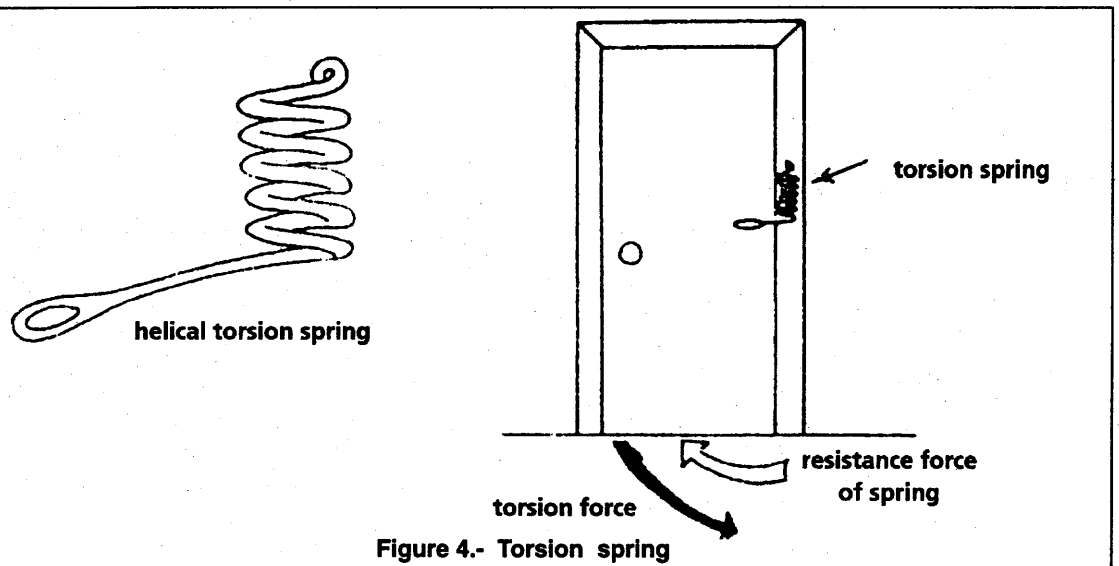


Figure 4.- Torsion spring

Figure 5 shows a *torsion bar*, it is a type of flat spring that resists being twisted or turned. Torsion bars are often used on automobiles in place of leaf springs. Normally one end of the bar is fixed in place so it can not turn, and the other end of the bar is attached to the part that creates torque or turning force.

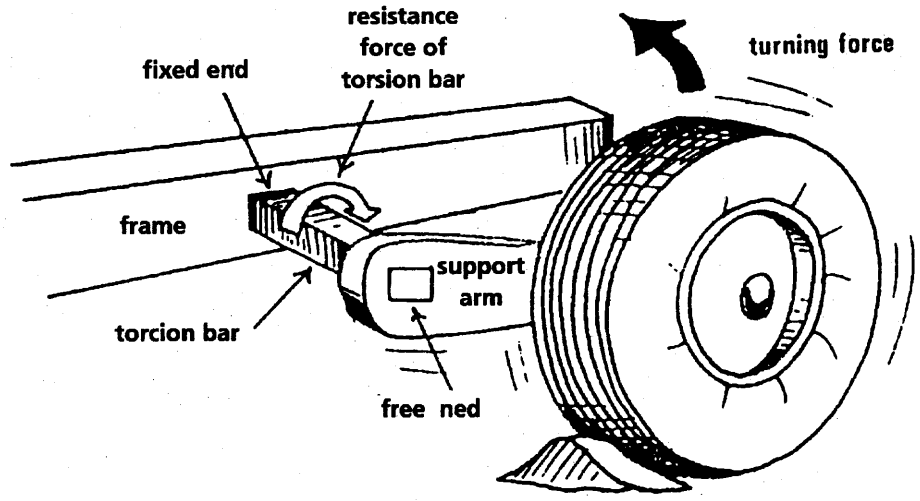


Figure 5.- Torsion bar

In figure 5, one end of the torsion bar is fixed in the frame of the vehicles so it can not rotate. The free end of the torsion bar passes through the support arm. The axle and wheel are attached to the support arm. When the wheel hits an object it begins to lift. This lifting causes the free end of the torsion bar to twist. The bar resists the turning force and limits the lifting movement.

UNIT EIGHT

SPRINGS

CLASSWORK ASSIGMENT : LESSON B

The following exercises should be completed in class with the instructor´s assistance:

1. Look at figure 1. Fill in the blanks below.

   The springs in figure 1 are _____ springs. Helical springs are also called _____ springs. The springs in figure 1a is a helical _____ spring. The coils are spread _____. The black arrows indicate _____ force. The compression force will _____ the length of the spring.

   The spring shown in 1b is a _____ spring.

   Extension springs are also called _____ spring.

   The coils are _____ together. The black arrows indicate the _____ force. The extension force will take the spring _____.

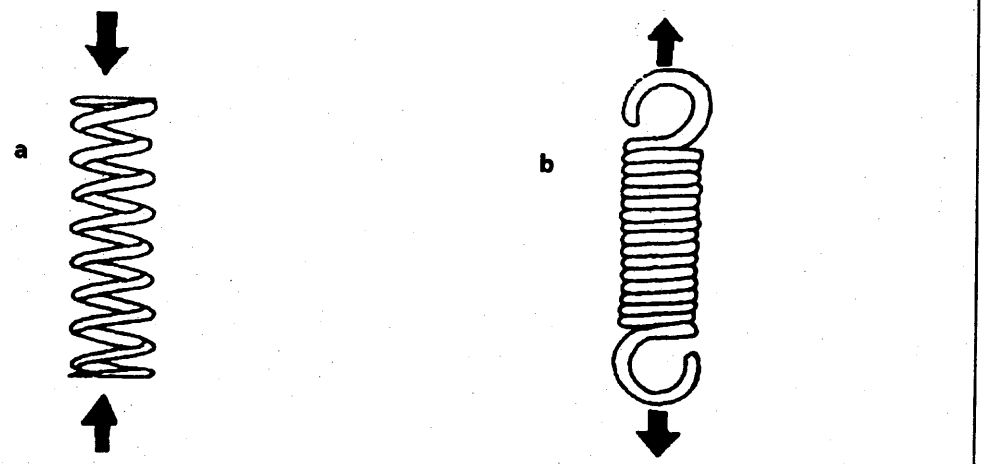


Figure 1

2. Look at figure 2. Fill in the blanks below.

The springs shown in figure 2 are all _____ springs.

The coils are spread _____.

Spring a is a _____ spring. It is also called a _____ spring.

Spring b is a _____ _____ spring.

Spring c is a _____ _____ spring.

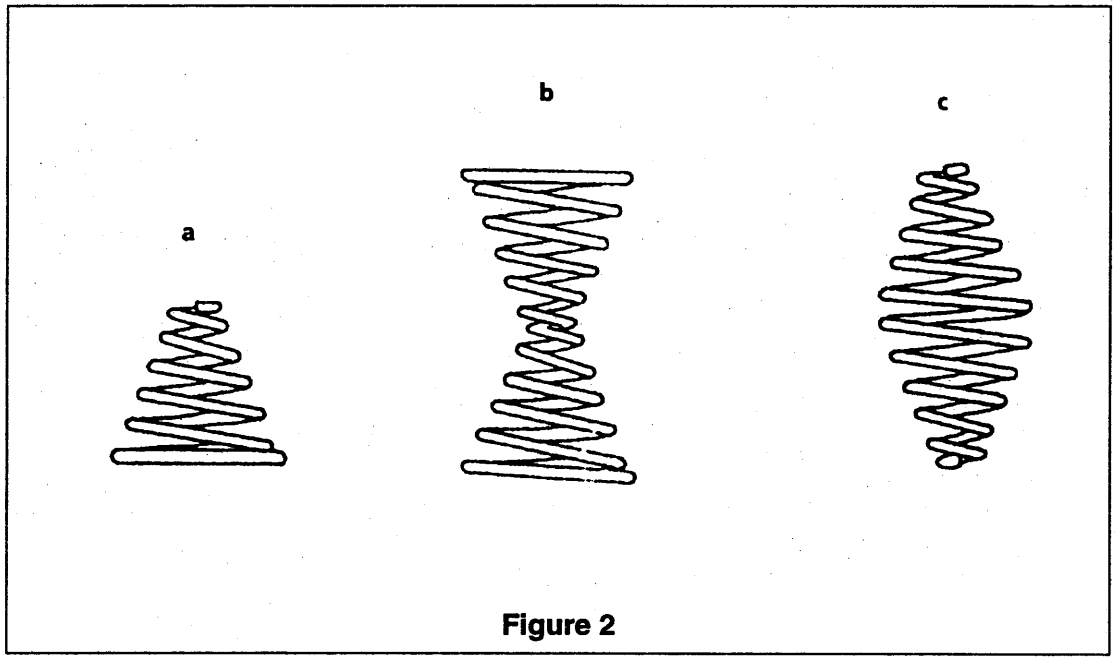


Figure 2

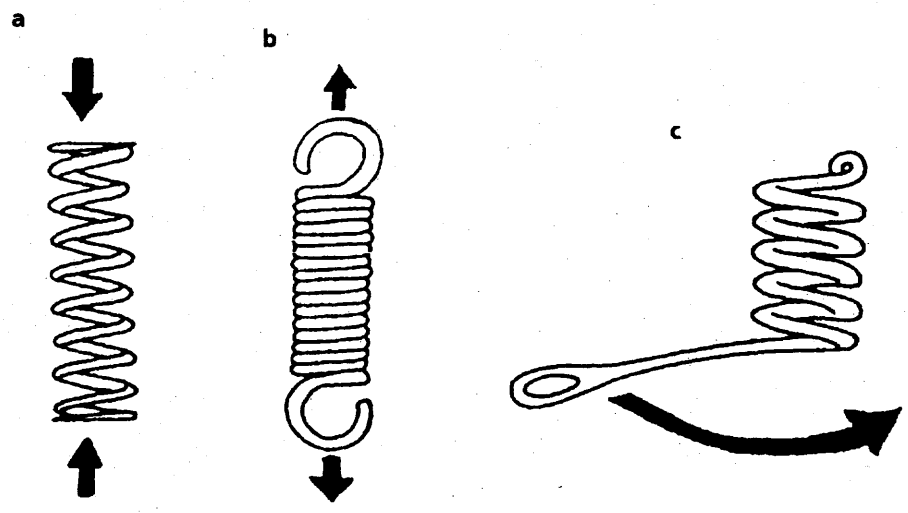


Figure 3

3. Look at figure 3. Fill in the blanks below.

Spring a is a _____ spring. The black arrows show the _____ forces.

Spring b is a _____ spring. The black arrows show the _____ forces.

The forceson spring a and spring b act in a straight line. The force acting on spring c is a _____ force ; it done not act in a straight line.

Turning force is called _____. Spring c is a _____ spring. The turning force makes the _____ smaller and tighter.

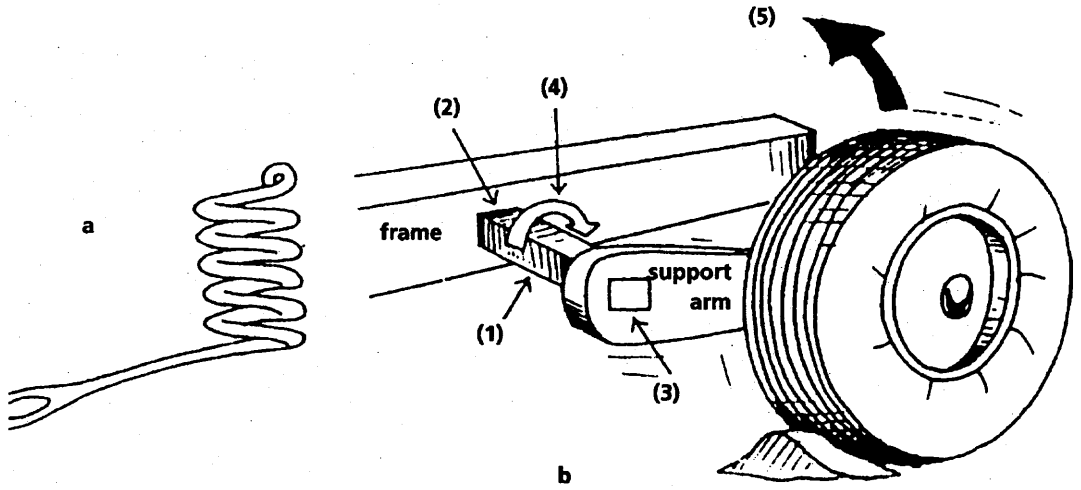


Figure 4

7. Look at figure 4. Fill in the blanks below.

Figure 4a shows a _____ springs.

Figure 4b shows a _____ bar unit.

(1) indicates the _____ _____

(2) indicates the _____ end. (It is not free to rotate).

(3) indicates the _____ end. (It will turn with the support arm).

(4) indicates the _____ of the torsion bar to the turning force.

(5) indicates the _____ force that is caused by the wheel rising.

UNIT NINE

POWER SYSTEMS

OBJECTIVES

1. Given a picture of an electric motor and a picture of a cylinder with a piston and shaft, the student will orally and/or in writing correctly identify that the electric motor provides power by a rotating shaft and the cylinder piston unit power by a reciprocating shaft.

2. Given a picture of a cylinder piston unit with the fuel air mixture burning inside the cylinder and a picture of a cylinder piston unit with a fuel air mixture burning outside the cylinder, the student will orally and/or in writing correctly identify the former as an internal combustion system and the latter as an external combustion system.

3. Given a picture of simplified turbine wheel and shaft, the student will orally and/or in writing identify the following components:
   - wheel
   - shaft
   - vanes
   - blades

UNIT NINE

POWER SYSTEMS

LESSON A

1. POWER SYSTEMS, GENERAL

You have studied the basic simple machines in the examples, the power or effort was provided by the man who operated the machine. These are known as *man-powered* or, if we include the use of animals, *muscle-powered* machines. However, in the modern technical world, simple, man-powered machines are rare. Various simple machines are combined to form complex machines which are powered by different kinds of mechanical and electrical devices. We will study these *motors* and *engines* in detail later, but now we will just consider them as sources of power that are used to operate complex machines. These *power systems* provide the input effort to the complex machines.

The power unit of a complex machine will usually provide power in the form of a *rotating shaft* or a *reciprocating shaft*. Figure 1 shows a typical electric motor as an example of a power unit that provides power in the form of a rotating shaft.

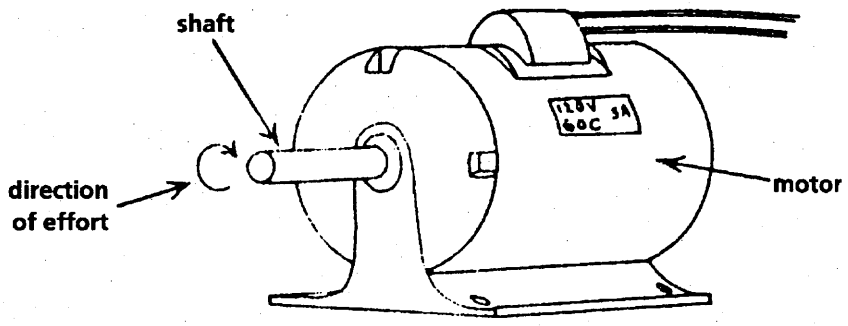


Figure 1.- Electric motor - rotating shaft

Power systems that provide power in the form of a reciprocating shaft are usually some type of *piston engine*. They are called piston engines because they have *pistons* that move in and out in a *cylinder*. When a piston moves out a certain distance as one movement, and then moves in the same distance as the next movement, we say the movements are reciprocating ; an engine based on this system is called a *reciprocating engine*. See figure 2.

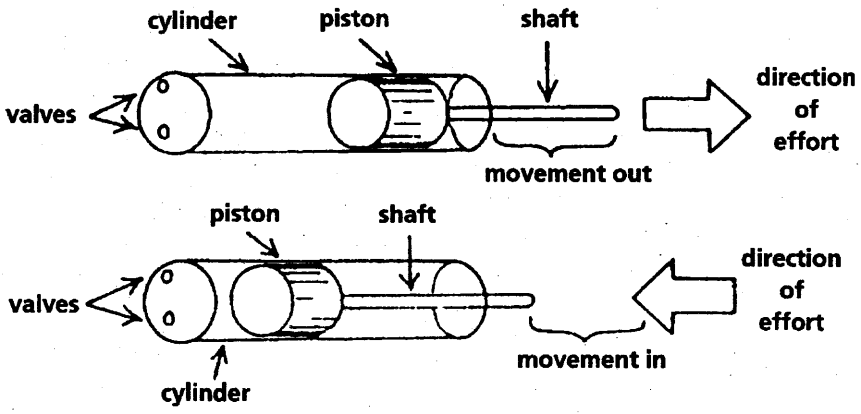


Figure 2.- Reciprocating movement

2. COMBUSTION TYPE POWER SYSTEMS

Power systems are separated into two basic types ; those that burn *fuel*, suchs as wood, coal, gasoline, etc., to provide power or energy, and those that use other methods to provide energy. Systems that burn fuel are called *combustion* systems. The gasoline motor in an automobile os a combustion engine ; it provides power by burning gasoline as a fuel. The electric motor pictured in figure 1 is not a combustion system, it uses electric current to provide power.

Combustion-type power systems burn fuel and oxygen to provide heat. The heat produced by the combustion is used to cause the expansion of gases. The force of the expanding gas is used to provide the power produced by the system. Most typical combustion system engines use heat-expanded gases to provide power.

Combustion system engines are either *internal combustion* engines or *external combustion* engines. When the fuel-air mixture is burned in a chamber, and the expansion of the burning gases is used to provide force or power, the engine is called an internal combustion (inside-burning) engine. See figure 3.

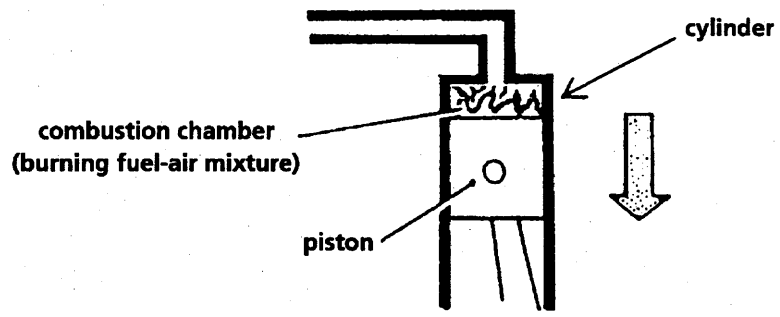


Figure 3.- Internal combustion engine

When the heat of a burning fuel-air mixture outside of a chamber is used to expand gases in a chamber, so that the expanding gases can be used to provide force or power, the engine is called an external combustion engine. See figure 4.

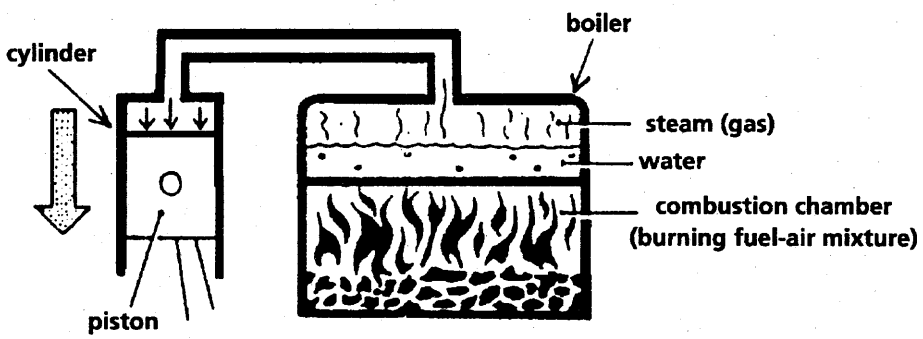


Figure 4.- External combustion engine

Most of the engines that you are familiar with, such as the engines in cars and trucks, are internal combustion reciprocal piston engines that burn a liquid (gasoline, diesel oil) fuel mixed with air. However, combustion engines are not limited to the reciprocating piston type, nor are they limited to burning liquid fuel. Many external combustion engines use solid fuel such as wood or coal, and many internal and external combustion engines use the force of the heated expanding gases to turn *turbines* rather than push pistons.

UNIT NINE

POWER SYSTEMS

CLASSWORK ASSIGMENT : LESSON A

The following exercises should be completed in class with the instructor´s assistance:

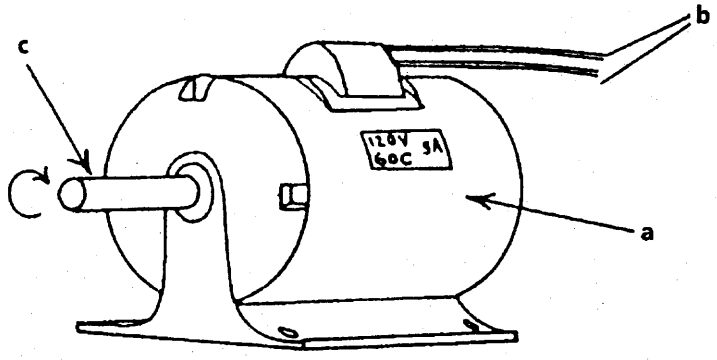


Figure 1

1. Look at figure 1. Write your answers in the spaces provided.

   Figure 1 shows an _____ motor. The letter a indicates the _____, b indicates the _____ that carry electric _____ to the motor. The letters c indicates the _____. The _____ motor provides power in the form of a _____ shaft. The electric motor does not burn a _____-air mixture. It is not a _____ engine.

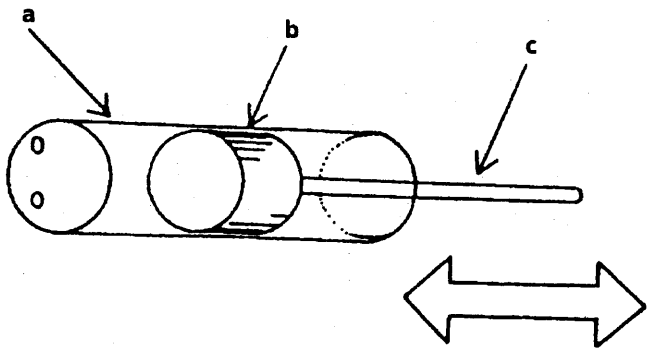


Figure 2

2. Look at figure 2. Write your answers in the spaces provided.

Figure 2 shows a _____-piston unit.

a indicates the _____.

b indicates the _____.

c indicates the _____.

The _____ can move _____ or _____ of the cylinder. We say it _____.

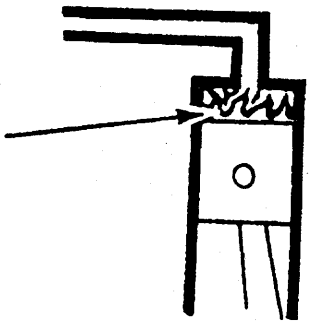


Figure 3

3. Write your answers in the spaces provided.

Figure 3 shows a cylinder- _____ unit. The arrow indicates a fuel-_____ mixture that is burning. When gases are heated, they _____. The burning _____ are expanding.

When the gases expand, the pressure inside the cylinder _____.
The expanding _____ push against the cylinder _____
and piston _____. This system shows _____
combustion. The gases are burning _____ the cylinder.

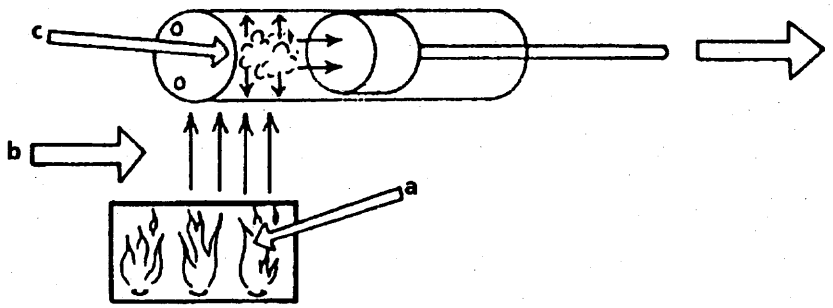


Figure 4

4. Write your answers in the spaces provided.

Figure 4 shows an _____ combustion system. a indicates the _____ unit. The _____ indicated by b, is used to cause the gases in the cylinder-piston _____, c, to expand. The gases in the cylinder push against the cylinder _____ and the piston _____. The _____ gases push the piston _____ of the cylinder.

UNIT NINE

POWER SYSTEMS

LESSON B

1. TURBINES

A turbines is a wheel-shapened disc that is placed so that when a liquid or gas pushes aginst *vanes* or *blades* on the *turbine*, the force will cause the turbine and shaft to rotate. See figure 1.

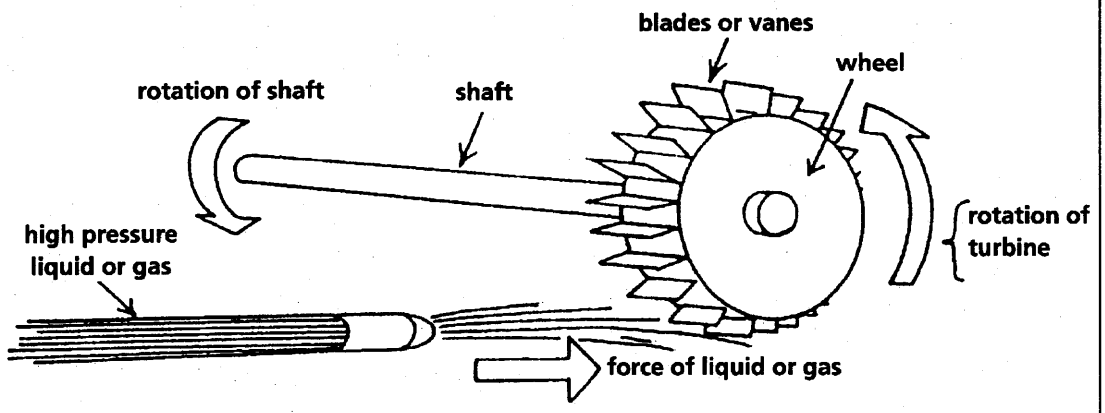


Figure 1.- Turbine

Turbines are used with several different types of power systems. They are often used in connection with water power to generate electricity. The force of the water is used to turn the turbines. They are often called *hydro-turbines* or *hydraulic turbines*. Electric systems that use them are called hydro-electric systems.

Steam turbines are often part of large external combustion engines that use the heat of the combustion to change water to steam, which is used to turn the turbine. Still other turbines, called *gas turbines*, are used in internal combustion engines. In these engines, the fuel-air mixture is burned in a chamber and the expansion of the burning gases is used to turn the turbine. See figure 2 and 3.

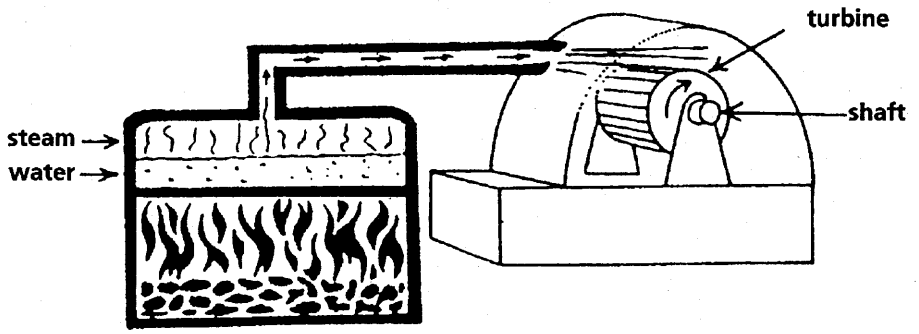


Figure 2.- Simplified external combustion steam turbine engine

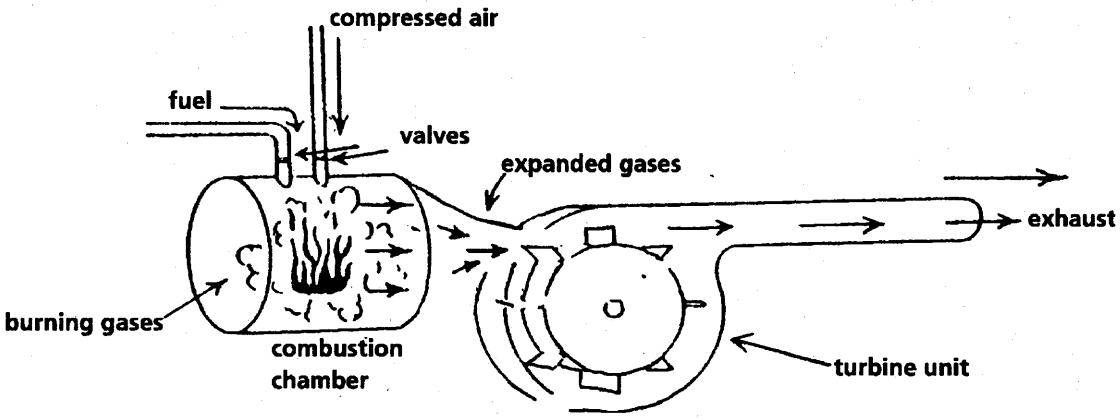


Figure 3.- Simplified internal combustion gas turbine engine

UNIT NINE

POWER SYSTEMS

CLASSWORK ASSIGMENT : LESSON B

The following exercises should be completed in class with the instructor´s assistance:

1. Look at figure 1. Write your answers in the spaces provided.

Figure 1 shows a simple _____ system.

a indicates the _____.

b indicates the _____ or _____.

c indicates the _____.

d indicates the a high-pressure water _____.

The high-pressure water comes out of the line and hits the _____ or _____ on the turbine _____. The force of the _____ pushes against the blades or _____. This force causes the _____ wheel to turn. As the wheel _____, additional _____ or blades are pushed by the force of the _____. When the _____ wheel turns, it causes the _____ to turn also. This type of turbine is called a _____-turbine or _____ turbine, because it uses the power of _____ to turn the wheel.

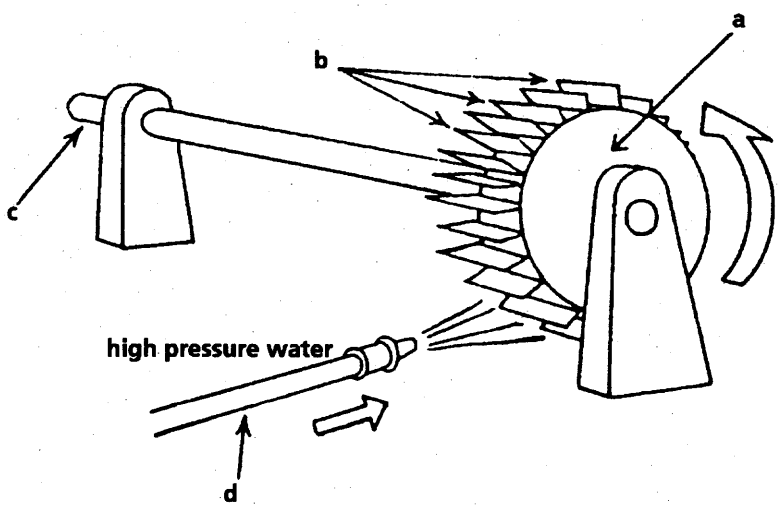


Figure 1

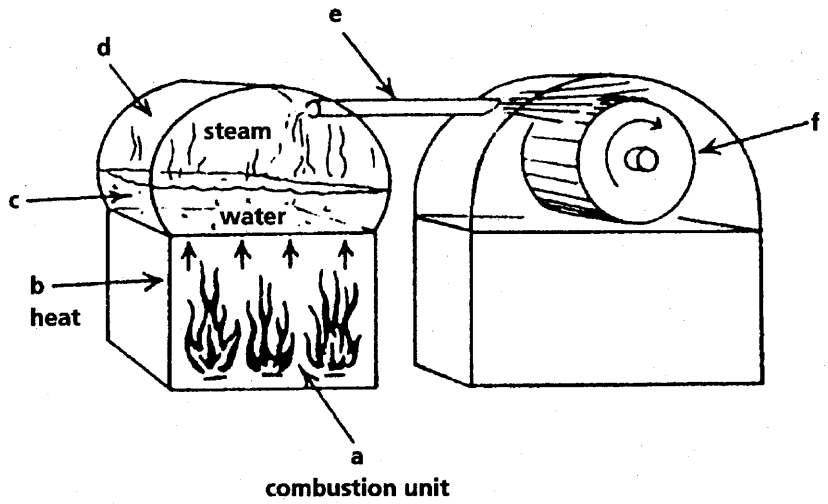


Figure 2

2. Write your answers in the spaces provided.

Figure 2 shows an _____ combustion system. The expansion of a heated _____ is used to turn a _____. This particular system is called a _____ turbine, because the gas that turns the turbine is steam. When water is _____ to 212°F. It changes to _____ ; this steam, which is a type of _____, expands when it is heated. The force of the gas is used to turn the _____. The combustion unit is outside, it is an _____ combustion _____ turbine engine.

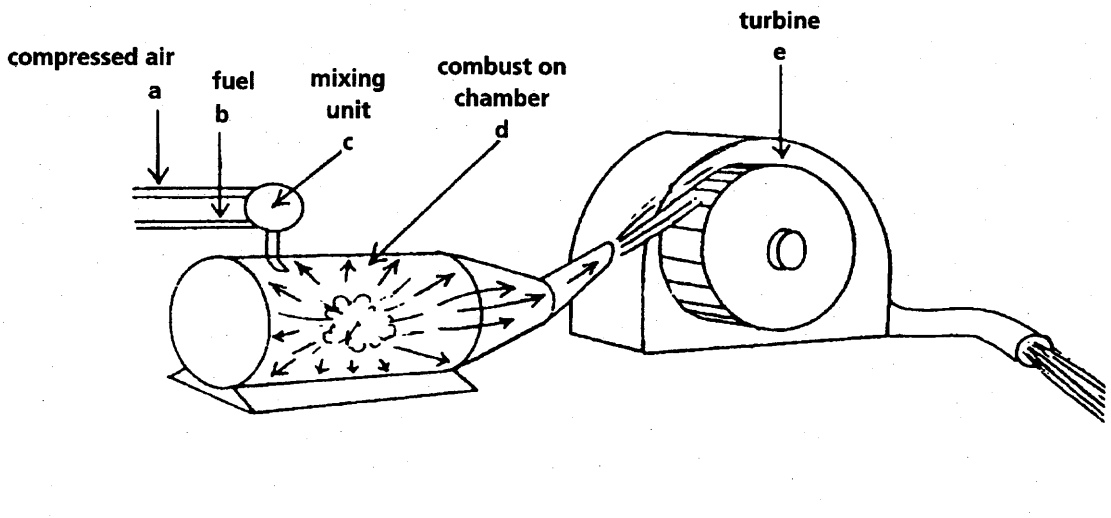


Figure 3

3. Write your answers in the spaces provided.

Figure 3 shows an _____ combustion system. The force of the expanding burning _____ is used to turn a _____. This is called a _____ turbine. It is an internal _____, gas _____ engine.

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