SEA TERM 2016
FOURTH CLASS CADET
MARINE ENGINEERING LAB
PROGRAM

MASSACHUSETTS MARITIME ACADEMY
BUZZARDS BAY, MASSACHUSETTS

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Engineering Sea Term Coordinator

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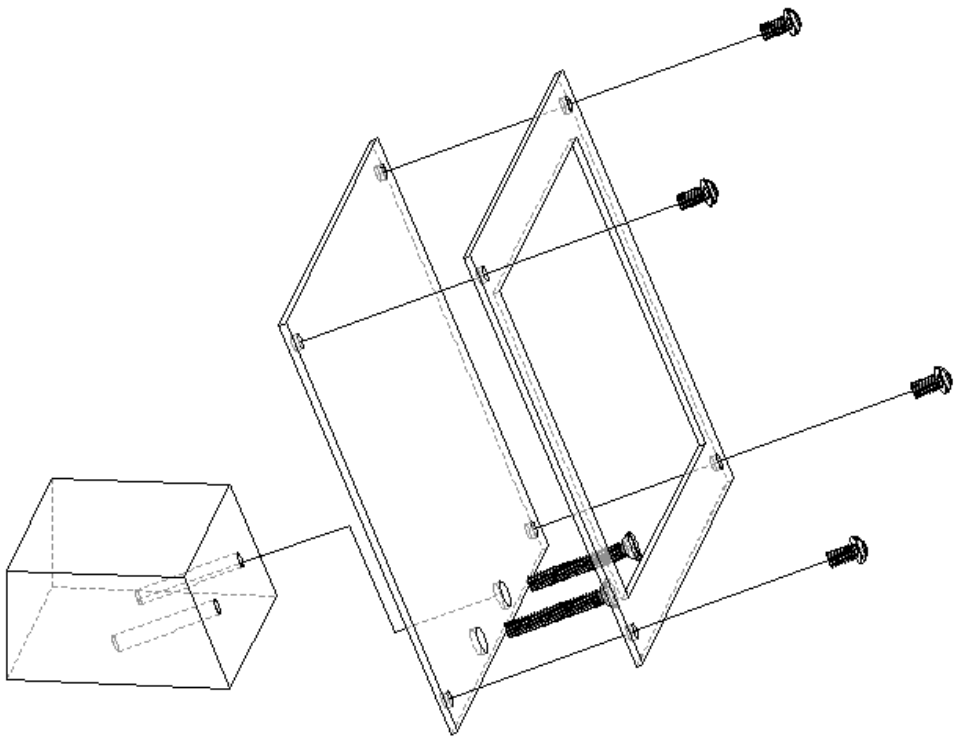
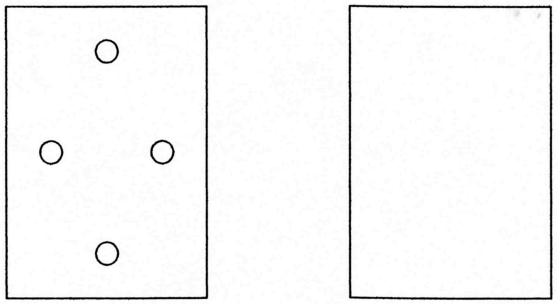
Lab #1 - Metal Work & Picture Frame Project



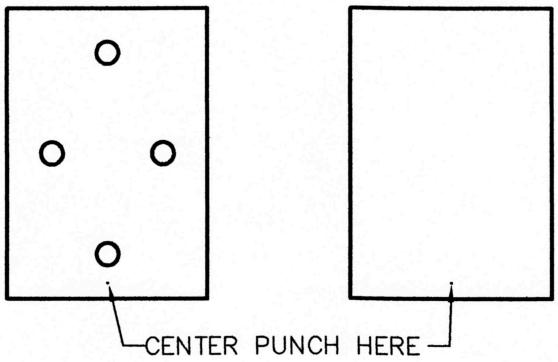
1. OBTAIN STOCK FROM INSTRUCTOR.



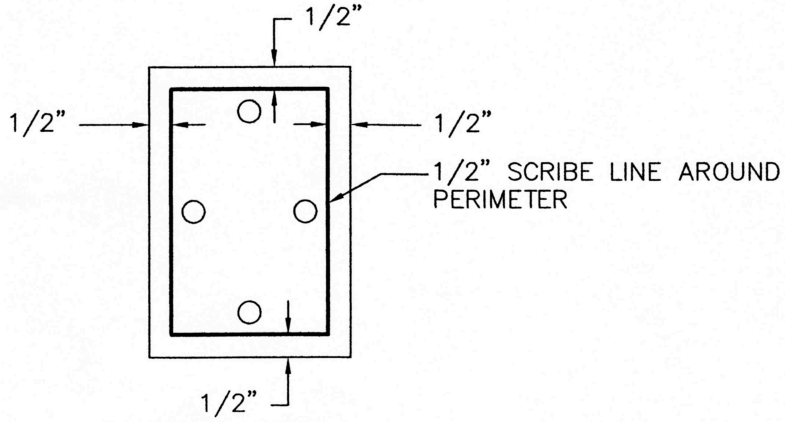
FRONT PLATE BACK PLATE

2. SPRAY ONE SIDE OF BOTH FLAT PLATES WITH LAYOUT DYE.

3. ON THE BACK OF BOTH PLATES CENTER PUNCH A "WITNESS MARK" IN THE MIDDLE OF THE BOTTOM EDGE OF BOTH PLATES. (THE SIDE WITHOUT THE DYE)

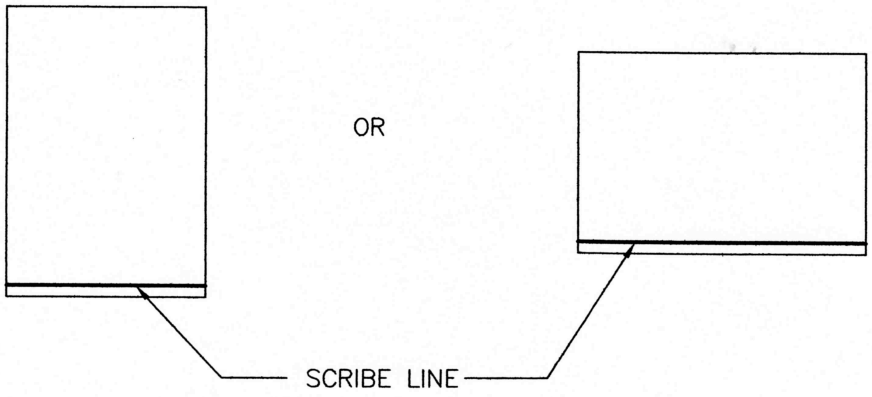


4. ON THE BOTTOM OF THE FRONT PLATE SCRIBE A 1/2" LAYOUT LINE AROUND THE PERIMETER.



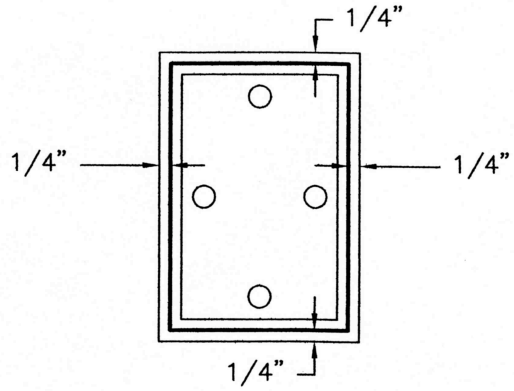
FRONT PLATE

5. ON THE BOTTOM OF THE BACK PLATE SCRIBE A 1/4" LAYOUT LINE.



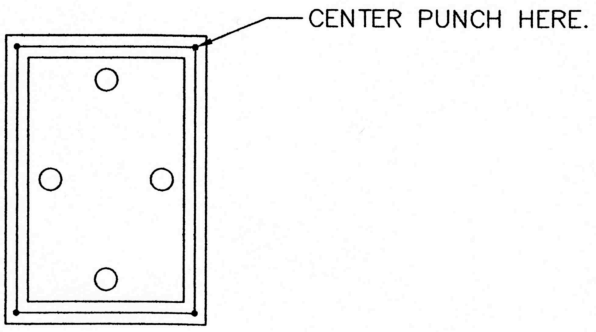
BACK PLATE

6. ON THE FRONT PLATE SCRIBE A 1/4" LAYOUT LINE AROUND THE PERIMETER.



FRONT PLATE

7. AT EACH CORNER CENTER PUNCH A MARK AT THE INTERSECTION OF THE 1/4" SCRIBE LINES.



FRONT PLATE

8. SELECT THE CORRECT SIZE DRILL FOR A 10–24 TAP AND INSTALL IN DRILL PRESS CHUCK.

9. ON THE DRILL PRESS SELECT THE CORRECT SPEED OF THE DRILL BY ADJUSTING THE POSITION OF THE BELT.

   USE THE FOLLOWING FORMULA FOR SPEED: $\frac{(CS \times 4)}{D}$

   CS – FOR STEEL STOCK WILL USING A HIGH SPEED DRILL WILL BE 100.

   D – DIAMETER

10. ALIGN AND SANDWICH BOTH PLATES AND SECURE TO DRILL PRESS USING VICE GRIP CLAMPS. (BE SURE TO ALIGN THE DRILL WITH THE HOLE IN THE TABLE) DO NOT DRILL INTO THE TABLE.

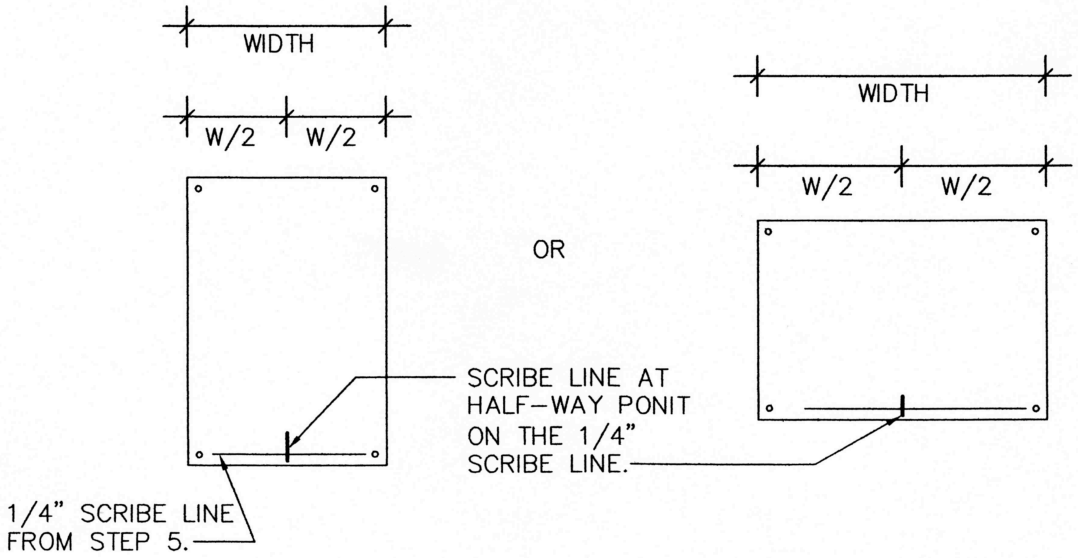
11. DRILL ONE HOLE AT THE CENTER PUNCH MARK IN ONE CORNER OF THE PLATE.

12. USING A SPARE DRILL BIT OF THE SAME SIZE, ALIGN THE PLATES AND DRILL THE REMAINING THREE CORNER HOLES.

13. REMOVE DRILL FROM CHUCK AND REPLACE WITH A 3/16" DRILL BIT.

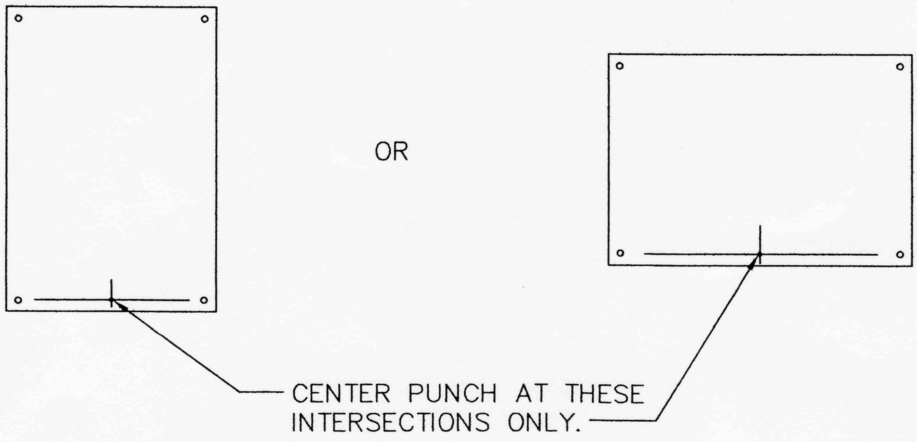
14. ALIGN CORNER HOLES WITH 3/16" DRILL BIT AND ENLARGE DRILLED CORNER HOLES ON THE FRONT PLATE ONLY.
    (CHECK TO MAKE SURE THAT THE DRILL BIT DOES NOT DEFLECT WHEN ENTERING PREVIOUSLY DRILLED HOLES.

15. SCRIBE A LINE ON THE BACK PLATE AT ONE HALF OF THE DISTANCE OF THE PLATE WIDTH.



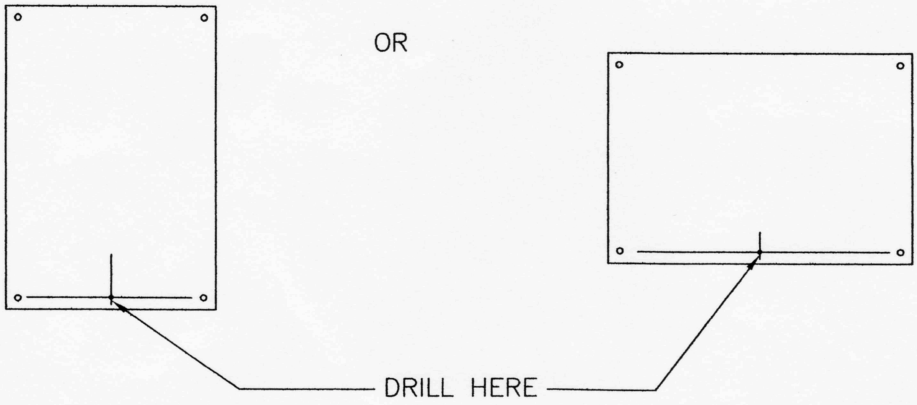
BACK PLATE

16. CENTER PUNCH A MARK IN THE MIDDLE OF THE 1/4" LAYOUT LINE.



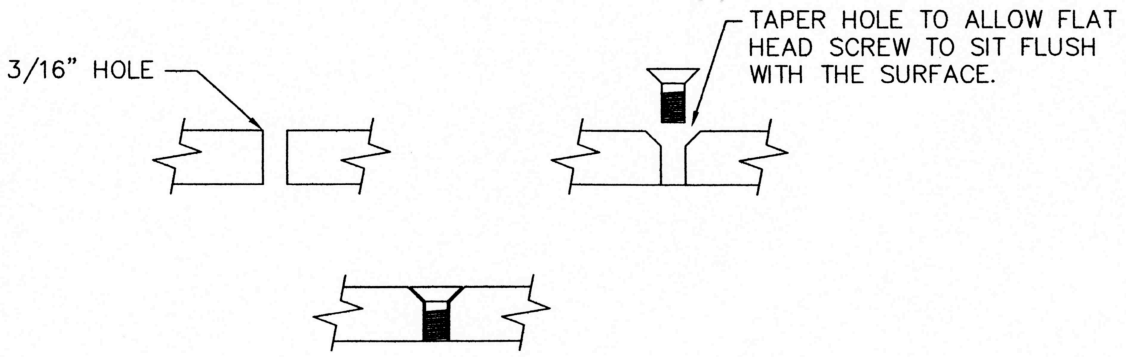
BACK PLATE

17. DRILL A 3/16" HOLE AT THIS CENTER PUNCHED MARKS.

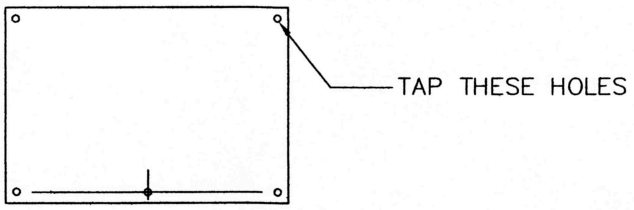


BACK PLATE

18. COUNTER SINK THE HOLE FOR A 10–24 FLAT HEAD SCREW.

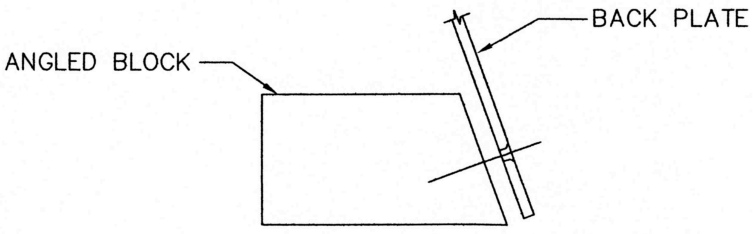


19. TAP ALL FOUR HOLES IN THE BACK PLATE WITH A 10–24 TAPER TAP.



BACK PLATE

20. SET THE ANGLED BLOCK AND BACK PLATE ON THE TABLE. CENTER THE BACK PLATE UP AGAINST THE ANGLED BLOCK AND CENTER PUNCH THROUGH THE COUNTERSUNK HOLE.

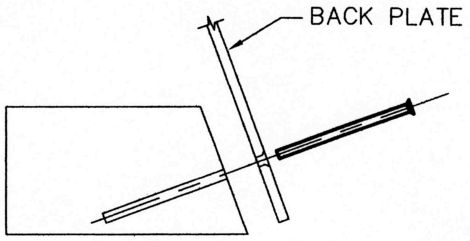


ANGLED BLOCK AND BACK PLATE

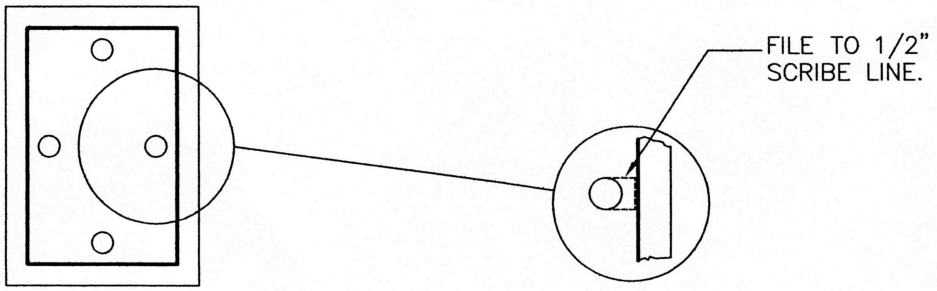
21. TAKE THE ANGLED BLOCK TO THE DRILL PRESS WITH TABLE ANGLED TO 20 DEGREES AND DRILL A HOLE FOR A 10–24 TAP TO A DEPTH OF 1" AT CENTER PUNCHED MARKS. USE DEPTH GAUGE ON DRILL PRESS TO DETERMINE THE DEPTH OF THE HOLE.

22. REMOVE THE BLOCK AND GO TO THE BENCH AND TAP BOTH BLIND HOLES FOR A 10–24 SCREW. USE ALL THREE TAPS: TAPER, PLUG AND BOTTOM TO GET COMPLETE THREAD TO BOTTOM OF HOLE.)

23. ASSEMBLE BLOCK AND BOTTOM USING ONE FLAT 10–24 MACHINE SCREW.



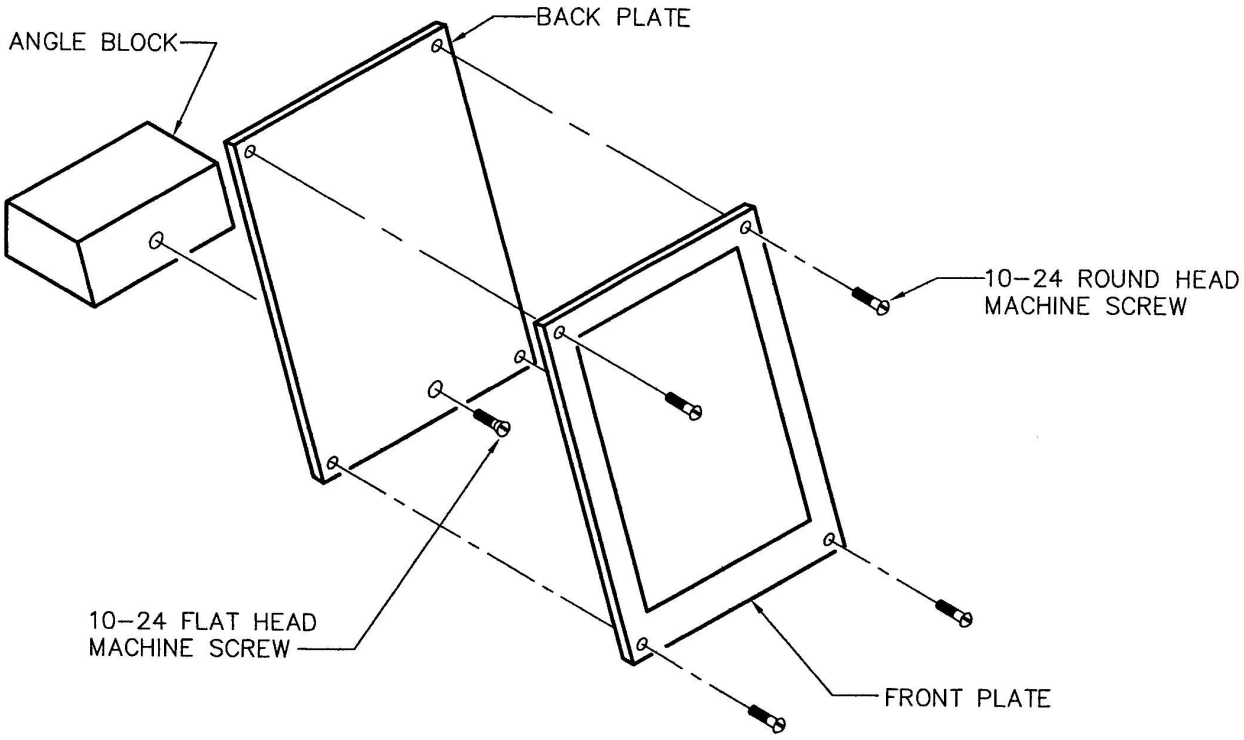
24. FILE FROM THE PUNCH HOLES OUT TO THE 1/2" SCRIBE LINE. REMOVE HACKSAW BLADE FROM FRAME AND INSERT THROUGH THE PUNCHED HOLES IN THE TOP PLATE. ADJUST THE END PINS TO POSITION THE BLADE AT A RIGHT ANGLE TO THE FRAME. SAW AROUND THE INSIDE OF FRAME INBOARD OF 1/2" LINE. (REMEMBER THE FURTHER AWAY FROM THE LINE THE MORE FILING WILL BE NECESSARY.



FRONT PLATE

25. FILE ALL EDGES TO THE 1/2" LAYOUT LINE.

26. ASSEMBLE TOP PLATE TO BACK PLATE USING FOUR 10–24 HEAD MACHINE SCREWS.



Hand Tool Usage

Use of Files

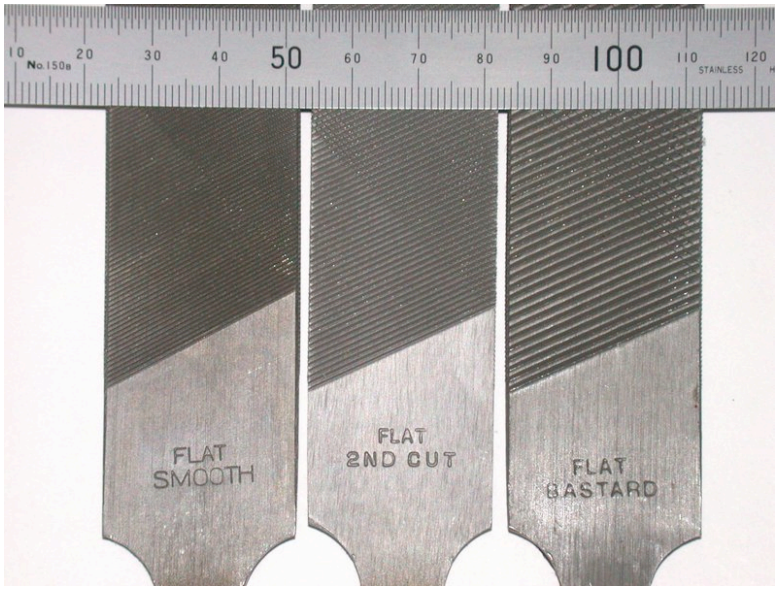
Many times in an engine room a smoother surface is required than can be obtained by the use of the available machine tools or by chipping, or it may be desired to reduce the size of some piece. For both of these purposes, great accuracy can be obtained by the careful and skillful use of files. In order-to smooth a rough surface, files of various degrees of fineness are employed: a coarse one first, followed by successively by finer grades, the piece being finished with the finest.

File Characteristics

A file is made of apiece of steel of the desired shape and size, and has a series of grooves cut across its face. Files have three distinct characteristics: namely length; kind (or name), which has reference to the shape or style; and the cut, which has

reference to both the character and the relative degree of coarseness of the teeth. It is not considered necessary to illustrate and describe here the multiplicity of sizes, kinds, and cuts of files in production, which run into thousands. Rather, it is considered sufficient to take up only those types that would normally be a part of the equipment of a first-class engine-room.

Chattering When Filing

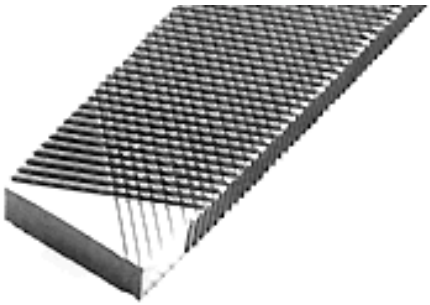


Files were first cut with regularly spaced teeth but this method was found objectionable because in filing, the teeth follow each other at regular intervals and drop into the cuts made by the preceding ones, causing chattering. Hand-cut files are more satisfactory as the slight irregularity in the spacing prevents chattering. This difficulty in machine-cut files was overcome by gradually increasing the spaces between the teeth from the end of the file to the middle, and then decreasing as the other end is approached.

Sizes of Files

The names applied to the different parts of a file are shown. The size of a file is generally indicated by giving the length, in inches, of the cut portion, the tang not being included. The tang is the tapered part that fits into the file handle. Thus, a 10-inch flat file, for instance, is one 10 inches long from the point of the file to the heel, or the part where the tang begins. The maximum width of files is typically 1.5 inches. In general, the length of files bears no fixed proportion to either their width or their thickness even though the files are of the same kind. When ordering files, it is necessary to state the length, the type, and the shape, as, for example, 10", second cut, half-round.

Cut of Files



The teeth of files are generally cut at a slight angle to the sides of the file or in a curve. The angle or curve varies for different materials. Most files used in shops are cut in one of three different ways and are known as single cut, double-cut, and circular cut files. Single cut files are cut with a single series of teeth running continuously from one end of the file to the other. They are usually used with a light pressure to produce a smooth surface finish.

By making another cut at an angle to the first, or over cut, a file is produced called a double-cut file. The second, or up-cut, is generally cut a little finer and not so deeply as the over-cut. The angles that the two cuts make with the axis of the file vary for different uses, the over-cut ranging from 35 to 55 degrees, and the up-cut from 75 to 85 degrees. The up-cut has the effect of dividing the small cutting edges produced by the over-cut into a large number of small, pointed teeth. Files of the double cut type are usually used under heavier pressure for fast metal removal.

Grading of Files

The coarse and bastard cut files, which are between the very coarse and the fine cuts, are used almost entirely on the coarser grades of work. The second cut and smooth files are employed in finishing and for the finer classes of work. The rough and dead smooth files are rarely used in the shop, although occasionally a rough single-cut file may be required for work on lead or other soft material. The dead-smooth double cut file is occasionally used on extremely fine work. The coarseness of the cut for each grade varies with the size of the file, the cut being coarser on the larger files. The comparative coarseness of 16 inch and 4 inch files is significant.

Kinds. of Files

Files are divided into three general classes with regard to their cross-sections, as quadrangular, circular, and triangular. These classes of files are further sub-divided into blunt, taper, hand, and safe-edge files. A blunt file has straight sides and the same width and thickness through out. A taper file is one whose sides are tapered. The same name is also given to the three cornered or triangular hand saw file. A hand file is one having its sides parallel and its thickness tapering from point to tang. A safe edge or

side file has one or both or its edges or sides smooth or uncut so that it may not injure that portion of the work which does not need to be filed

Handling Files

Good filing is an art. Grip, stroke, and pressure must be varied to fit the job and the kind of file used. There are three elementary methods of filing, namely straight or cross filing, draw filing, and lathe filing. Most work to be filed is held in a vise, which for general filing should be at about elbow height. If a great deal of heavy filing is to be done, it is well to have the work lower. If the work, however, is of a fine or delicate nature, it is better to raise it to near the eye level.

The right way to hold a file is learned as easily as the wrong way. In moving the file across the work, commonly called cross-filing. Although the most common, cross-filing is one of the, most difficult forms of filing. In moving the file back and forth, the hands tend to swing in arcs of circles about the joints of the arms, while the body sways more or less, depending on the work. To overcome these tendencies so as to move the file in straight lines requires a great deal of practice, and careful observation of the results of certain movements. Filing on narrow work is especially difficult. The work becomes a fulcrum on which the file rests at different points along its course, and, if an equal pressure is put on each end, the file will tilt first one way, then another, depending on the point of contact and the leverage. A rounded rather than a flat surface is inevitable.

Pressure on File

One of the quickest ways to ruin a good file is to use too much pressure on the file on the forward stroke. In all kinds of filing place just enough pressure on the file during the forward stroke to make it cut freely. On the return stroke, it is best to lift the file clear of the work, except on very soft metals.

Cleaning Files

The clogging of the cuttings in the file teeth, forming hard, sharp pins that scratch the work, is known as pinning. It occurs more readily in some materials than in others. As soon as the slightest indication of pinning is observed, great care should be taken to keep the teeth clean. Sometimes this is done by rapping the file against a wooden block or the work bench, but it is better to keep a file cleaner on hand. Cleaners are made in two styles. A wire brush, called a file card, is attached to a wooden handle. In the other type, there is a second brush on the other side of the wooden block. Vigorous brushing in the direction of the teeth usually removes the pins, but in cases where the brush will not remove them, a piece of soft sheet brass or a piece of copper or iron wire flattened out at on end may be used.

Care of Files when not in Use

In too many cases, files are thrown into a box or drawer with many other tools, with resulting damage to the files and all other cutting edges. Files should never be thrown upon one another or upon other tools or hard objects. They should always be carefully cleaned and then hung on a rack by their handles or stood up with their tangs in holes in some place where they are protected from dirt and moisture so that rust will not corrode their teeth points. If files must be put in a tool box, they should first be wrapped in paper.

Hack Sawing

The hack-saw is a tool used to saw metal. It consists of a frame, handle, and blade. The frame in most modern hack saws is adjustable so as to take blades of different lengths. A screw on the clamp at the handle end serves to tighten the blade in the frame by turning either a thumb nut or the handle itself. The clamps that pass through the frame are usually square, so that the saw blade can be set in four positions, and can therefore be operated in any of four directions. Some saws are so designed that the blade can be positioned at various angles between the vertical and the horizontal. This design is often an advantage because the operator can use the saw in places where there would not be sufficient clearance for a saw having only the four-positions.

Hack Saw Blades

Blades used in hack-saws are so hard that it is not practical to attempt to sharpen them. Hence, they are discarded when dull. Blades for hand hack saws are usually made in three lengths: 8, 10, and 12 inches. The length being the center-to-center distance between the holes in the blade. They are also made in different grades of tooth coarseness, or pitch. The most commonly used blades having 14, 18, 24, or 32 teeth per inch. The finer-tooth blades should be used for very thin metal such as sheet metal, tubing, or pipe, and the 18-tooth blade will take care of all general work. When sawing very thin sheet stock, or when circumstances require that a coarse saw be used for cutting pipe or tubing, clamp the work in a vise between two pieces of wood and saw through both wood and metal at the same time to avoid breaking the teeth of the saw.

Using Hack Saws

Hack-saw frames are not all adjusted for length in exactly the same way, but the method used is so simple that a short inspection of the saw will disclose the method employed. To replace a blade, the thumbnut is backed off so as to make the blade loose on the pins of the clamps, and the blade is removed. If a blade of the same length is to replace the old one, simply place it on the pins with the teeth facing in the proper direction, that is, away from the handle, and tighten up the thumb screw until the blade is tightly

stretched, making the entire assembly rigid. Use precaution however, when tightening the blade so as to not to break the blade, shear the pins, or bend the frame.

Place the work to be sawed in a vise and bring the line at which the cut is to be made as close to the vise jaws as possible to prevent the work from springing. In starting the cut at a marked line, it is advisable to nick the surface of the work with a sharp file to break any sharp corner that might tend to strip the saw teeth. This nick will also aid the beginner to start the saw at the proper place.

Thread Cutting - Taps

The tool used for cutting internal threads is called a tap, and the process of threading is called tapping. Threads can be tapped on a lathe, in a drill press, and by hand. Hand tapping will be discussed in this exercise.

Holes in thin stock may be tapped in one operation by running the taper tap clear through the piece, but if the hole is of great depth or the material is hard, then a second or plug tap must be run down to relieve the long cut made by the taper tap. By using these two taps alternately, holes may be tapped to any depth that the taps will reach. A third tap, called a bottoming tap, will cut threads to the bottom of a hole.

A taper tap is used to start a thread, a plug tap is used to tap a deep hole, and a bottoming tap is used to cut threads to the bottom of a hole. Regardless of which tap is used, it is always important to consistently use cutting oil. Shown to the right are the three taps: taper - top, plug - middle, and bottoming.

NOTES

Lab #2 - Measuring Instruments and Tools

Measuring Instruments and Tools

Having the correct tool to provide an accurate measurement or reading is a necessity when working with machinery. Accuracy is determined by the tolerance of the piece of work being measured. When measuring your height, for example, you might feel an accuracy of 1/2" to be acceptable. A piece of lumber should be accurate to within 1/16th inch (0.06125"). A piece of machinery may need to be accurate to within a few thousandths (0.001) of an inch.

Using the English system, one foot is divided into 12 inches, then further divided into halves (1/2), quarters (1/4), eights (1/8), sixteenths (1/16), thirty-seconds (1/32), and sixty-fourths (1/64). The greater the scale, the more precise the reading is. Readings requiring greater precision than 64ths will typically be measured in thousandths of an inch. The decimal equivalents of the fractions above are shown in Table 1.

Fractional Measure	Decimal Equivalent
1/4	0.250
1/8	0.125
1/16	0.06250
1/32	0.03125
1/64	0.015625

Table 1

Thus, 1/64th of an inch is approximately 15 thousandths. A dollar bill is between 4 and, 6 thousandths (0.004 - 0.006) of an inch thick. Dimensionally, one would indicate that it is 0.005 +/- 0.001 inch thick. Many tools are available to measure accurately including:

- Rulers, usually graduated in fractions of an inch;
- Micrometer, both inside and outside, generally graduated in thousandths of an inch;
- Vernier Caliper, also used to measure inside and outside dimensions and graduated in thousandths of an inch;
- Dial Indicator, used to measure trueness or concentricity;
- Feeler Gauge, used to measure small inside clearances;
- Thread Gauges, used to measure the number of threads per inch on a screw.

Engineer's Rule

RULES

Engineers rules are made from hardened and tempered steel marked off with high accuracy. They are made from strips 10-30 mm wide and in lengths from 4" to 18". Folding pocket rules are available with an extended length 24". Extending spring rules are used where great accuracy is unnecessary. In engineering, rules are used for marking-off, setting calipers and dividers. etc.

THICKNESS GAUGE (FEELER GAUGE)

Thickness, or feeler, gauges are thin blades of spring steel of exact thickness used for measuring small gaps (or clearances) between parts. They are usually made in sets of various thicknesses pinned together at one end

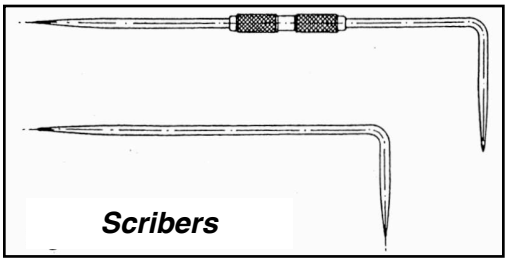
Thickness or Feeler Gauge

THREAD GAUGE (SCREW PITCH GAUGE)

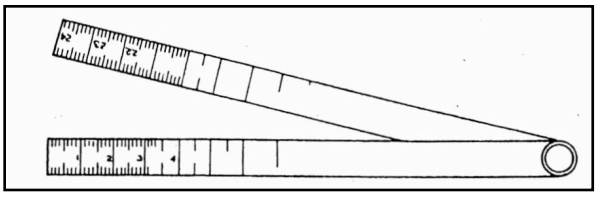
The thread gauge has several blades, each with a number of teeth of different standard pitch and form, and mounted at either end of a holder. These blades are used when machining threads so that the thread form and pitch may be checked. Another type of gauge is used for setting thread- cutting tools.

SCRIBER

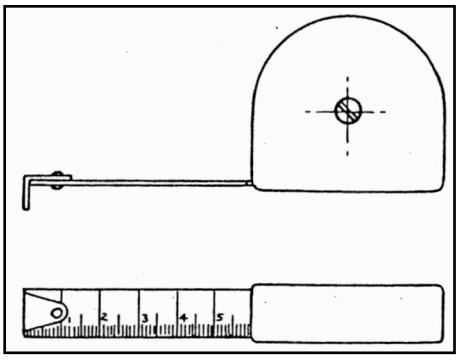
A scriber is a thin steel rod with a pointed end or ends, one of which may be bent at right angles to allow access to holes. Some scribers may have a knurled handle in the middle. The scriber is used for marking off , and it produces a fine scratched (or scribed) line on a machined face.



Scribers

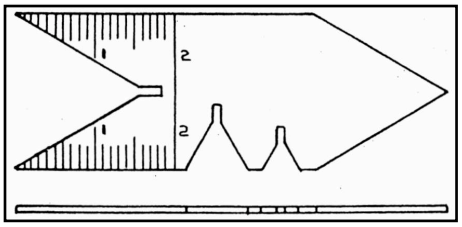


Folding Rule



Spring Tape Rule

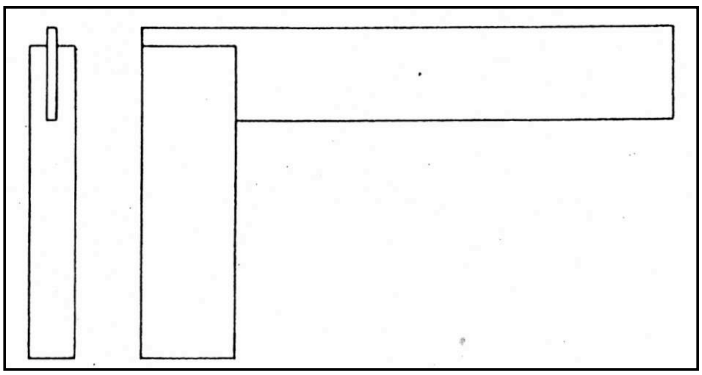
Thread Gauge (Screw Pitch



Screw Cutting Tool Setting

SQUARE (TRY SQUARE)

This is made from two rectangular pieces of steel joined at right angles, and is used to check internal and external right angle corners, especially when hand fitting.



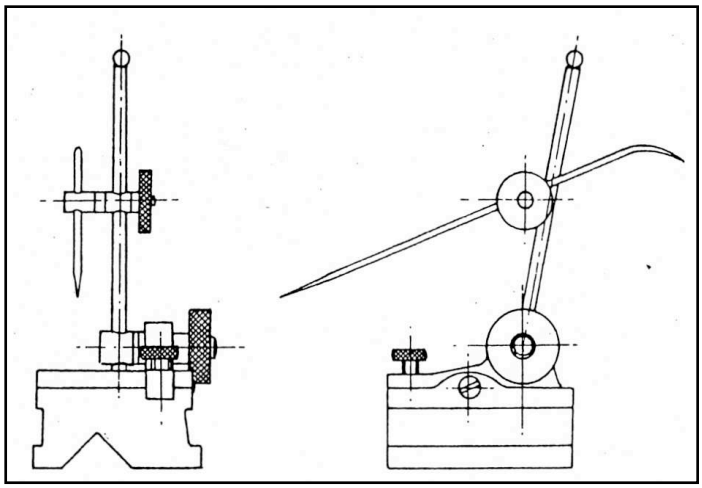
Square (try-square)

SURFACE GAUGE

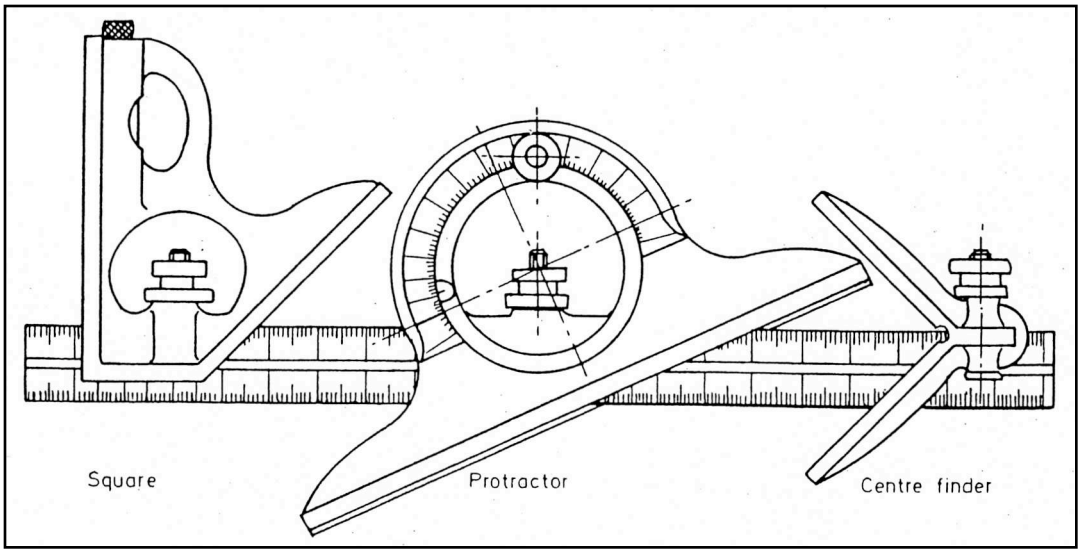
A surface gauge has three main parts, a base, a post and a scriber. The base is ground flat and has a machined V groove for use on round work. The post can be tilted by means of a screw and carries either a scriber for marking-off, or a dial gauge.

COMBINATION SET

This consists of a steel rule with a slot (or keyway) along its length, to which one of three heads may be attached, namely, a square, a centre finder and a protractor.



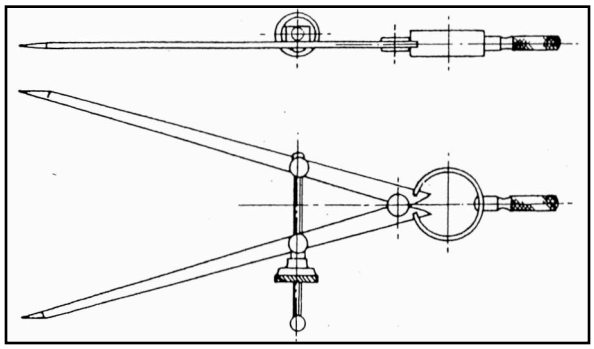
Surface Gauge with Scribe



Combination Square Set

DIVIDERS

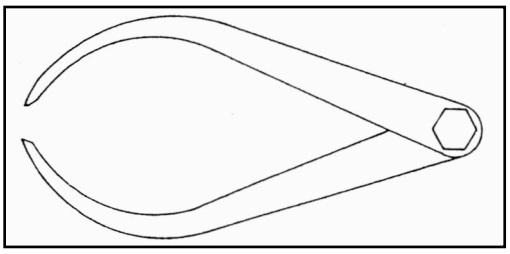
Dividers consist of a pair of adjustable hinged points used for measuring and transferring sizes and also for scribing circles and radii when marking-off. The hinge may be of the “firm joint” type or with a spring, as shown.



Spring Dividers

OUTSIDE CALIPERS (CALIPERS)

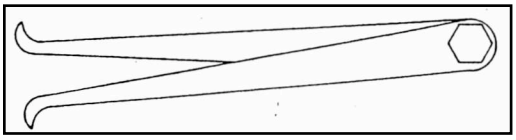
An adjustable pair of curved and hinged legs used for measuring the thickness of parts and diameters of shafts, etc. The calipers may have a 'firm joint', as shown, or be of the 'spring joint' type.



Outside Calipers

INSIDE CALIPERS

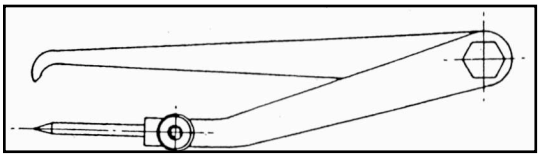
The hinged legs are bent outwards so that inside measurements such as the bore of a pipe may be measured.



Inside Calipers

JENNY CALIPERS

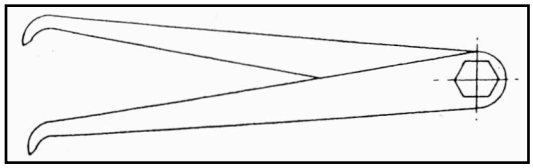
Also known as *hermaphrodite calipers or odd legs*, these have one leg curved inwards and one straight leg which sometimes has a replaceable point. They are used for measuring the distance from a point to an outside surface.



Jenny Calipers

GEAR-TOOTH CALIPERS

A gear-tooth caliper has an “inside” leg and an “outside” leg. It can be used for measuring the distance from an inside edge to an outside edge.



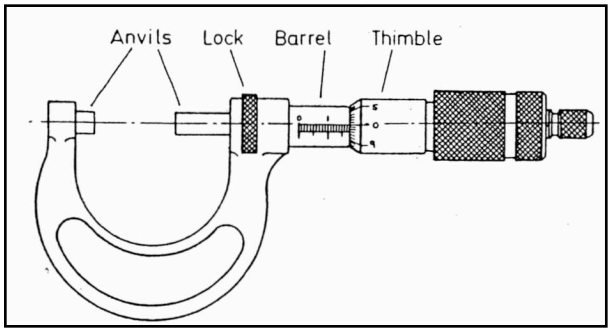
Gear Tooth Calipers

MICROMETERS

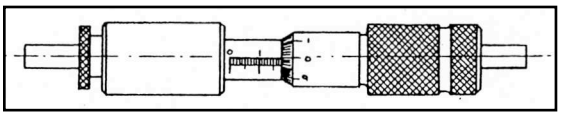
Micrometers are instruments used for the accurate measurement of internal and external dimensions of objects, particularly those of cylindrical shape. The measurement is based upon the advance of an internally-threaded thimble rotated on a precision screw. Micrometers are made in a very large range of types and sizes, the most common being the outside micrometer measuring up to 25 mm in 0.01 mm intervals (1 in. in 0.001 in. intervals). It has a fixed graduated barrel screwed to take the graduated thimble which is knurled to give a good finger grip and which has a movable anvil attached to it. The barrel is attached to a semi-circular frame at the opposite end of which is mounted a fixed anvil. The object to be measured is

placed between the anvils and the thimble is rotated until the object is nipped by them. The size is then read from the graduations on thimble and barrel. Large outside micrometers are supplied with extensions for the fixed anvil.

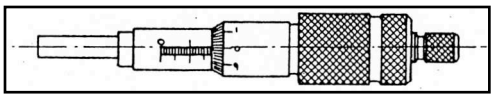
An *inside micrometer* has the fixed anvil projecting from the end of the thimble opposite to the moving anvil, and extension rods may be used to extend the range. The barrel and thimble assembly, called a micrometer head, can be obtained separately and can be attached to any precision measuring instrument.



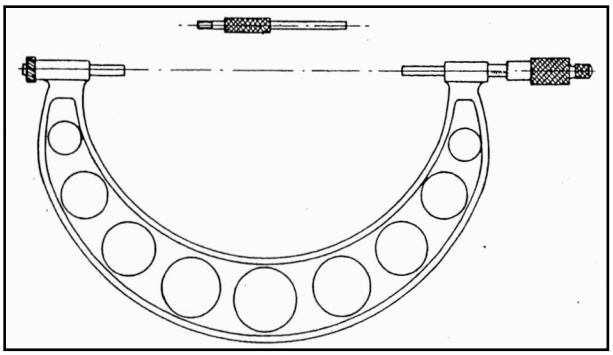
Outside Micrometer (1 in. - 25 mm)



Inside Micrometer



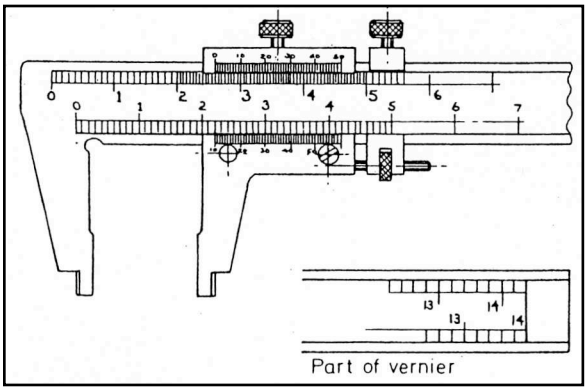
Micrometer Head



Outside Micrometer (1 in. - 25 mm)

VERNIER CALIPER GAUGE

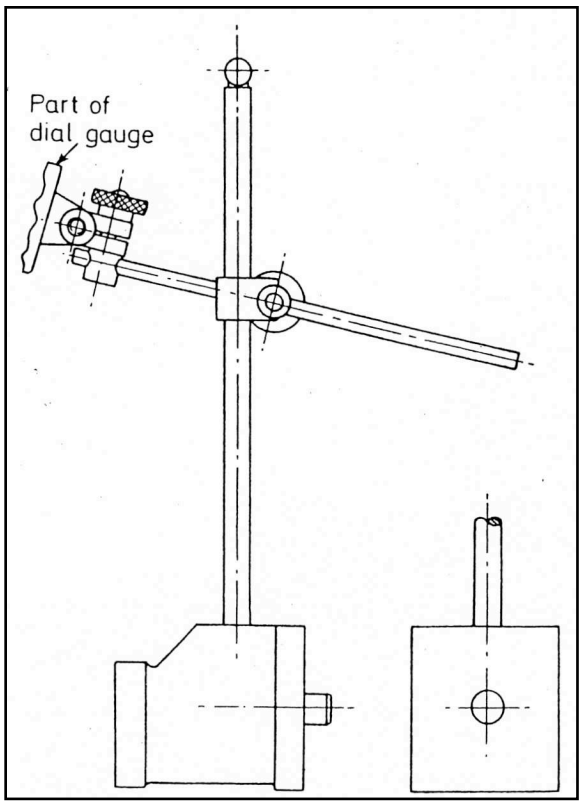
This instrument, used for internal and external measurement, has a long flat scale to which a fixed jaw is attached at one end, and a sliding jaw with a cursor running along the scale. A scale on the cursor is read in conjunction with the fixed scale. Outside measurements are made between the jaws and inside measurements over projections on the jaws.



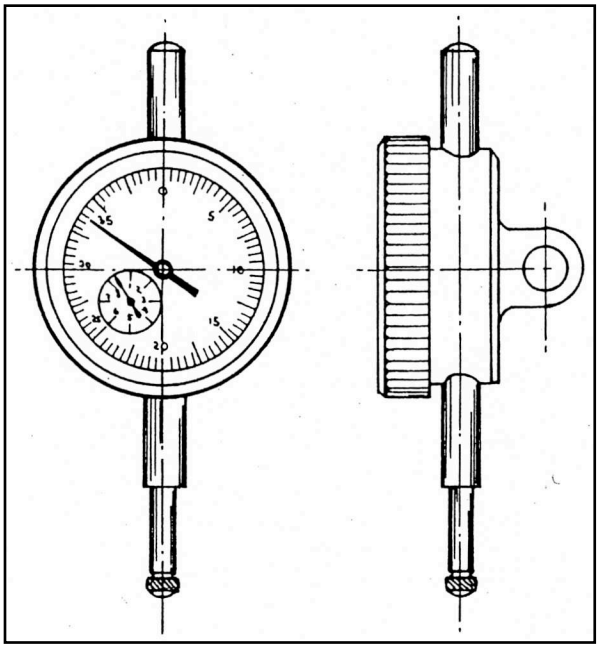
Vernier Caliper Gauge

DIAL GAUGE (DIAL INDICATOR)

The movement of a plunger is magnified and displayed on a dial on which intervals of 0.002 mm (0.0001 in.) are possible. The dial has a fixing lug by which it can be attached to a surface gauge post or a magnetic base test set.

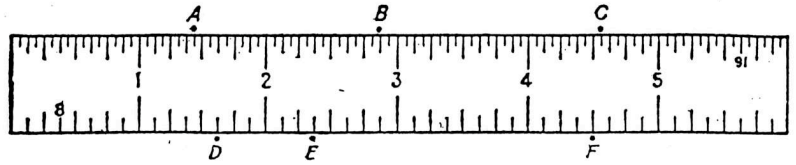


Magnetic Base Test Set



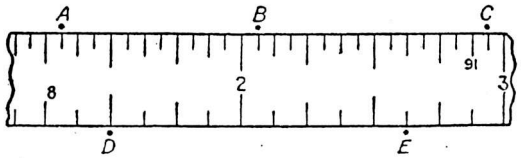
Dial Gauge (dial indicator)

1. Determine the readings (A-F) on the ruler below:



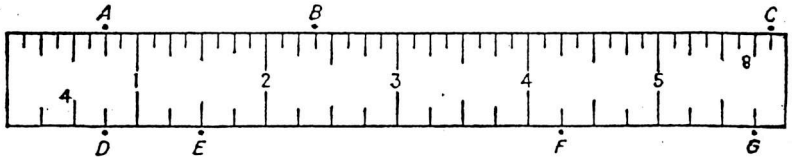
A	
B	
C	
D	
E	
F	

2. Determine the readings (A-E) on the ruler below:



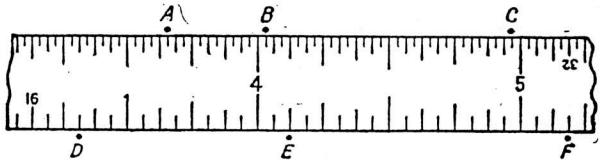
A	
B	
C	
D	
E	

3. Determine the readings (A-G) on the ruler below:



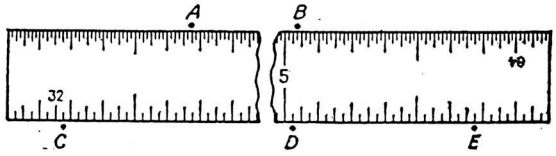
A	
B	
C	
D	
E	
F	
G	

4. Determine the readings (A-F) on the ruler below:



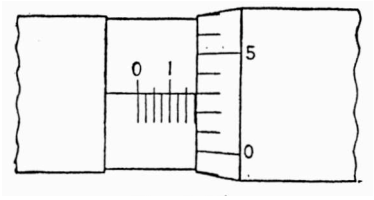
A	
B	
C	
D	
E	
F	

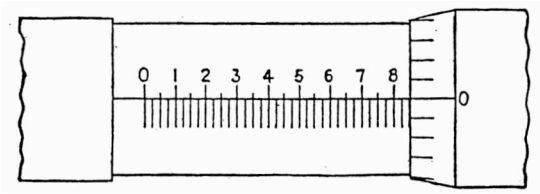
5. Determine the readings (A-E) on the ruler below:

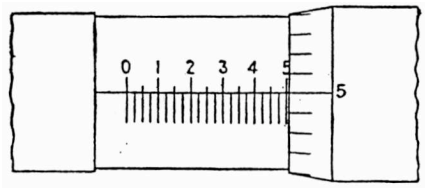


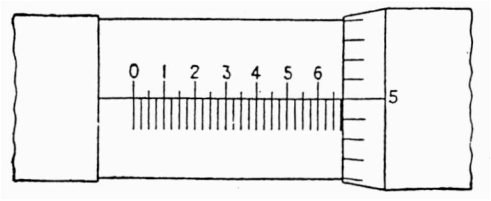
A	
B	
C	
D	
E	

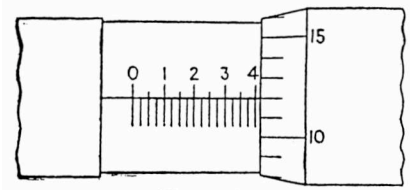
Determine the readings on each of the micrometers:

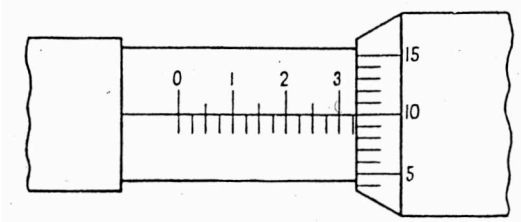


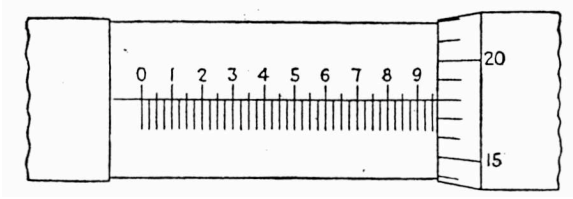


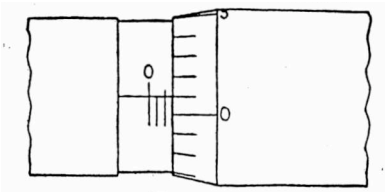


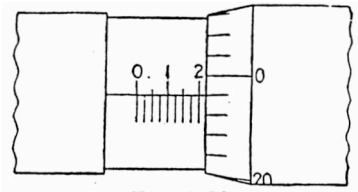


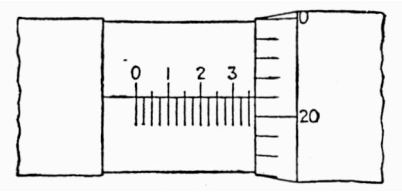


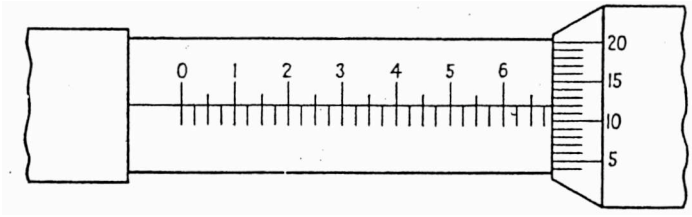


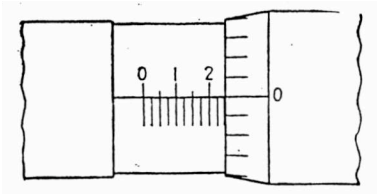






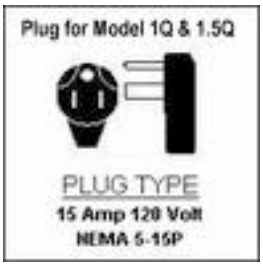






NOTES

Lab #3 - Electrical Wiring



Electricity

Electricity is pretty magic stuff. You can't see it, you can certainly feel it, it can do a world of good for you ***and it can kill you***. You may have heard the old adage that it isn't the voltage that kills you - it's the current. That is true. But if the voltage is high enough, the current will flow! If that path happens to be across your heart, you will probably die. And if there isn't someone there to perform CPR, you will probably not be able to try an electrical repair again - ever!

So here is some information that will help you understand the fundamentals of electricity so that you can fix an electrical circuit or appliance without tempting the grim reaper.

First - always shut off the power and ***LOCK OUT - TAG OUT*** the equipment so that it cannot be energized.

Electricity flows in a similar fashion to water. Electrical voltage is akin to pressure of water in a pipe or hose. It is really that simple. When you increase the pressure in a pipe, the water comes out faster. Oh, another analogy - resistance to electrical flow is akin to a restriction in a pipe or hose, so that even if you increase the pressure in a water supply system you can't make water flow very much if the resistance is infinite - like the faucet is turned off. There can be no water flowing if the faucet is closed; there can be no current flowing in a circuit,if the wires are hanging in free space. Opening the faucet is like giving electricity a path (lower resistance than air) to flow through, like an electrical appliance or a light bulb, or your body.

Now on to some practical stuff. Let's talk about a car battery. If you ever accidentally shorted out a car battery's terminal like you might do with jumper cables, you saw a spark that looked like Willie the Welder was working. Soooo, if a car battery can make that kind of spark it can probably kill you, right? Well, not really. Don't get me wrong here - if you apply the energy in a penlight battery to your brain you can do serious damage - even kill yourself. But if you were to grab the terminals of a car battery with your hands you might not even feel it. If your hands were soaked in salt water for a while you might feel a tingle but not a very strong tingle. The resistance of your normally dry hands is sufficiently high enough to limit the current to a few micro-amps. See, the old adage is correct in one sense - no current, no dead!

But we aren't talking about car batteries here, we are talking about the scary wires that run through your house and the ones running through the ship. Wires that can bite are wires that can kill.

The first thing you need to know is that electricity needs a completed path in order for current to flow. So if you take a light bulb and connect one terminal of it to a battery nothing happens. If you complete the path by connecting the other terminal on the bulb to the other terminal on the battery, the light will light. Use this analogy in thinking about working with the electrical circuits in your home. If you felt comfortable enough to remove a wall plate from a duplex outlet you would see a white wire and a black wire. If the outlet is wired correctly, the black wire goes to the gold terminal and the white wire goes to the silver terminal. By convention, the black wire is the "hot" wire and the white wire is the common or neutral.

I must regress a bit here. Way back at the generating station, you know, the people that get a lot of your money each month for allowing you to have lights and toasters? Well, back there they took one wire from their generator and hooked it to the black wire and the other to the white wire. They also connected the white wire to ground - good old mother earth - you know, dirt! When that pair of wires comes into your home the white wire is once again connected to good old mother earth and the black wire to a circuit breaker and then on to the duplex outlet you are staring at.

Back to the duplex outlet. if one wanted to end it all one could simply grab the white wire with one hand and the black wire with the other, and it would be lights out - unlike what you would get if you connected the wires to a lamp. Notice I said both hands have to be involved - to complete the circuit.

Sooooo, if you weren't quite sure you wanted to end it all you could grab the black wire with one hand and just sit there contemplating your navel. Nothing would happen. Except that you would probably get bored after a while and go take a nap. On the other hand (no pun intended) if some other part of your body were in contact with, say a water pipe, which goes directly under the ground, the electric current would flow and you would be on your way to eternity.

One way people get zapped is to be holding on to the black wire and reach for a screwdriver that is resting on the sink or basin in contact with a faucet. See, the circuit is completed and they join the rest of the careless in lala land.

The lesson to be learned here is that one needs to be really careful that NO other part of the body is in contact with the ground portion of the house current circuit if one intends to be probing around in an electrical outlet box. Of course the real message here is that one should find the correct circuit breaker and switch it to the "off" position prior to removing the cover plate, however there is a small percentage of visitors in lala land who did follow that instruction only to find that they switched off the wrong breaker. Follow the rule - always - one hand works, nothing else touches ground - keep the other hand in your pocket!

One fallacy is that if your circuit is protected by a GFCI, or Ground Fault Circuit Interrupter, you can't get hurt working on that circuit. You can get zapped just as dead, but you might have to work at it a bit harder.

Sometimes the end of an extension cord or power cord gets worn out, bent beyond repair, or burned from excessive heat buildup. If the rest of the cord is still intact, the end can be replaced rather than discarding the cord. However, the price of a new cord is often little more than the price of one replacement end. This is particularly noticeable with the more common 16 gauge cords.

Installing Plug & Receptacle Ends on Extension Cords

"The expected learning outcome is that the trainee…"

1. Understands basic electrical fundamentals.
2. Is able to correctly wire an extension cord with plug and receptacle ends.
3. Correctly tests the newly created extension cord.
4. Is able to use electrical hand tools

Before you begin, be sure the extension cord is disconnected from the wall plug.

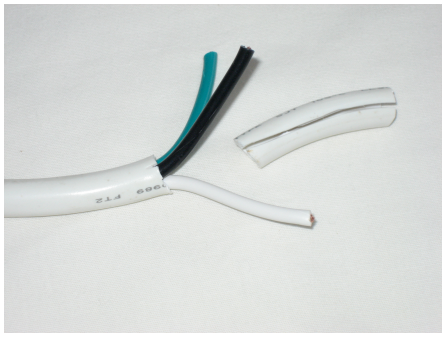
Required Materials:

☑ 1 each: NEMA 5-15 P (plug end) and NEMA 5-15 R (receptacle end)

☑ 16 inches of 14/2 or 16/2 electrical cable

☑ Wire Cutter, Wire Stripper, and Screwdrivers

Procedure:



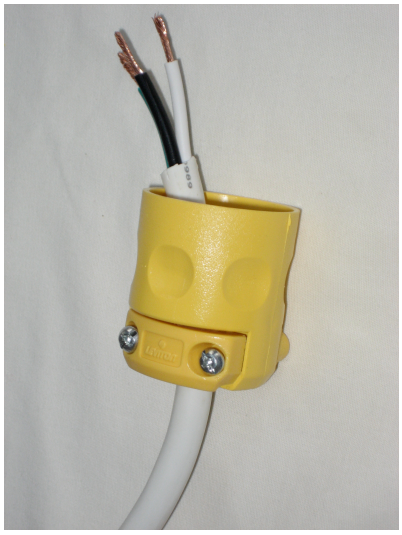
1. Cut off the old plug plus 1 inch of cord.

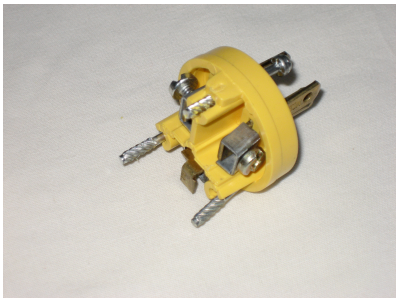
2. Using 16/2 or 14/2 cable w/ground wire, strip back the insulation 2 inches to separate wires.

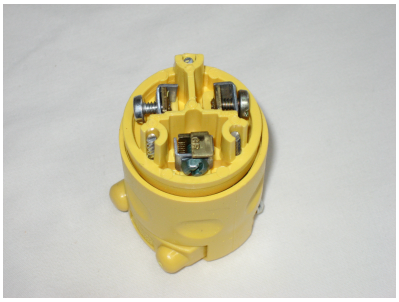
3. With wire strippers, strip insulation from 1/4 inch of each wire.

4. Twist wires clockwise and pull wire back into plug, wrapping it clockwise.

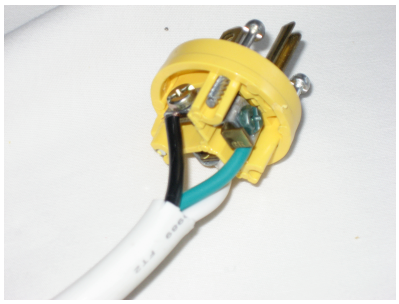
5. Place the tail end of the plug or receptacle over the wire. Leave loose until later. *Do not forget this step!*



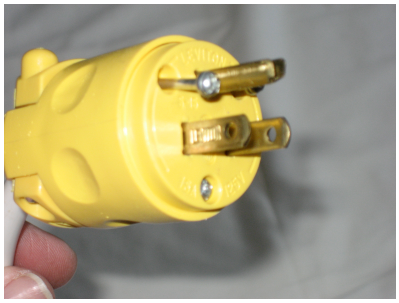




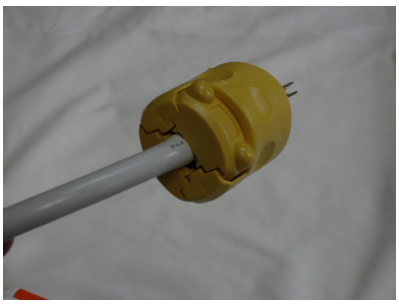
6. Loosen the three screws on the front end of the plug or receptacle. Note the following:
   a. The terminals are different colors. The GOLD terminal is the HOT terminal, and corresponds to the BLACK wire. The SILVER or white terminal corresponds to the WHITE wire. The GREEN terminal corresponds to the GREEN or ground wire.
   b. The wire is installed between the clamps so that when tightened the wire will not become twisted. Do not place the wire around the screw.
   c. There is only room for approximately 1/4" of wire under the terminal clamp. Excess wire can cause a fault. Trim excess stripped wire before installing.

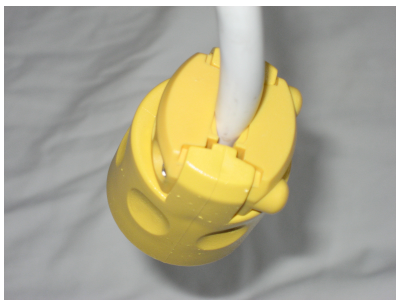


7. Line up the cap and base of the receptacle or plug. Note that they meet only one way. DO NOT twist the base, rather turn the cap to meet the base. Tighten the three screws which secure the base to the cap.



8. Tighten the two screws on the end of the cap which clamp the cable. Be careful to only tighten enough to secure the wire, but not enough to crush it.





9. Repeat this process for the other end of the extension cord.
10. When complete, submit the device to one of the instructors for testing. ***DANGER: DO NOT PLUG THE CORD INTO A LIVE OUTLET BEFORE IT IS TESTED.***

NOTES

Lab #4 - Copper Pipe Fitting

Soldering Copper Tubing

STCW requirement OICEW-1-1D

Project time: 2 hours

"The expected learning outcome is that the trainee…."

Understands the proper operations necessary to produce and create leak-free workman-like solder joints in copper tubing.

Each student will cut, prep and make a soldered joint and as a group will fabricate the soldered copper tubing project as illustrated. The finished project will be pressure tested with fresh water.

Tools Supplied by the Engineering Department:

- ☑ Tubing cutter
- ☑ Tape measure
- ☑ Propane or MAPP gas bottle and nozzle
- ☑ Tubing cleaning brushes and/or abrasive paper
- ☑ Striker
- ☑ 95-5 lead-free soft solder & flux paste
- ☑ Wet and dry rags
- ☑ Portable CO2 fire extinguisher

SAFETY FIRST

- Safety glasses and gloves are required for this exercise and must be provided by the student.
- Hot solder can spatter so safety glasses and protective clothing is a must!
- Gloves also reduce the chance of burns on,hands
- Because the torch could cause fires in near-by-combustible materials, having a fire extinguisher. on hand is also a requirement.

Materials Required: (for one project)

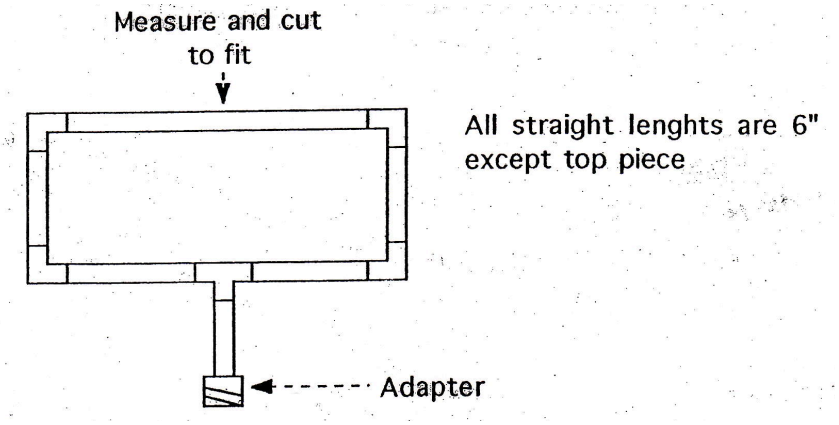
- ☑ 4 - 90 degree 1/2” elbows
- ☑ 1/2” Copper Pipe, 42” in length
- ☑ 1 female sweat to male NPT 1/2” adapter

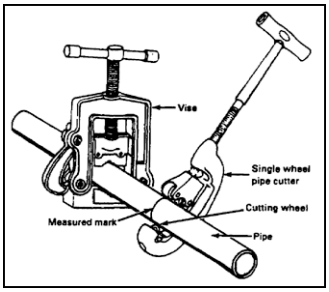
Uses Aboard Ship

Soldered rigid copper tubing is used aboard ship for hot and cold domestic potable water, compressed air lines for pneumatic controls, hot water heating systems, refrigeration gas lines, sea water cooled machinery supply lines and chilled water air conditioning. Soldered rigid copper tubing is NEVER used in high pressure or high temperature systems such as steam or hydraulics.

Sizing Copper Tubing

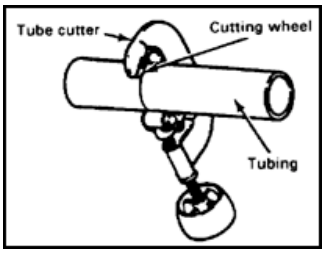
The rigid copper tubing we are using is often referred to as "plumbing tubing", is described by its approximate inside diameter (Nominal I.D.) and wall thickness. The actual outside diameter is always 1/8" larger than the nominal I.D. The diameter required is determined by the volume of liquid or gas that must flow through the piping. Diameters such as 1/4, 3/8, 1/2, 3/4, and 1 inch are commonly used. The wall thickness will be based on the working pressure of the system. Thicker walled tubing will also last longer. Type “K” tubing has the thickest and is used in high pressure systems. Type “L” is a thinner wall and is used for water heating systems. Type “M” is used for low pressure water and heating systems. Type “DWV” is the thinnest wall and is used for drain, waste and vent systems with little or no pressure inside. These standard sizes



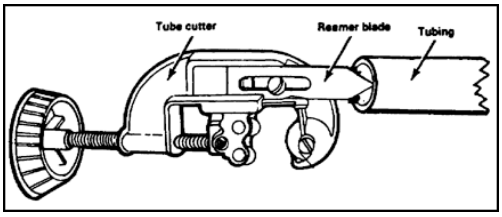


are printed on the outside of the tubing and are color coded as follows: K = green; L = blue, M = red, and DVW = yellow.

Procedure:



1. Measure and cut the copper tubing to the lengths shown in the drawing. When measuring, note that 1/2” of tubing fits into the 1/2” pipe fitting.
2. To cut the tubing, place the pice to be cut in the tubing cuter and gently screw down on the cutting wheel until it touches the tubing. Spin the cutter about the tubing while closing in in the cutter about 1/8 of a turn per revolution. Too much pressure on the cutter wheel can crush the pipe or damage the wheel.



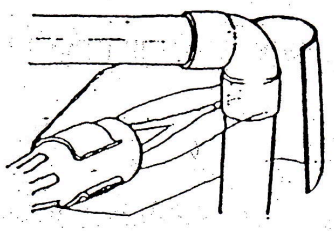
3. Remove the burr from the inside of the tubing using the vee shaped reamer on the handle of the cutter.
4. Mechanically clean the external surface of the tubing and the inside of the fitting to remove oxides and dirt which prevents the solder from adhering to the copper. Use

emery cloth, sandpaper, or a special wire brush made for this purpose. Do not touch the cleaned surfaces with your hands as the oils and sweat will prevent good solder

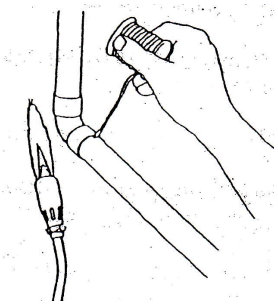
Cleaning the fitting and applying the flux.

adhesion

5. Apply paste flux to the cleaned surfaces with an acid brush. Flux prevents oxides from forming, wets the copper surface, and helps the solder flow evenly into the joint.
6. Insert the tubing into the fitting. Turn the fitting a quarter turn to evenly distribute the flux.
7. Solder the fitting onto the pipe. The solder used is soft solder or 95-5 solder made up of tin and antimony and melts between 320 and 550 degrees Fahrenheit . 50-50 solder (lean and tin) is no longer used in potable water systems due to health hazards. Hard solder or silver solder melts at 550 - 800 degrees Fahrenheit and is used on high temperature or pressure systems. A propane gas torch is used to provide the heat necessary to melt the solder. MAPP gas (acetylene and propane mixed) burns as a higher temperature than propane alone.



8.Install the torch head on the gas tank and open the valve slowly. Using the striker, light the torch and adjust the flame so that it is about 2-3 inches long. Note the color of the flame, the hottest part is the blue tip inside the yellow cone.



9.Heat the fitting only, not the tubing, until the tubing is hot enough to melt the solder. tubing is hot enough to melt the solder. As the flux starts to bubble out of the joint, briefly remove the flame then quickly touch the solder to the edge of the joint until the solder melts and flows into the joint and around the entire joint. It may be necessary to touch the solder in two or three places and re-apply heat from the torch to insure a complete seal. Capillary action causes the solder to be drawn into the small space between the tubing and the fitting when the temperature of the two pieces is just hot

enough to melt the solder. Over-heating will cause the solder to run back out of the joint. Solder all sides of a fitting, such as a tee, at the same time. Reheating a fitting can weaken an already good soldered joint.

10. Finish by wiping the joint with a wet rag to quickly solidify the solder and clean the visible surface of the joint.

Common Soldering Mistakes

- ☑ Not properly cleaning the joint.
- ☑ Using TOO much heat, driving the solder back out of the joint.
- ☑ Heating the tubing or the solder,instead of the fitting.
- ☑ Using too much solder which leads to beads of solder forming inside of the tubing which can break loose possibly blocking valves downstream of the joint.
- ☑ Having any water in the tubing which will keep the temperature of joint too low to melt the solder.

Review Questions

1. Why is cleaning the copper surfaces of the tubing and the fitting necessary prior to soldering?

2. What three things can be used to clean the copper tubing prior to soldering?

3. Why is flux used for soldering copper tubing?

4. What will happen if the tubing cutter wheel is turned in too much during the cutting process?

5. What part of the flame from a propane torch is the hottest?

6. What is 50-50 solder and can it be used for all services that copper tubing is used for?

7. What services can be used with soldered copper tubing?

8. Why is MAPP gas used instead of propane gas?

9. What part should be heated during soldering of copper tubing, the tubing or the fitting?

10. What will happen if the fitting and tubing are overheated as the solder is being applied?

11. What type of action occurs to draw in the solder as the fitting is heated?

12. What is the approximate melt temperature of soft solder?

13. List three services aboard ship that soldered copper tubing is used in?

14. What are the four-wall thicknesses, as designated by a letter system, that are used with standard copper tubing?

15. Why is it necessary to remove the inside burr from the copper tubing after it has been cut?

16. What safety equipment should be worn when soldering copper tubing?

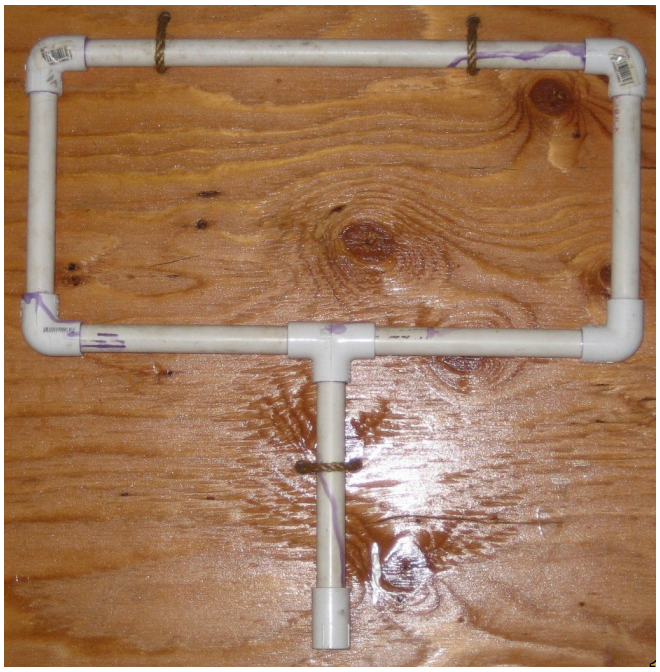
17. Why should a,fire extinguisher be nearby when soldering?

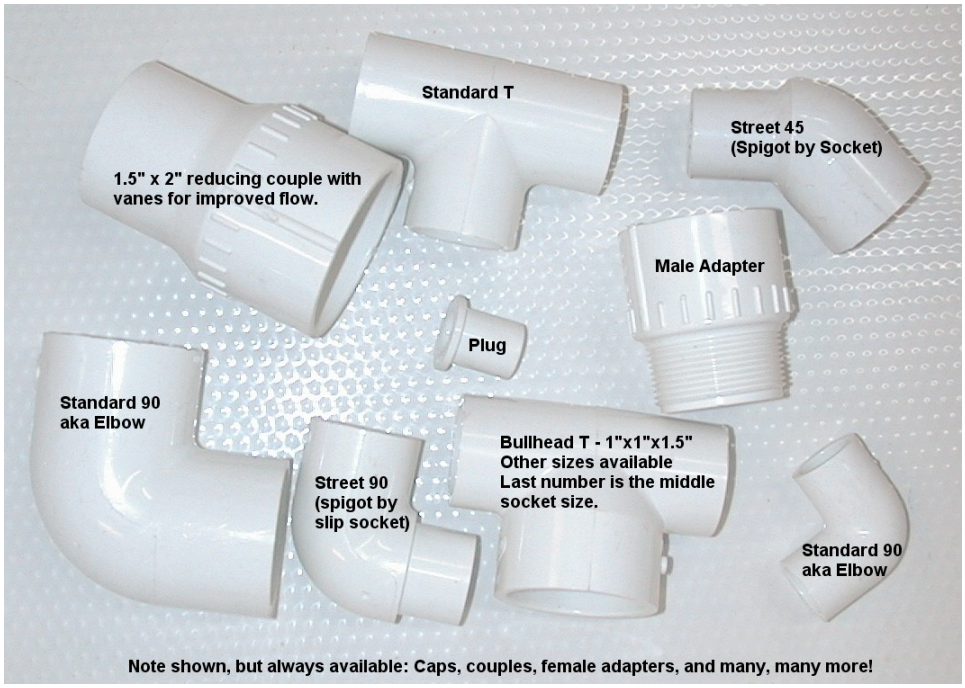
18. Why can't soldered copper tubing be used for high pressure steam?

19. Why is 95-5 solder used instead of 50-50 solder?

20. What four colors indicate the wall thickness of rigid copper tubing?

Lab #5 - PVC Pipe Fitting





PVC Pipe Fitting

Project time: 2 hours

"The expected learning outcome is that the trainee…."

Understands the proper operations necessary to produce and create leak-free workman-like joints in PVC tubing.

Each student will cut, prep and make a PVC welded joint and as a group will fabricate the PVC tubing project as illustrated. The finished project will be pressure tested with fresh water.

Tools Supplied by the Engineering Department:

- ☑ Tape measure
- ☑ Tubing Cutter
- ☑ PVC Cleaner and Cement
- ☑ Tubing cleaning brushes and/or abrasive paper

SAFETY FIRST

- Safety glasses and gloves are required for this exercise and must be provided by the student.
- PVC cleaner and cement can spatter so safety glasses and protective clothing is a must!
- Gloves also reduce the chance of chemical burns on hands
- Because the PVC cleaner and cement are highly flammable, having a fire extinguisher on hand is also a requirement.

Materials Required: (for one project)

- ☑ 4 - 90 degree 1/2” elbows
- ☑ 1/2” PVC Pipe, 42” in length
- ☑ 1 female PVC slip to male NPT 1/2” adapter

Uses Aboard Ship

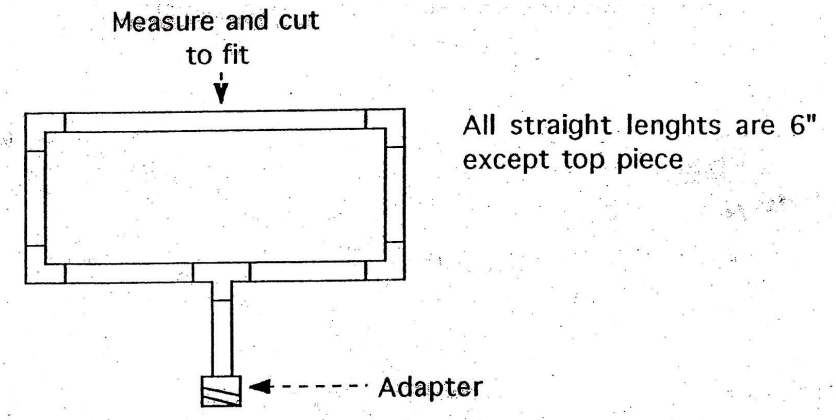
PVC pipe is used aboard ship for many hot and cold domestic potable water lines as well as sea water cooled machinery supply lines and chilled water air conditioning. PVC tubing is NEVER used in high pressure or high temperature systems such as steam or hydraulics. Additionally, PVC tubing is never used on compressed air lines or tested with compressed air.

Sizing PVC Tubing

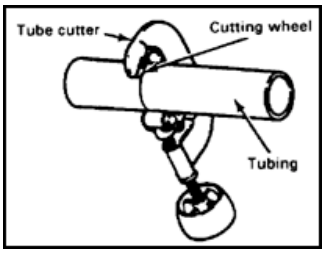
The rigid PVC copper tubing we are using comes in two wall thicknesses known as Schedule 40 and Schedule 80. Schedule 80 has a thicker wall thickness. Other lightweight PVC tubing is available for uses such as irrigation and drainage lines, but is not found aboard ship. Diameters such as 1/2, 3/4, and 1 inch are commonly used.

Procedure:

1. Measure and cut the PVC tubing to the lengths shown in the drawing. When measuring, note that 1/2" of tubing fits into the 1/2" pipe fitting.



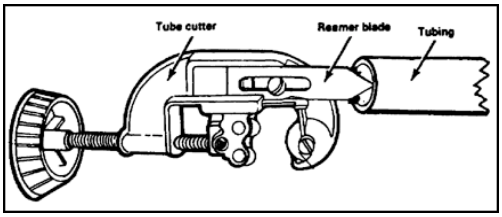
2. To cut the tubing, place the pice to be cut in the tubing cuter and gently screw down on the cutting wheel until it touches the tubing. Spin the cutter about the tubing while closing in in the cutter about 1/8 of a turn per revolution. Too much pressure on the cutter wheel can crush the pipe or damage the wheel. Alternatively, a PVC pipe cutter can also be used. The cutter has a ratchet mechanism and works similarly to a pair of scissors.



3. Remove the burr from the inside of the tubing using the vee shaped reamer on the handle of the cutter.

4. Chemically clean the external surface of the tubing and the inside of the fitting to remove oxides and dirt which prevents the glue from adhering to the PVC using PVC pipe cleaner. Using the brush provided in the can, scrub the surface of the pipe and the fitting with the primer.

5. Since PVC glue sets quickly, the pipe joint should be made within one minute after applying the glue. Apply glue liberally to the outside end of the pipe and the inside of the fitting.



6. Immediately slide the pipe into the fitting pushing it all the way to the bottom. Twist the pipe or fitting 1/4 turn to insure an even layer of glue. Align the fitting and pipe to any layout lines you may have made, and hold in place for 30 seconds.

7. The following table indicates correct setting times based on pipe sizes and ambient temperature. Damp or humid conditions require 50% more curing time.

Initial Set Times for PVC Pipe			
Ambient Temperature, F	Pipe Size 1/2" - 1 1/4"	Pipe Size 1 1/2" - 3"	Pipe Size 4" - 8"
60 - 100	15 min	30 min	1 Hr
40 - 60	1 Hr	2 Hr	4 Hr
0 - 40	3 Hr	6 Hr	12 Hr

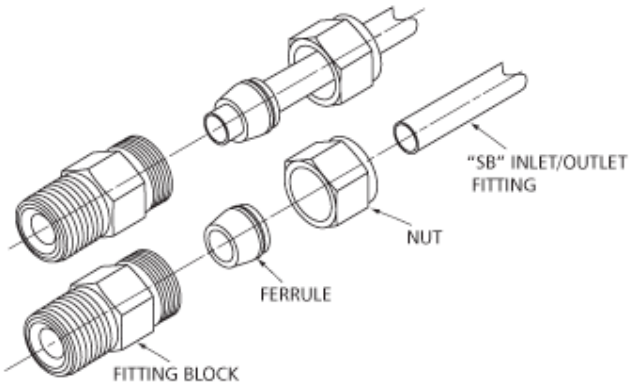
Common PVC Piping Mistakes

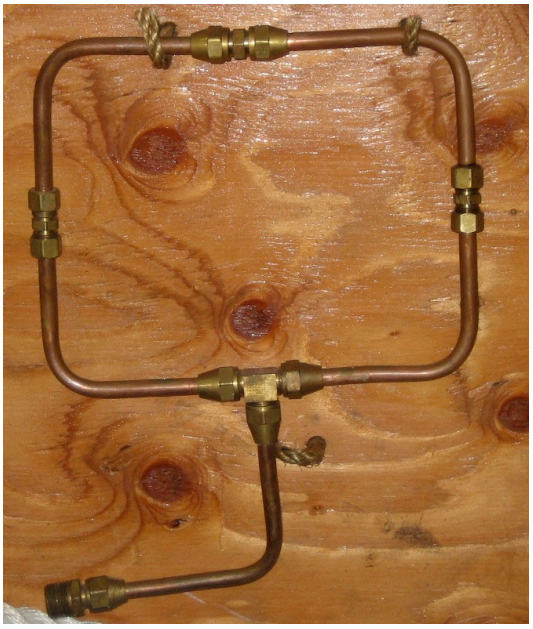
- ☑ Not properly cleaning the joint.
- ☑ Allowing the primer to dry out before applying the cement.
- ☑ Not fully beveling the edge of the pipe or cleaning off all chips so that the pipe will not slide into the fitting completely.
- ☑ Not allowing enough curing time during cold weather or humid conditions.

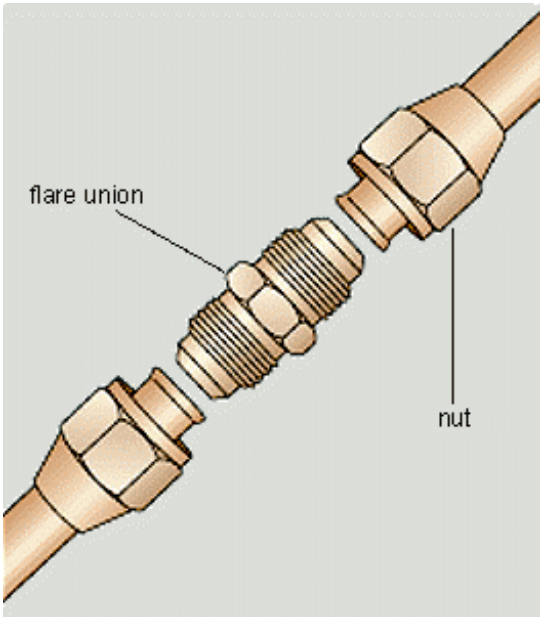
Review Questions

1. What should be done to the outside of the pipe prior to applying the cement?
2. What is the name of the liquid that is applied to the surface of the pipe and fitting prior to applying the cement and why is it used?
3. What type of service can PVC pipe be used for?
4. What is the maximum working temperature that PVC pipe should be exposed to?
5. What are two typical wall thicknesses used with PVC pipe?
6. How long should the pipe and fitting be held together to insure a tight joint?
7. How long do you wait after gluing up a PVC piping system before you can subject it to working pressure?
8. Why should the PVC pipe be dry-fit then taken apart prior to gluing?
9. Why can PVC pipe NOT be used for steam systems or compressed air systems?
10. How does temperature and humidity affect curing times for PVC glued joints?
11. Why is the PVC fitting given a 1/4 turn after it is inserted into the pipe?
12. Why is the end of the PVC pipe chamfered after cutting and prior to gluing?

Lab #6 - Copper Tubing







Soft Tubing with Flared & Compression Fittings

STCW requirement OICEW-1-18

Project time: 2 hours-

"The expected learning outcome is that the trainee…."

Understands and performs procedures required to bend and make up joints in soft refrigeration tubing .

Each student will bend tubing 90 degrees and assemble a flared and compression joint. The student group will construct the project as illustrated and pressure test it with fresh water upon completion.

Tools supplied by the Marine Engineering Department:

- ☑ Tubing cutter with reamer
- ☑ Tubing benders
- ☑ Jig to measure tubing bends
- ☑ Tape measure
- ☑ Flaring die block
- ☑ Flare and tubing nut wrenches of 1/2, 9/16, 5/8, and 3/4"
- ☑ Flaring kit

Safety Equipment Required

- ☑ Safety Glasses

Materials Required

- ☑ 5 pieces of 3/8 soft copper tubing 10" long
- ☑ 1 - 3/8" x3/8" flare adapter
- ☑ 2 - 3/8" x3/8" compression adapters
- ☑ 1 - 3/8" flare Tee
- ☑ 1 - 3/8" compression x 1/2" male NPT adapter

Uses Aboard Ship

Flared and compression fitting copper tubing is used aboard ship for hot and cold domestic potable water, compressed air lines for pneumatic controls, hot water heating systems, refrigeration gas lines (usually double flare), sea water cooled machinery supply lines, gauge lines, diesel fuel lines and chilled water air conditioning.

Copper tubing with flared or compression fittings are not used for high temperature or high-pressure systems, such as steam or high pressure hot fuel oil.

Sizing Tubing

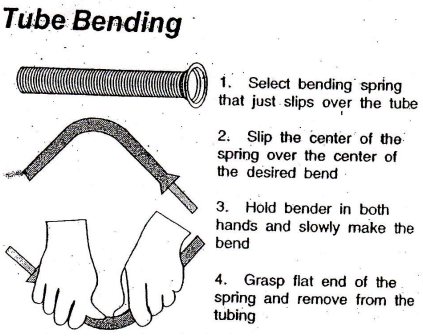
The soft copper tubing being used is called ACR tubing and is used in the air conditioning and refrigeration industry. It is sized by its actual out side diameter. The O.D. determines the amount (volume) of liquid or gas that can flow through the tubing. Diameters such as 1/8, 1/4, 5/16, 3/8, 7/16, 1/2, 5/8, and 3/4 inch are commonly used.

The wall thickness of the tubing determines the pressure the tubing can withstand and is designated by three letters and colors:

- K color coded GREEN, the thickest.
- L, color coded BLUE, medium thickness for general plumbing.
- M, color coded RED, thin for heating and cooling coils.

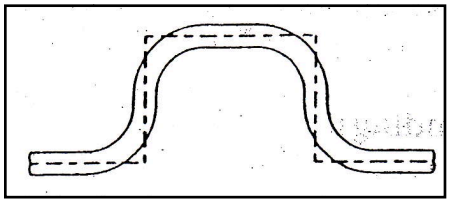
Bending Tubing

Tubing material that has been annealed or softened by a heating process in sizes from 3/16" to 3/4" can be easily bent using hand tube benders. Simple spring type benders to diverse mechanically driven types can be used.

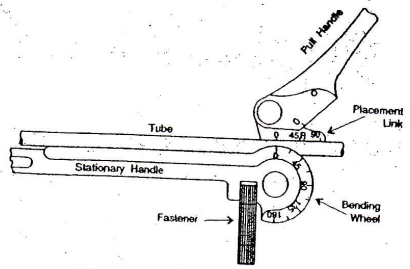


Tube Gain

Tube Gain or bending length increase occurs when bending tubing. The actual bend made does not follow the absolute profile of the straight line layout, but short cuts the angles. This short cutting of the corners gives additional length to the remaining straight tube and is commonly called gain. Gain for 90-degree bends is approximately equal to the O.D. of the tube being bent.

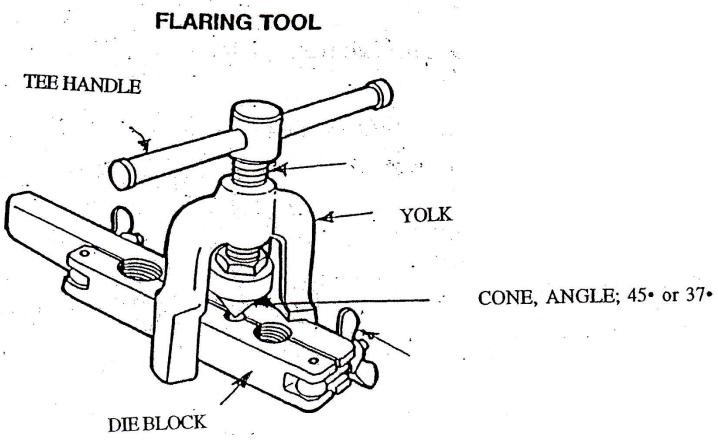


A tube bent around a corner follows a shortened path.

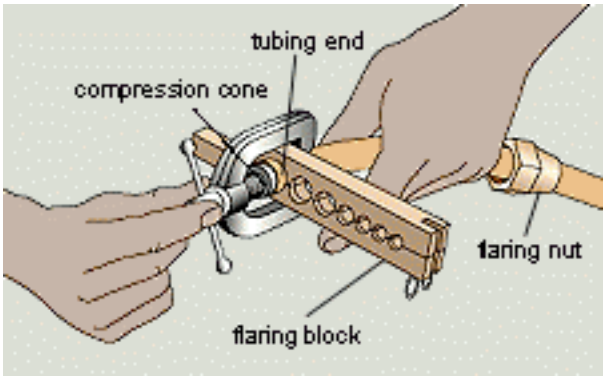


Flaring

Flare fittings can be used to join soft lengths of tubing to fittings. To make a tight fluid seal against the fitting, the end of the tube must be accurately flared with a flaring tool. When flaring, soft tubing is used to prevent splitting of the flare.

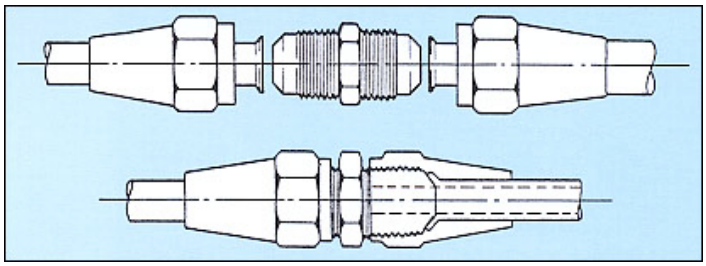


The tool has a die block with holes for several sizes of tubing. The two halves of the die block are clamped around the tubing and a yolk is slid onto the die block from one end. The yolk has a TEE handle that drives a screw feed cone into the tubing end creating the flare against the die block.



Flaring the Tubing

1. Put the tubing nut on the shortest end of the 90 degree tubing bend. ***Make sure the threads of the nut are towards the end of the tubing that is to be flared.*** Slide the nut down out of the way.
2. Insert the tubing into the correct hole size in the die block. ***Make sure that the end of the tubing to be flared protrudes through the side of the die block that has the flare angle on it.*** Extend the end of the tubing to be flared approximately 1/8" above the die block. Clamp the die block halves together tightly.
3. Slide the yolk over the die block and center the cone over the end of the tubing.. Screw down on the tee handle driving the cone into the tubing end creating the flare. Do not drive the cone down too far as this will thin out the flare and make it weak or it can drive the outer edge of the flare out too far keeping the nut from sliding over it.
4. Release the yolk and die from the tubing.
5. Inspect the flare for uneven edges, splits, or cracks. If any are present the tubing will have to be re-cut and re-flared.
6. Once the end is flared, attach the flared end nut onto the fitting.

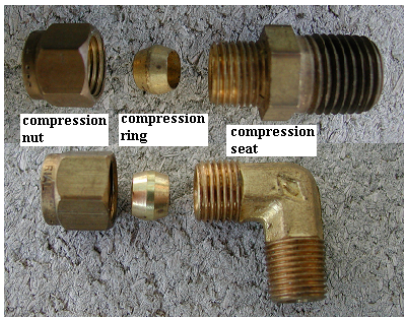


Common Flaring Mistakes

- ☑ Forgetting to install the tubing nut on the tubing before flaring the tubing.
- ☑ Not properly removing the burr inside the tubing after cutting.
- ☑ Not having enough tubing extend above the die block.
- ☑ Having too much tubing extend above the die block.
- ☑ Using too much force to form the flare.

Compression Fittings

A compression fitting is a type of coupling that makes a strong, permanent connection between a piece of pipe and a fitting. The fitting consists of three parts: a compression nut, a compression ring (also called a ferrule), and a compression seat. Installation of

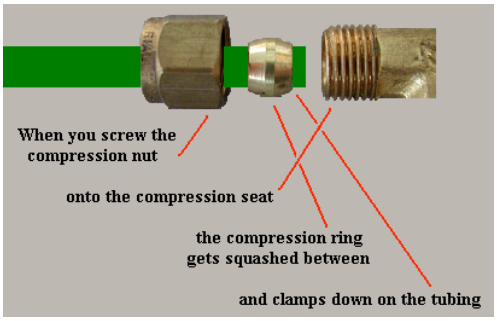


compression fittings is quick and easy, but can be put together incorrectly as well. To install compression fittings onto a 90 degree bend:

1. Slide the compression nut onto the long side of the unflared 90 degree bend.
2. Slide the ferrule onto the tubing.
3. Line up tubing and push into one end of the body of the compression adapter fitting. Push the nut down over the ferrule and screw it onto the body finger tight.
4. When the tubing nut is tightened with wrenches, the ferrule is compressed between the nut, the body, and around the outside of the tubing creating the seal.

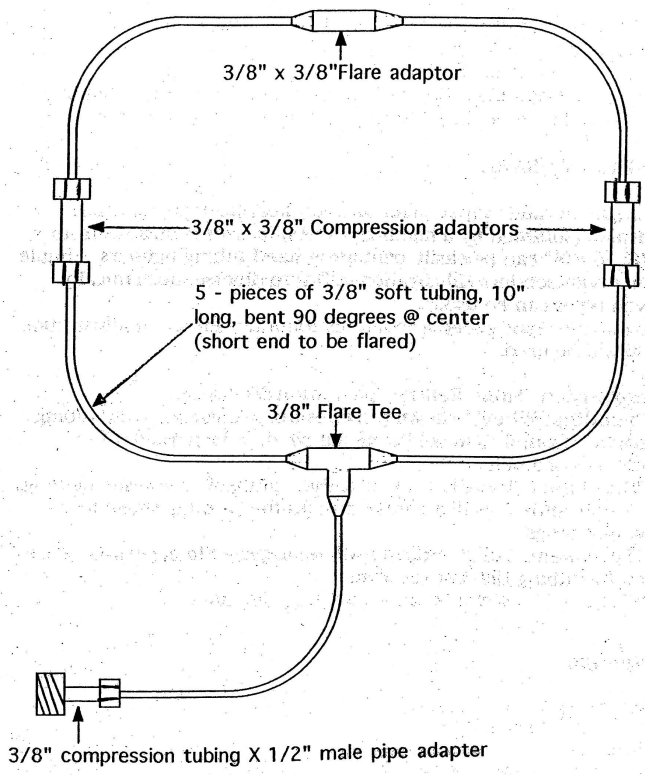
Common Compression Fitting Mistakes

- ☑ Not pushing tubing far enough into fitting or ferrule is at or partially beyond end of tubing. Tubing may blow out of fitting under pressure or end of tubing may be crushed almost closed when nut is tightened.
- ☑ Over tightening nut, crushing tubing too far in restricting fluid flow.



Procedure for Tubing Project

The copper tubing project involves making a piping system as shown here Each student shall make part of the project, with the entire group testing the system.



1. Unroll and straighten the tubing from the coil. Measure and mark a 10” section, then cut and ream the piece.
2. Using a tubing bender, bend the tube 90 degrees, maintaining equal lengths on either side of the bend. Note the centering marks on the tubing bender for this purpose.
3. Install flared or compression fittings as shown in the diagram.
4. With the project assembled and all the compression and flare nuts finger tight, each student is to tighten the flare nut and compression nut on his bent tubing section following the directions herein.
5. The object with both flare and compression fittings is to tighten them just enough to prevent leakage under pressure.

6. A special wrench called a “Tubing Wrench” is used on the nuts to turn them and prevent rounding them off. If it is possible to use a tubing wrench to hold the body of the fitting from turning, use it here also for the same reason. If not, carefully use an “Open End Wrench” of the correct size.
7. Tighten flare nuts snugly; do not over tighten. If they leak under pressure, tighten again until the leakage stops.
8. Tighten compression nuts as follows:
   a. Before tightening the nut with wrenches, pencil mark the nut to indicate its starting position.
   b. Always use two wrenches, one on the fitting and one on the nut. Failure to do this can cause the tubing to twist and crimp.
   c. For tubing sizes of 3/16” or less, tighten the nut 3/4 of a turn from finger tight. For larger sizes, tighten the nut 1 1/4 turns.
   d. If leakage occurs under pressure, tighten until leakage stops.
9. If considerable tightening is done and the fitting continues to leak, there is a problem with the joint and it must be replaced.
10. Test the system using water.

Review Questions

1. What three types of services can flare fittings be used for?

2. What is the name of the tool used to hold the tubing while the flare is being formed?

3. What are the two angles used for flaring and what is each one typically used for?

4. What will happen if the tubing cutter wheel is turned in too much during the cutting process?

5. Why are tubing nut wenches used instead of regular open end wenches or adjustable wenches?

6. How far should the tubing protrude above the die block for a correct flare?

7. With what type of service would a double-flare be used?

8. What is annealed tubing and why is it used?

9. What could cause the finished flared tubing not to seal properly?

10. What can happen if the tubing is not extended enough out of the die block when the tubing is flared?

11. What is the name of the piece that fits under the nut on the tubing for compression fittings to create the seal?

12. With compression fittings why is it so important to cut the end of the tubing square?

13. How much should 3/8" tubing compression nuts be tightened initially with wrenches?

14. Due to “tubing gain” when bending tubing 90 degrees, how much is the increase in length on the unbent section of 1/2” tubing?

NOTES

Lab #7 - Black Iron Pipe

Black Iron Pipe Fitting

STCW Requirement - OICEW-2-1C

Project time: 2 hours

"The expected learning outcome is that the trainee...."

Understands and performs the operations involved in making proper leak-free threaded joints.

Each student will cut and thread pipe and the student group will assemble the black iron threaded pipe project as illustrated and will pressure test the finished project with fresh water.

Tools supplied by the Marine Engineering Department:

- ☑ Pipe cutter with reamer
- ☑ Pipe vise
- ☑ Pipe wrench
- ☑ Threading dies with ratchet handle
- ☑ Files
- ☑ Tape measure
- ☑ Pipe dope and thread tape

Safety Equipment Required

- ☑ Safety Glasses
- ☑ Work Gloves

Materials Required

- ☑ 3 - 90 degree 1/2” elbows
- ☑ 1 - Tee, 1/2”
- ☑ 1 - Union, 1/2”
- ☑ 6 feet of 1/2” Black Iron pipe

Uses Aboard Ship

Black iron threaded pipe (aka steel) is used aboard ship for most of the piping systems including steam, sea water, lube oil, fuel oil, compressed air, condensate water, feed water, and fresh water cooling. High-pressure steam, feed water and larger fuel lines are required to be welded rather than threaded for greater strength.

Types of Pipe

Pipe is available in many types of material including black iron, stainless steel, bronze, brass, plastic (PVC) and fiberglass. Steel pipe can be coated with zinc to reduce corrosion, but never with oil piping systems as the zinc flakes off.

Pipe Sizes

Pipe is sold in standard sizes such as 1/2, 3/4, 1, 1 1/4, 1 1/2, 2, etc. These are nominal sizes based on the approximate ID of the pipe. The strength of the pipe is based on its wall thickness.

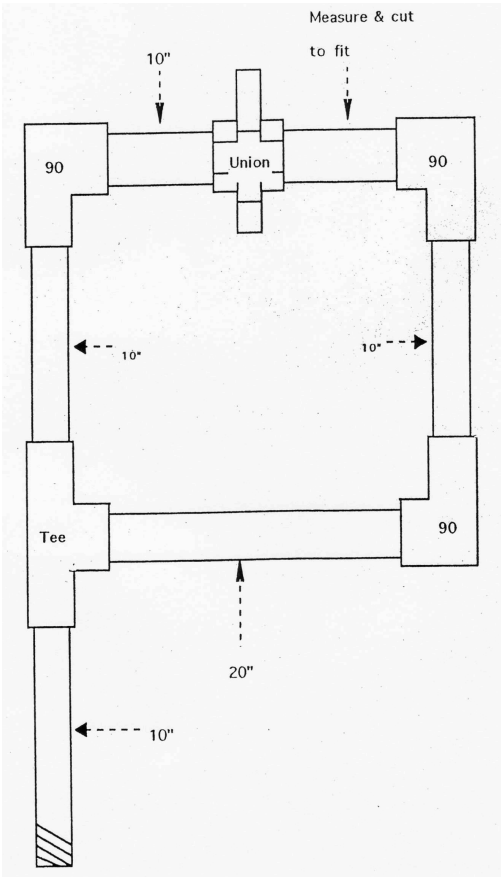
To make pipe stronger, the wall thickness increases, however the outside diameter (OD) remains the same, the inside diameter (ID) decreases. To insure designed volume flow in a piping system, a larger pipe size is required as the pressure is increased. Each pipe size is available in a number of wall thicknesses, called schedules. The greater the Schedule number, the greater the wall thickness. Standard schedules are 10, 20, 40, 80, 120, and 160. Standard sizes are 40, 80, and 160.

Threads

Threads on the outside of a pipe are called ***male threads*** and are cut into the pipe with a ***DIE***. Threads on the inside of fittings are called ***female threads*** and are cut with a ***TAP***. Pipe threads are normally ***right hand*** and are ***tapered 3/4" per foot*** in order to jam the pipe and fitting threads as they are screwed together creating a tight seal. A good fit will have two or three threads still exposed on the pipe when the joint is tight. Pipe dope or thread tape is used as a sealant that helps the threads make a leak free joint.

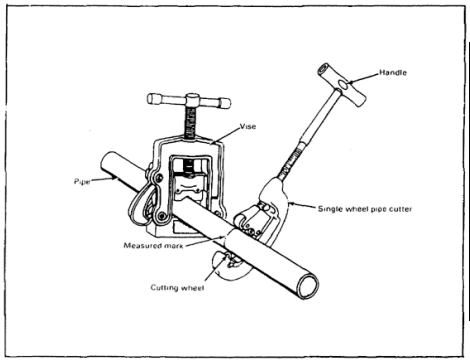
Procedure for Black Iron Piping Project

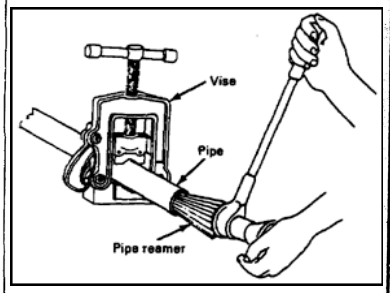
The black iron piping project involves making a piping system as shown here Each student shall make part of the project, with the entire group testing the system.

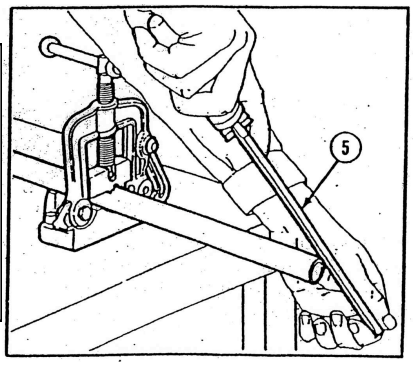


1. MEASURE AND CUT THE PIPE to the lengths shown on the drawing. Measure, cut and install the right top piece after the rest of the system is assembled. Note that 1/2" pipe threads into the fittings approximately 5/8".
2. Use a pipe cutter to cut the pipe to the correct length.
   a. Open the jaws of the cutter and place over the end of the pipe. Tighten handle by rotating it until the cutter wheel touches the pipe. Turn in an additional 1/4 turn. Rotate entire cutter around the pipe, turning the handle 1/4 turn on each revolution.
   b. As the cutter cuts, the inside diameter of the pipe will be slightly reduced as metal is extruded inward. Too much force on the cutter (more than 1/4 turn) will cause

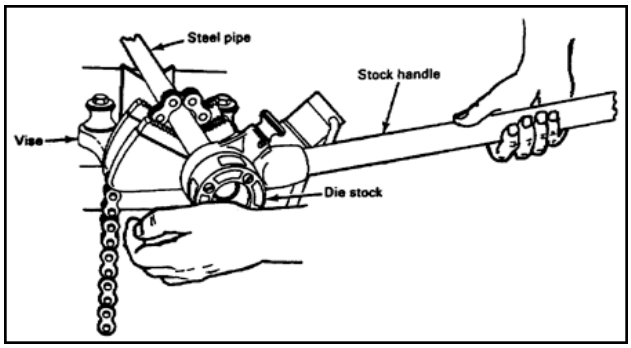
increased extrusions or breakage of the wheel. Increased force will also cause the outside diameter to increase or raise slightly, making it difficult to fit the die.



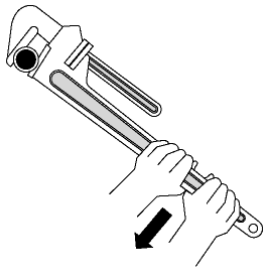




3. Remove the burr. After the pipe is cut, any burrs must be removed using a pipe reamer. DO NOT examine the sharp burr with your fingertip as it will cut your finger.
4. File the shoulder of the pipe to a 45 degree bevel as shown.
5. Threading. Use a die and die stock to thread the ends of the pipe. Use the following steps:



   a. Insert the correct size die in the die stock.
   b. Slide the die stock over the pipe end and apply pressure to the stock with one hand.
   c. With the other hand, turn the stock handle clockwise slowly until the die has taken a bite on the pipe.
   d. Give the stock handle one complete clockwise turn and then back off a quarter turn, applying cutting oil as needed.
   e. Repeat this action until ¼ inch of the pipe is beyond the die stock.
   f. Remove the die stock by turning the handle in a counterclockwise direction.
6. After the pipe is cut and threaded, clean the piece, apply a small amount of pipe sealant, and screw on the fitting using a pair of pipe wrenches.
   a. Pipe wrenches have adjustable jaws with teeth that cut into the pipe when rotated in the direction of the jaws. Rotating the opposite direction to the jaw opening will cause the wrench to come loose, sometimes with violent injuries.
   b. Always use two pipe wrenches at a time, one on the pipe and the other on the fitting. Never use a damaged pipe wrench.



7. Test the system using water.

Common Piping Mistakes

- ☑ Not beveling the pipe end enough.
- ☑ Trying to cut too much thread without reversing to clean the chip and the die.
- ☑ Not using enough cutting oil.
- ☑ Threading too far.
- ☑ Not threading far enough.
- ☑ Forgetting to use pipe sealant.

Review Questions

1. What does the schedule for pipe indicate?

2. What type of service is black iron (steel) pipe used for aboard ship?

3. What is the name of the tool used to cut male threads on a pipe called?

4. What is the name of the tool used to remove the inside burr on the pipe after it has been cut?

5. Why is cutting oil used when threading pipe?

6. How much taper is commonly used on a pipe thread and why?

7. If the chip is not removed when threading pipe what can happen if you force the die handle to cut more?

8. Why is pipe dope or tape used on pipe joints?

9. What is the name of the tool used to cut female threads?

10. If you decided to use a larger schedule pipe, but the same size, what would happen to the flow rate in the system?

11. What are three commonly used pipe schedules used aboard ship?

12. Why is it necessary to remove the burr from inside of the pipe after it has been cut?

13. Is pipe sized according to the inside or the outside diameter?

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