

Chapter 1

INTRODUCTION TO THE MACHINE SHOP

GENERAL INFORMATION

FORMS, RECORDS, AND REPORTS

Accurate records are valuable. Unit officers are responsible for completion of forms, records, and reports. DA Pam 738-750 lists records, reports, and authorized forms that are normally used for inspection and repair. Properly executed forms authorize and record repair or replacement of materiel. The forms, records, and reports document the work required, follow the progress of the work within the shops, and indicate the status of the material upon completion of repairs.

FIELD REPORT OF ACCIDENTS

The reports necessary to comply with the requirements of the Army Safety Program are prescribed in detail in AR 385-40. These reports are required for any accidents involving injury or damage. For a listing of all forms, refer to DA Pam 25-30.

Any deficiencies detected in the equipment covered herein should be immediately reported in accordance with DA Pam 738-750. These reports will be submitted as an Equipment Improvement Recommendation on SF 368.

DEFINITION OF MACHINE TOOLS

Machine tools are power-driven equipment designed to drill, bore, grind, or cut metal or other material.

LISTING OF MACHINE TOOLS

A complete list of machine tools including specialized machine tools currently authorized for issue is in Component List C 3405/70-IL.

SPECIALIZED MACHINE TOOLS

In view of the different design and operating features incorporated in specialized machine tools (cylinder boring

machines, brake reliners, valve seat grinders, and so forth) by various manufacturers, no attempt has been made to include information pertinent to them in this manual. For complete information on these tools, see pertinent TM 9-3400-, TM 9-5100-, and TM 9-9000-series technical manuals covering the specific machines.

RISK-MANAGEMENT

To assure a high degree of safety, no machine -tool is to be used unless the risk management process as outlined below is understood and applied by the user and the supervisor:

1. Identify the potential hazard(s) that the machine tool can generate.
2. Assess the probability and severity of the hazard(s) by utilizing the Risk Assessment Matrix in figure 1-1. Risk acceptance decision authority for the risk levels is as follows:
 - a. **Extremely high** - CG, TRADOC; DCG, TRADOC; or the Chief of Staff, TRADOC.
 - b. **High** - Major subordinate commands, installation commanding generals, and school commandants of general officer rank.
 - c. **Moderate and low** - Delegated to the appropriate level in your unit chain of command.
3. Determine the risk control measures that will eliminate the hazard(s) or reduce the risk.
4. Implement the risk control measures before and during operation of the machine tool to eliminate the hazards or reduce their risks.
5. Supervise and evaluate the process. Enforce the established standards and risk control measures. Evaluate the effectiveness of the control measures and adjust/update them as necessary.

		PROBABILITY				
		Frequent	Likely	Occasional	Remote	Unlikely
		A	B	C	D	E
S E V E R I T Y	Catastrophic I	Extremely High			High	Moderate
	Critical II	High	High		Moderate	
	Marginal III	High	Moderate			
	Negligible IV	Moderate	Low			

Figure 1-1. Risk assessment matrix.

PROBABILITY

- A. **FREQUENT** - Individual soldier/item - Occurs often in the career/equipment service life. All soldiers or item inventory exposed - Continuously experienced during operation/mission.
- B. **LIKELY** - Individual soldier/item - Occurs several times in career/equipment service life. - All soldiers or item inventory exposed. - Occurs frequently during operator/mission.
- C. **OCCASIONAL** - Individual soldier/item. - Occurs sometimes in career/equipment service life. All soldiers or item inventory exposed. Occurs sporadically, or several times in inventory service or operations/mission.
- D. **REMOTE** - Individual soldier/item - Possible to occur in career/equipment service life. All soldiers or item inventory exposed, Remote chance of occurrence - Expected to occur sometime in inventory service life or operation/mission.
- E. **UNLIKELY** - Individual soldier/item - Can assume will not occur in career/equipment/service life. All soldiers or item inventory exposed. - Possible, but improbable; occurs only very rarely during operation/mission.

SEVERITY

- I. **CATASTROPHIC** - Death or permanent total disability. System loss. Major property damage.
- II **CRITICAL**- Permanent partial disability. Temporary total disability in excess of 3 months. Major system damage. Significant property damage.
- III. **MARGINAL** - Minor injury. Lost workday accident with compensable injury/illness. Minor system damage. Minor property damage.
- IV. **NEGLIGIBLE** - First aid or minor supportive medical treatment. Minor system impairment.

RISK LEVELS

- EXTREMELY HIGH** - Loss of ability to accomplish mission.
- HIGH** - Significantly degrades mission capabilities in terms of required mission standards.
- MODERATE**- Degrades mission capabilities in terms of required missions standards.
- LOW** - Little or no impact on accomplishment of mission.

MACHINE SHOP WORK

SCOPE

Machine shop work is generally understood to include all cold-metal work by which an operator, using either power driven equipment or hand tools, removes a portion of the metal and shapes it to some specified form or size. It does not include sheet metal work and coppersmithing.

LAYING OUT WORK

“Laying out” is a shop term which means to scribe lines, circles, centers, and so forth, upon the surface of any material to serve as a guide in shaping the finished workpiece. This laying out procedure is similar to shop drawing but differs from it in one important respect. The lines on a shop drawing are used for reference purposes only and are not measured or transferred. In layout work, even a slight error in scribing a line or center may result in a corresponding or greater error

in the finished workpiece. For that reason, all scribed lines should be exactly located and all scriber, divider, and center points should be exact and sharp.

SCRIBING LINES ON METAL

The shiny surface, found on most metals, makes it difficult to see the layout lines.

Layout dye (Figure 1-2), when applied to the metal surface, makes it easier for the layout lines to be seen. Layout dye is usually blue and offers an excellent contrast between the metal and the layout lines.

Before applying layout dye, ensure that all grease and oil has been cleaned from the work surface. Otherwise the dye will not adhere properly.

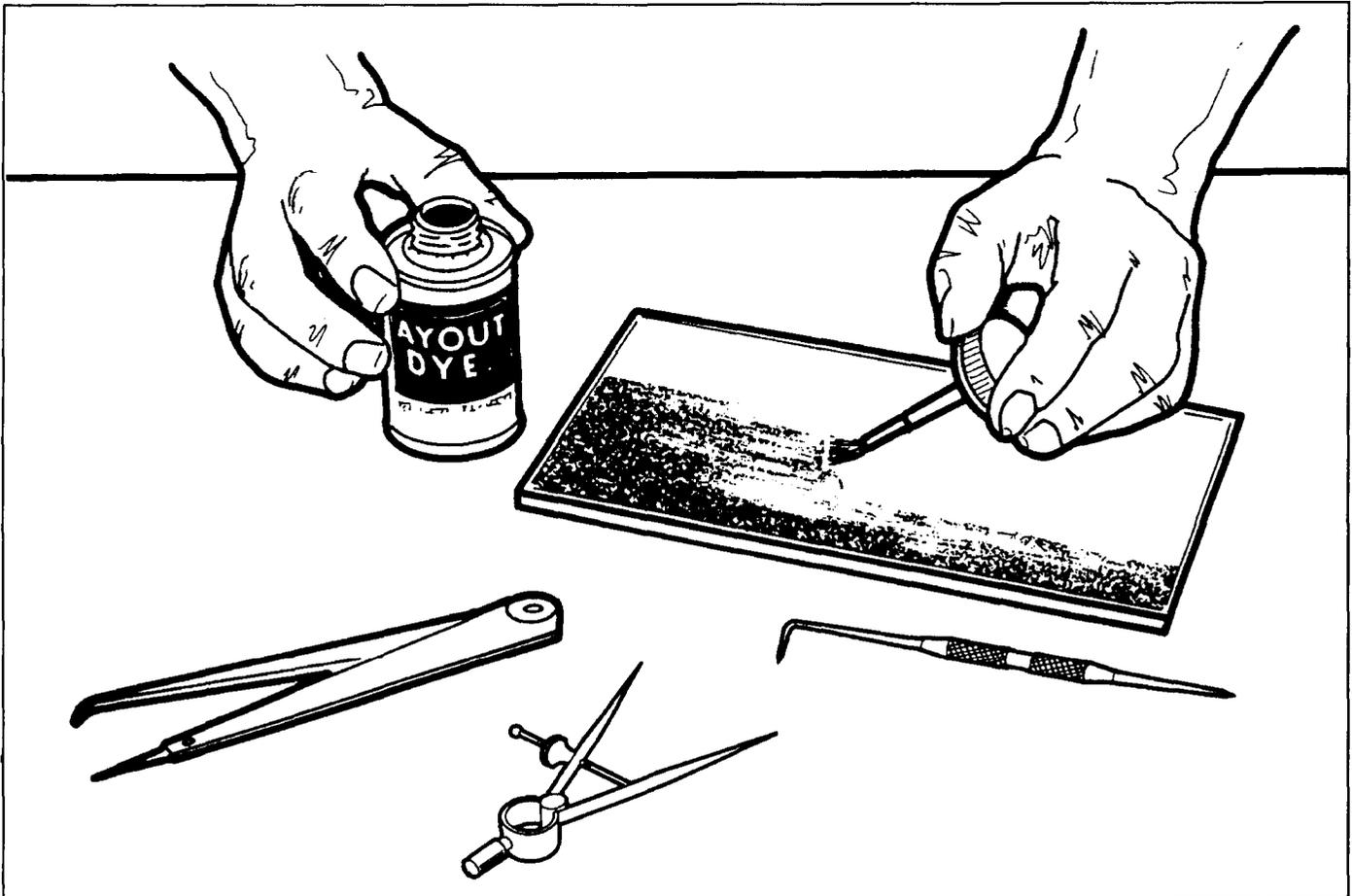


Figure 1-2. Applying layout dye.

COMMON LAYOUT TOOLS

Scriber

To obtain an accurate layout, fine lines must be scribed in the metal. A scriber (Figure 1-3) is the layout tool that is used to produce these lines. The point is made of hardened steel and is kept sharp by honing on an oilstone.

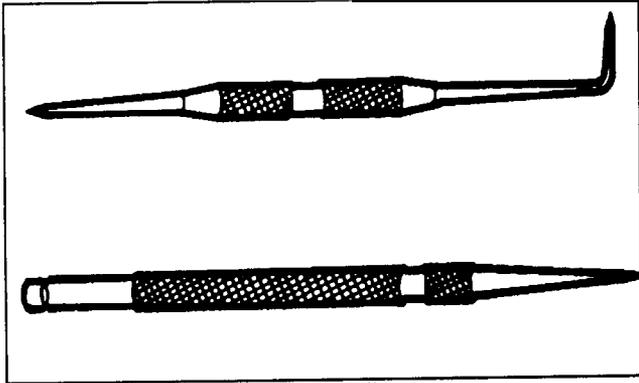


Figure 1-3. Scribers.

Divider

When laying out circles, arcs, and radii, it is best to use the divider (Figure 1-4). The legs of the divider must be of the same length and be kept sharp. The divider can be used to

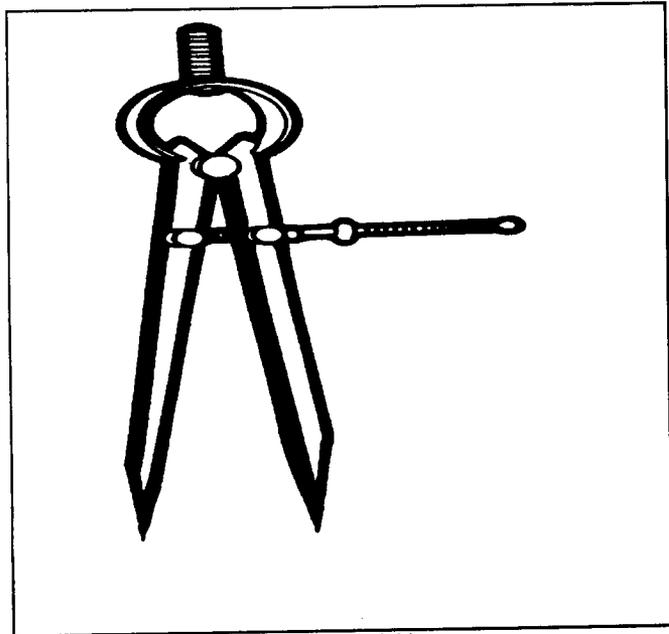


Figure 1-4. Divider.

lay out and measure distances (Figure 1-5). To set the divider to the correct length, place one point on an inch mark of a steel rule and open the divider until the other leg matches the correct measure-merit required (Figure 1-6).

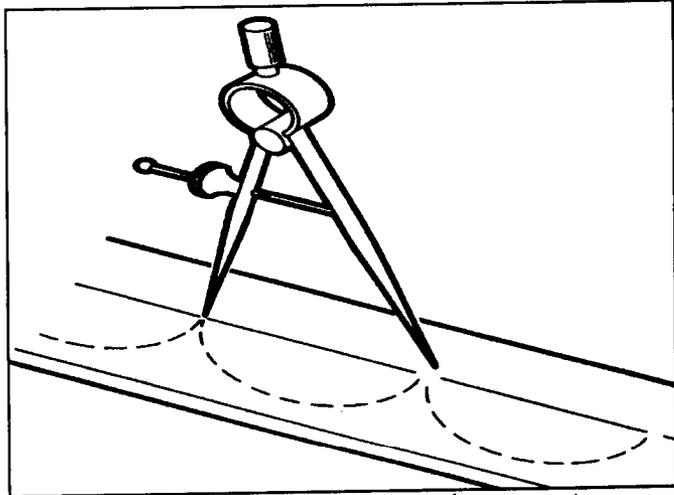


Figure 1-5. Using divider to layout equal measurement.

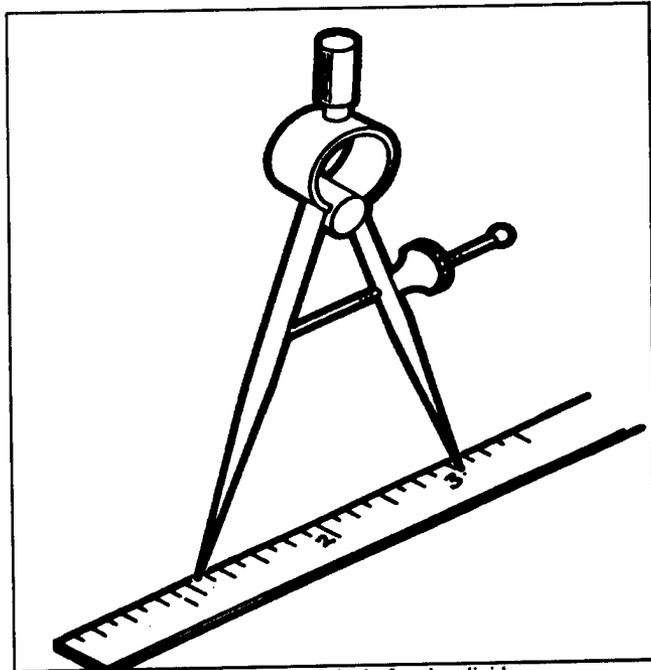


Figure 1-6. Correct method of setting dividers.

Trammel

When scribing circles, arcs, and radii that are too large to be produced with the divider, a trammel should be used (Figure 1-7). The trammel is made of three main parts: the beam, two sliding heads with scriber points, and an adjusting screw that is attached to one of the heads. The trammel can be made to scribe larger distances with the use of extension rods. This layout tool is set in the same manner as the divider.

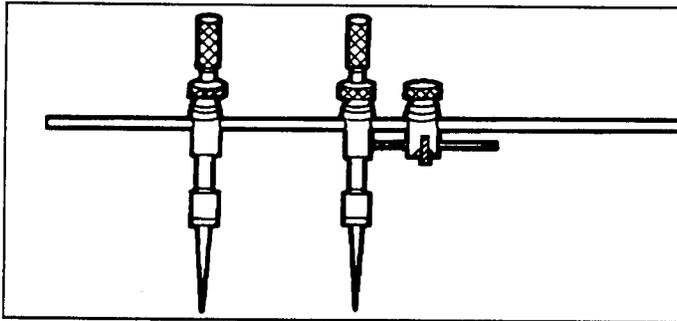


Figure 1-7. Trammel.

Hermaphrodite Caliper

The hermaphrodite caliper (Figure 1-8) is a tool used to lay out lines that are parallel with the edges of the workpiece (Figure 1-9). It can also be used to locate the center of cylindrical shaped workpieces (Figure 1-10).

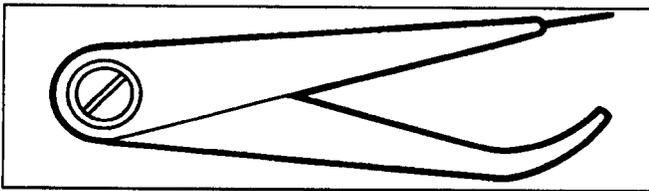


Figure 1-8. Hermaphrodite calipers.

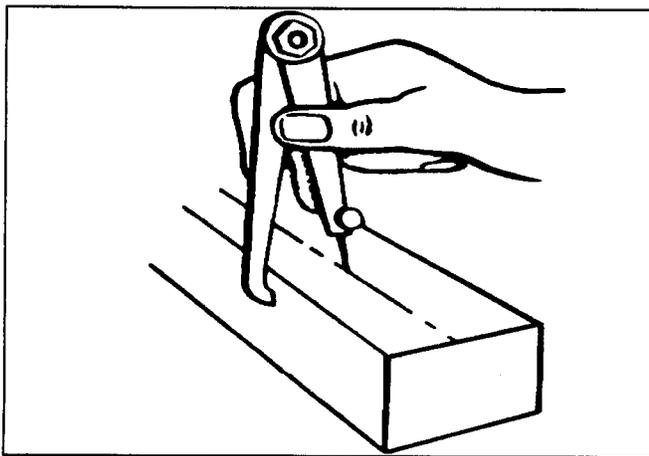


Figure 1-9. Laying out lines parallel to the edge of workpiece.

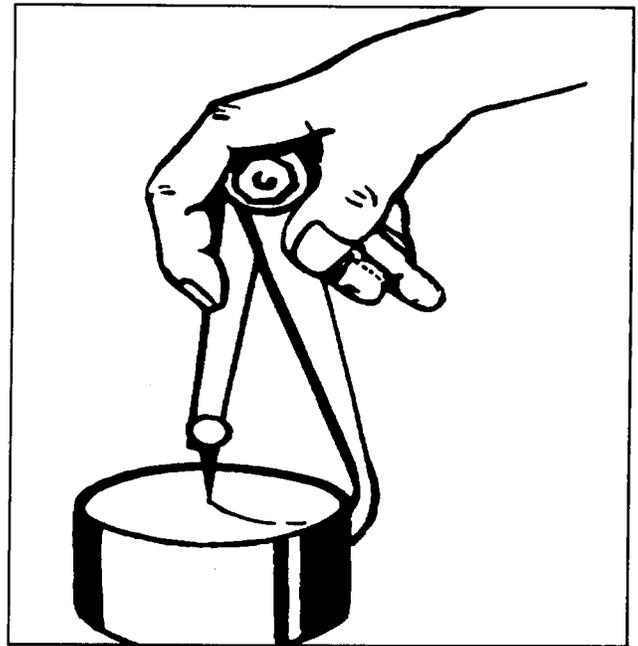


Figure 1-10. Obtaining center of cylindrical work.

Surface Gage

A surface gage (Figure 1-11) is used for many purposes, but is most often used for layout work. The gage can be used to scribe layout lines at any given distance parallel to the work surface (Figure 1-12).

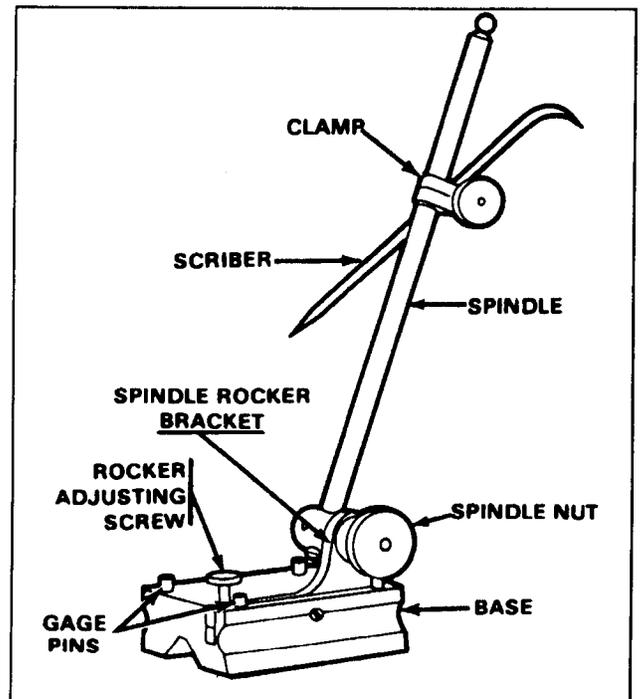


Figure 1-11. Surface gage.

Surface Plate

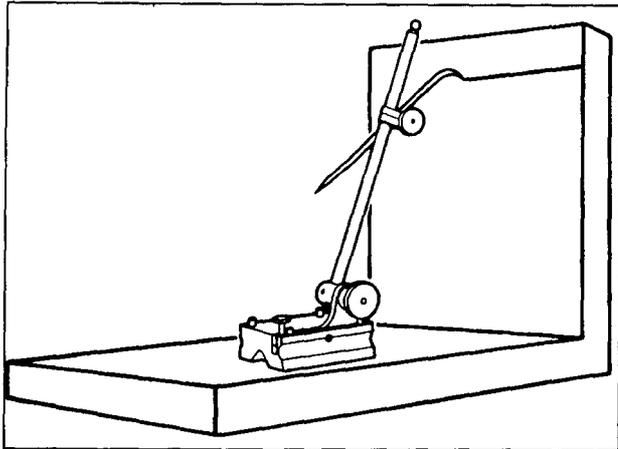


Figure 1-12. Parallel line scribed with surface gage.

A surface plate (Figure 1-14) provides a true, smooth, plane surface. It is used in conjunction with surface and height gages as a level base on which the gages and the workpiece are placed to obtain accurate measurements. These plates are made of semi-steel or granite and should never be used for any job that would scratch or nick the surface.

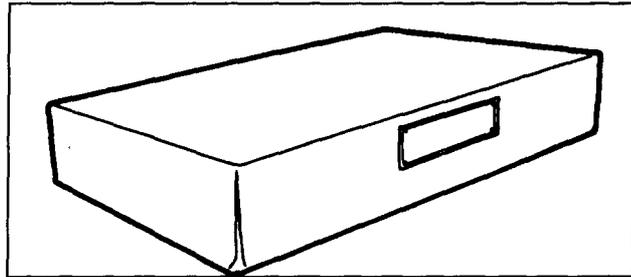


Figure 1-14. A granite surface plate.

The spindle may be adjusted to any position with respect to the base and tightened in place with the spindle nut (Figure 1-11). The rocker adjusting screw provides for finer adjustment of the spindle by pivoting the spindle rocker bracket. The scriber can be positioned at any height and in any desired direction on the spindle by adjusting the scriber. A surface plate and combination square (Figure 1-13) are needed to set the surface gage to the correct dimension.

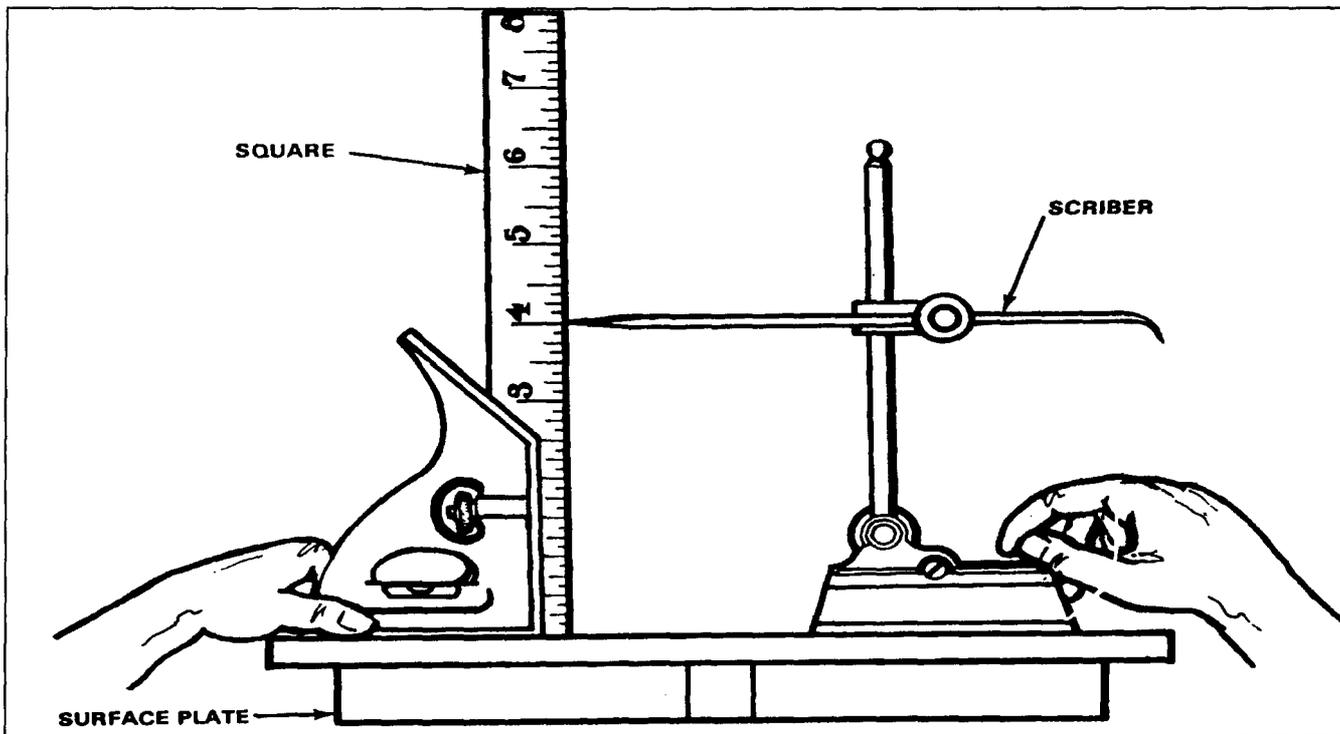


Figure 1-13. Setting surface gage scriber on surface plate 2.

Vernier Height Gage

The vernier height gage (Figure 1-15) is a caliper with a special foot block to adapt it for use on a surface plate. Height gages are available in several sizes: the most common are the 10, 18, and 24 inch gages in English measure and the 25 and 46 cm gages in metric measure. Like the vernier caliper, these height gages are graduated in divisions of 0.025 inch and a vernier scale of 25 units for reading measurements to thousandths of an inch. Always be sure the bottom of the foot block (Figure 1-15) is clean and free from burrs.

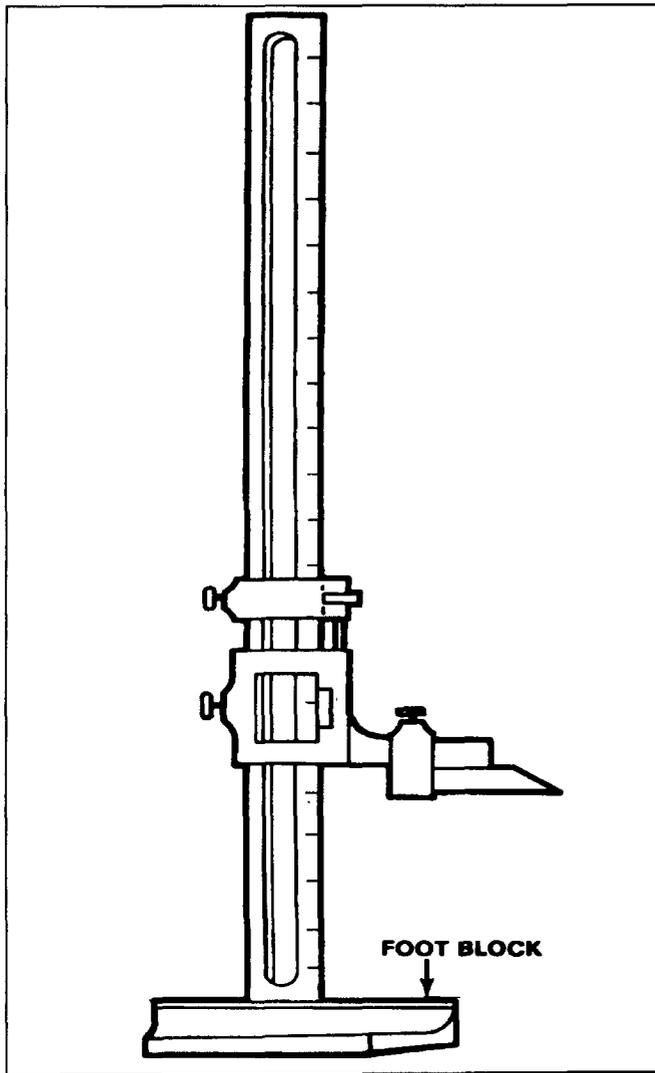


Figure 1-15. Vernier height gage.

Figure 1-16 shows the height gage with a tungsten carbide marker. This marker is used to lay out lines on glass, hardened steel, or other hard materials.

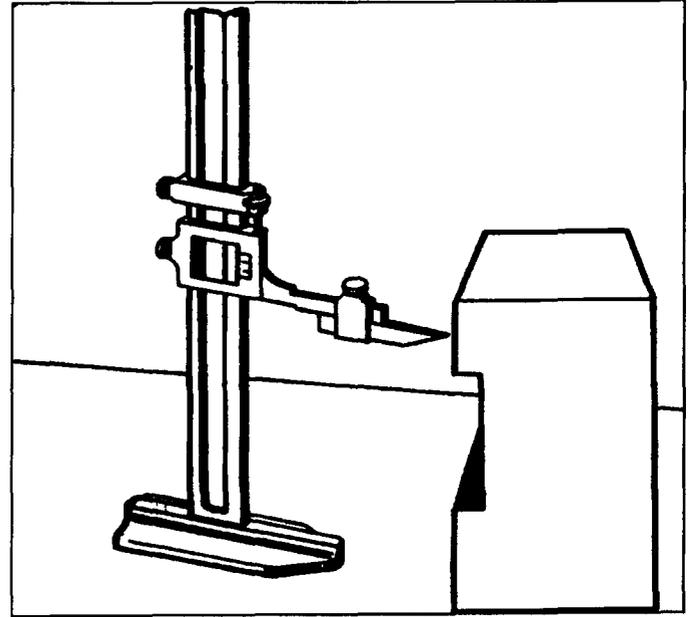


Figure 1-16. Using height gage with carbide marker.

Figure 1-17 illustrates the use of an offset scribe with the height gage. This scribe reaches below the gage base. Do not attempt to adjust the sliding jaw while it is clamped to the upright beam.

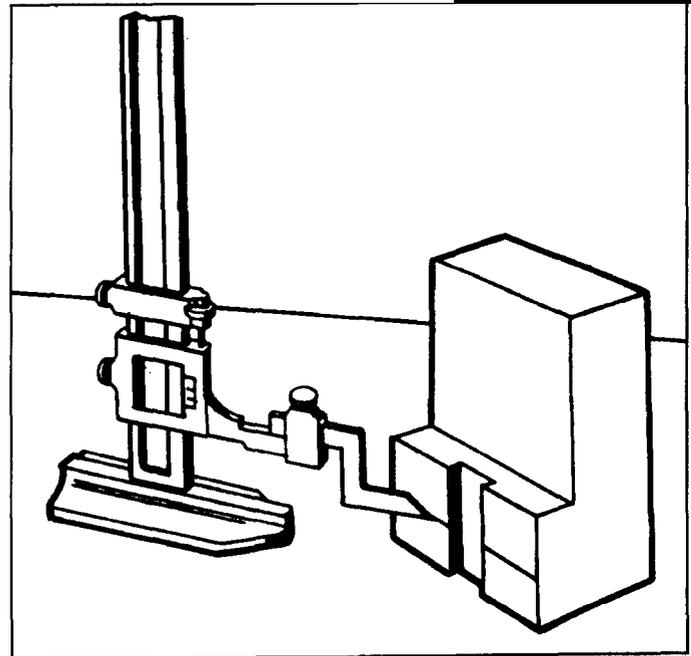


Figure 1-17. Using height gage with offset scribe.

Combination Square Set

The combination square set (Figure 1-18) is used for a number of layout operations. The set consists of a blade (graduated rule), square head, protractor, and center head.

Blade

The blade is designed to allow the different heads to slide along the blade and be clamped at any desired location. The groove in the blade is concave to eliminate dirt buildup and permit a free and easy slide for the heads. By removing all the heads, the blade may be used alone as a rule.

Square Head

The square head is designed with a 45° and 90° edge, which makes it possible to be used as a try square and miter square. By extending the blade below the square, it can be used as a depth rule. The square head can also be used as a level.

Protractor Head

The protractor head is equipped with a revolving turret graduated in degrees from 0 to 180 or to 90 in either direction. It is used to measure or lay out angles to an accuracy of 1°.

Center Head

The center head, when inserted on the blade, is used to locate and lay out the center of cylindrical workpieces.

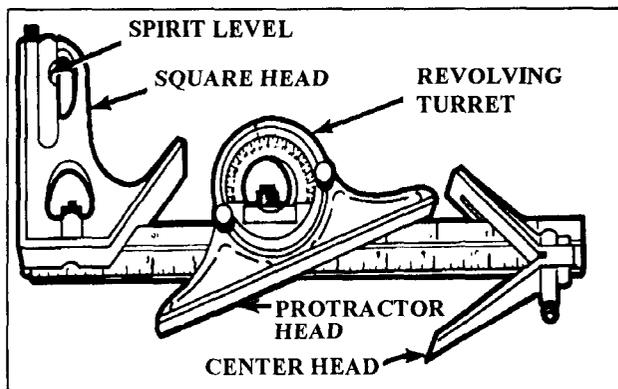


Figure 1-18. Combination square set.

Bevel Protractor

The bevel protractor (Figure 1-19) consists of an adjustable blade with a graduated dial. The blade is usually 12 inches long and 1/16 inch thick. The dial is graduated in degrees through a complete circle of 360°. The most common use for this tool is laying out precision angles. The vernier scale is used for accurate angle adjustments and is accurate to 5 minutes or 1/12°.

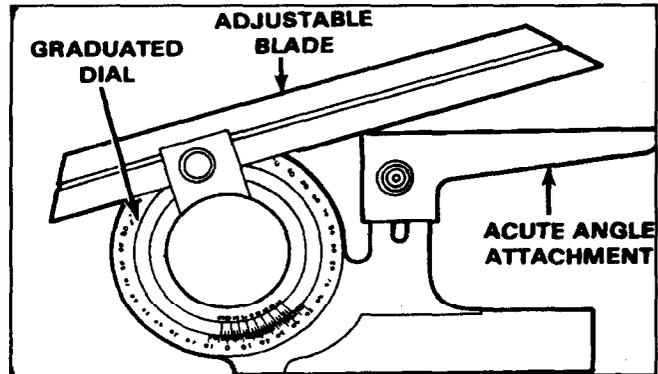


Figure 1-19. Bevel protractor.

STEPS IN MAKING A LAYOUT

Planning before beginning any layout is one of the most important steps. Each job may require different layout tools depending on the accuracy needed; however, there are certain procedures which should be followed in any layout. Figure 1-20 shows a typical layout.

- Study the shop drawing or blueprint carefully before you cut off the stock. Allow enough material to square the ends if required.
- Remove all oil and grease from the work surface and apply layout dye.
- Locate and scribe a reference or base line. All the other measurements should be made from this. If the workpiece already has one true edge, it can be used in place of the reference line.
- Using the base line as a reference line, locate and scribe all center lines for each circle, radius, or arc.
- Mark the points where the center lines intersect using a sharp prick punch.
- Scribe all circles, radii, and arcs using the divider or trammel.
- Using the correct type protractor, locate and scribe all straight and angular lines.
- Scribe all lines for internal openings.
- All layout lines should be clean, sharp, and fine. Reapply layout dye to all messy, wide, or incorrect lines and rescribe.

JIGS AND FIXTURES

The layout tools mentioned in this section are only the most commonly used. For more information on the use and care of these tools and other layout and measuring tools, refer to TM 9-243.

The primary purpose of jigs and fixtures is to align the tool and hold the workpiece properly during machining. A fixture is a device which holds the work while cutting tools are in operation. It differs from a jig in that it has no guides or special arrangements for guiding tools. A jig is also a fixture for locating or holding the work and guiding the cutting tool in operations such as drilling, reaming, counterboring, and countersinking.

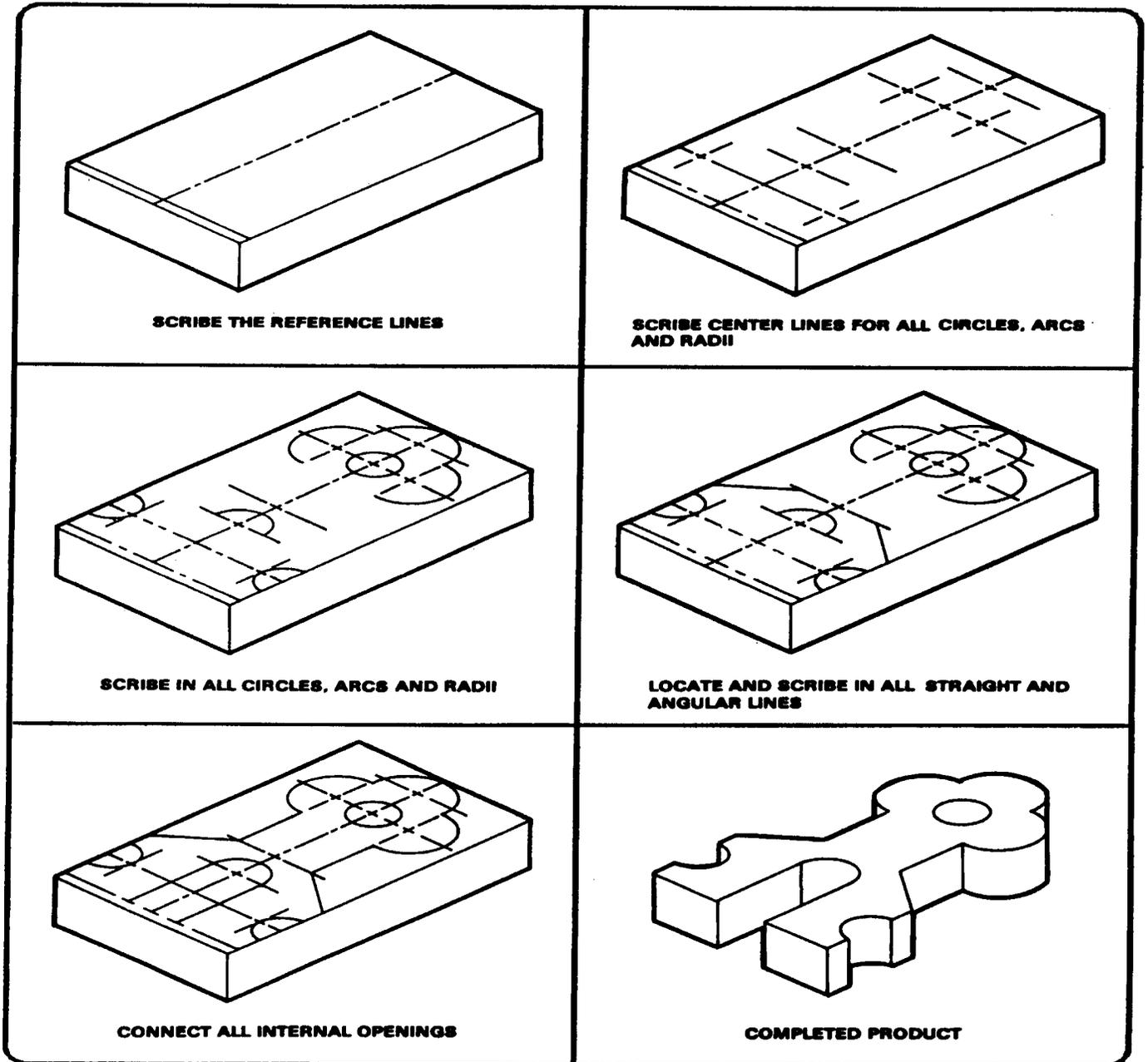


Figure 1-20. Typical Layout.

Jigs and fixtures can greatly reduce the cost of manufacturing large quantities of parts. Their use is also an advantage when the interchangeability and accuracy of the finished products are important. They also can be used in low or limited production jobs if extreme accuracy must be maintained. One of their greatest advantages is that relatively unskilled labor can accomplish the job using these special tools.

MECHANICAL DRAWINGS AND BLUEPRINTS

Mechanical Drawings

A mechanical drawing, made with special instruments and tools, gives a true representation of an object to be made, including its shape, size, description, material to be used, and method of manufacture.

Blueprints

A blueprint is an exact duplicate of a mechanical drawing. These are the most economical and satisfactory working drawings in use. They do not soil easily and are comparatively easy to read. Blueprint paper is a good grade of white paper coated with a chemical solution, making it greenish yellow. A blueprint is made by placing a tracing of a mechanical drawing on a sheet of blueprint paper and exposing it to light. During exposure, the light penetrates where there are no lines or printing on the tracing but does not penetrate where there are lines or printing. The print is then washed in water, which changes the exposed chemical to a dark blue and washes the chemical off where lines and printing prevented exposure. In other words, the process leaves white lines on dark blue background.

Working From Drawings

Detail prints usually show only the individual part or piece that must be produced. They show two or more orthographic (straight-on) views of the object, and in special cases, they may show an isometric projection, without dimension lines, near the upper right corner. An isometric projection shows how the part will look when made. Each drawing or blueprint carries a number, located in the upper left-hand corner and in the title box in the lower right-hand corner of the print. The title box also shows the part name, the scale used, the pattern number, the material required, the assembly or subassembly print number to which the part belongs, the job order number, the quantity and date of the order, and the names or initials of the persons who drew, checked, and approved the drawings (Figure 1-20). Accurate and satisfactory fabrication of a part described on a drawing depends upon the following:

- Correctly reading the drawing and closely observing all data on the drawing.
- Selecting the correct tools and instruments for laying out the job.
- Use the baseline or reference line method of locating the dimensional points during layout, thereby avoiding cumulative errors.
- Strictly observing tolerances and allowances.
- Accurate gaging and measuring of work throughout the fabricating process.
- Giving due consideration when measuring for expansion of the workpiece by heat generated by the cutting operations. This is especially important when checking dimensions during operations, if work is being machined to close tolerances.

Limits of Accuracy

Work must be performed within the limits of accuracy specified on the drawing. A clear understanding of tolerance and allowance will help you avoid making small, but potentially large errors. These terms may seem closely related but each has a very precise meaning and application. The paragraphs below point out the meanings of these terms and the importance of observing the distinctions between them.

Tolerance

Working to the absolute or exact basic dimension is impractical and unnecessary in most instances; therefore, the designer calculates, in addition to the basic dimensions, an allowable variation. The amount of variation, or limit of error permissible is indicated on the drawing as plus or minus (+) a given amount, such as + 0.005 or + 1/64. The difference between the allowable minimum and the allowable maximum dimension is tolerance. When tolerances are not actually specified on a drawing, fairly concrete assumptions can be made concerning the accuracy expected, by using the following principles. For dimensions which end in a fraction of an inch, such as 1/8, 1/16, 1/32, 1/64, consider the expected accuracy to be to the nearest 1/64 inch. When the dimension is given in decimal form the following applies: If a dimension is given as 2.000 inches, the accuracy expected is +0.005 inch; or if the dimension is given as 2.00 inches, the accuracy expected is +0.010 inch. The +0.005 is called in shop terms, "plus or minus five thousandths of an inch." The + 0.010 is called "plus or minus ten thousandths of an inch."

Allowance

Allowance is an intentional difference in dimensions of mating parts to provide the desired fit. A clearance allowance permits movement between mating parts when assembled. For example, when a hole with a 0.250-inch diameter is fitted with a shaft that has a 0.245-inch diameter, the clearance allowance is 0.005 inch. An interference allowance is the opposite of a clearance allowance. The difference in dimensions in this case provides a tight fit. Force is required when assembling parts which have an interference allowance. If a shaft with a 0.251-inch diameter is fitted in the hole identified in the preceding example, the difference between the dimensions will give an interference allowance of 0.001 inch. As the shaft is larger than the hole, force is necessary to assemble the parts.

Precautions

Be sure you have the correct print for the part to be made or repaired. You want the print which has not only the correct title, but also the correct assembly number. Never take a measurement with a rule directly from the print because the tracing from which the print was made may not have been copied from the original drawing perfectly and may contain scaling errors. Also, paper stretches and shrinks with changes in atmospheric conditions. Dimensions must be taken only from the figures shown on the dimension lines. Be very careful in handling all blueprints and working drawings. When they are not in use, place them on a shelf, in a cabinet, or in a drawer. Return them to the blueprint file as soon as the job is done. Blueprints and working drawings are always valuable and often irreplaceable. Make it a point never to mutilate, destroy, or lose a blueprint.

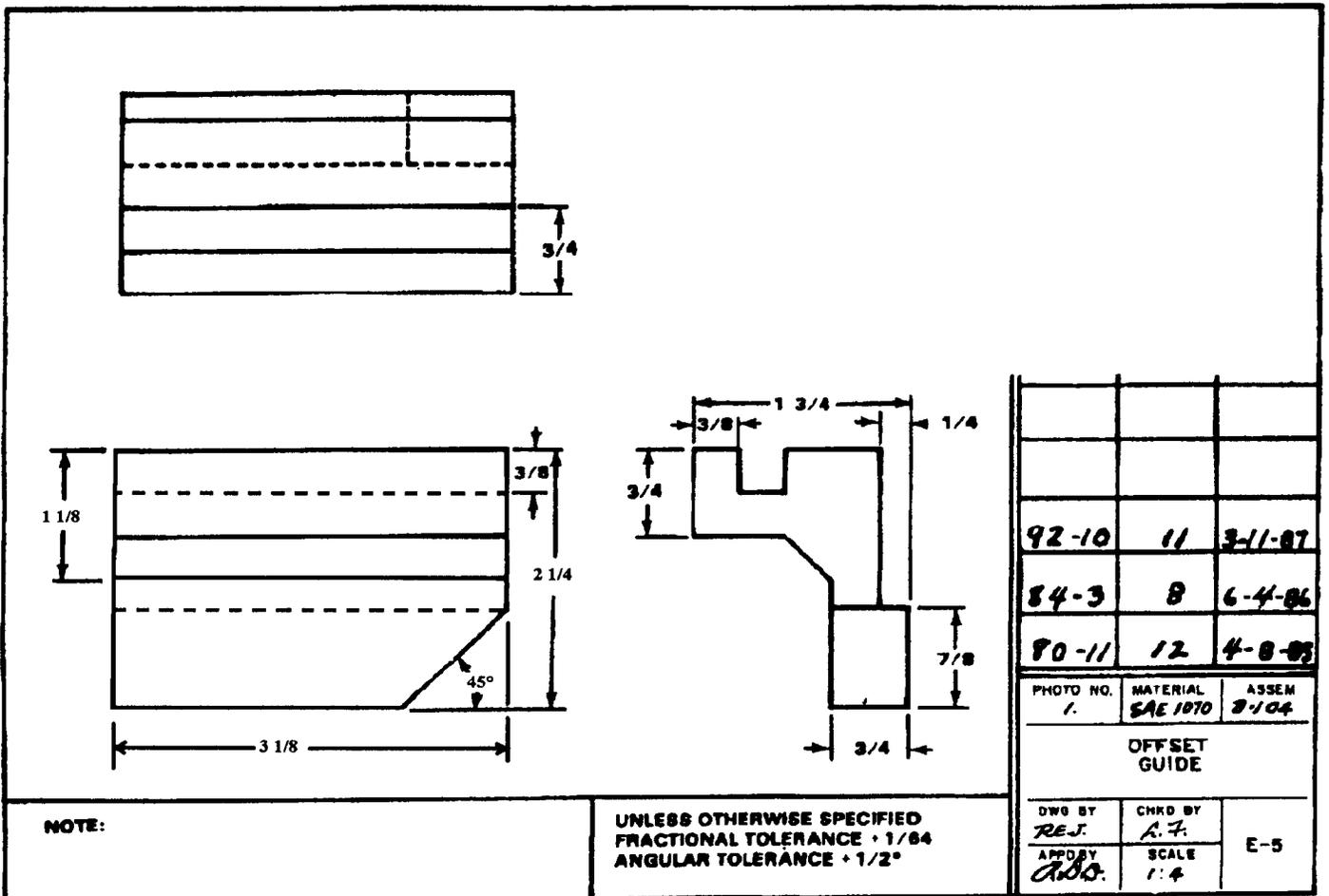


Figure 1-21. Typical blueprint.

GENERAL SHOP SAFETY

All tools are dangerous if used improperly or carelessly. Working safely is the first thing the user or operator should learn because the safe way is the correct way. A person learning to operate machine tools must first learn the safety regulations and precautions for each tool or machine. Most accidents are caused by not following prescribed procedures. Develop safe work habits rather than suffer the consequences of an accident.

Most of the safety practices mentioned in this section are general in nature. Safety precautions for specific tools and machines are described in detail in the chapters along with the description of the equipment. Study these carefully and be on the alert to apply them.

EYE PROTECTION

Using eye protection in the machine shop is the most important safety rule of all. Metal chips and shavings can fly at great speeds and distances and cause serious eye injury. Safety glasses must be worn when working with handcutting tools, since most handcutting tools are made of hardened steel and can break or shatter when used improperly.

There are many different types of safety glasses available in the supply system; however, the ones that offer the best protection are the safety glasses with side shields. Safety goggles should be worn over prescription glasses. For specific information about eye protection, contact the Occupational Health Clinic or refer to TB MED 586.

HAZARDOUS NOISE PROTECTION

Noise hazards are very common in the machine shop. High intensity noise can cause permanent loss of hearing. Although noise hazards cannot always be eliminated, hearing loss is avoidable with ear muffs, ear plugs, or both. These are available through the local supply system or from the Occupational Health Clinic. Ear plugs must be properly fitted by qualified personnel. For specific information on hearing protection, refer to TB MED 501.

FOOT PROTECTION

The floor in a machine shop is often covered with razor-sharp metal chips, and heavy stock may be dropped on the feet. Therefore, safety shoes or a solid leather shoe must be worn at all times. Safety shoes are available in the supply

system. These have a steel plate located over the toe and are designed to resist impact. Some safety shoes also have an instep guard.

GRINDING DUST AND HAZARDOUS FUMES

Grinding dust from abrasive wheels is made up of extremely fine particles of the metal and the wheel. Some grinding machines are equipped with a vacuum dust collector. When operating a grinder without a vacuum, wear an approved respirator to avoid inhaling the dust. Whenever possible, use coolant when grinding. This will aid in dust control. Grinding dust can be very dangerous to your health, especially beryllium or parts used in nuclear systems. These materials require careful control of grinding dust.

Metals such as zinc give off toxic fumes when heated above their boiling point. Inhaling these fumes may cause temporary sickness, or death. The fumes produced from lead and mercury are very harmful, as their effect is cumulative in the body and can cause irreversible damage. When unsure of the materials being machined, it is advisable to wear a respirator. For more specific information on respirator safety, refer to TB MED 502.

PROPER LIFTING PROCEDURES

Using improper lifting procedures may result in a permanent back injury. Back injury can be avoided if the correct lifting procedures are followed. When lifting heavy or large objects, get some assistance or use a hoist or forklift.

Objects within your ability can be lifted safely as long as the following procedures are followed:

- Keep your back straight.
- Squat down, bending at the knees.
- Use the leg muscles to do the work and lift slowly. Do not bend over the load as this will put excessive strain on your spine.
- Carry the object where it is comfortable, and pay close attention to where you are walking and objects around you.
- When placing the object back on the floor, use the same procedures as when it was lifted.

ELECTRICAL SAFETY

Exposure to electrical hazard will be minimal unless the operator becomes involved with machine repair. The machine operator is mostly concerned with the on and off switch on the machine tool. However, if adjustments or repairs must be made, the power source should be disconnected. If the machine tool is wired permanently, the circuit breaker should be switched off and tagged with an appropriate warning statement. Most often the power source will not be disconnected for routine adjustment such as changing machine speeds. However, if a speed change involves a belt change, make sure that no other person is likely to turn on the machine while the operator's hands are in contact with belts and pulleys.

SAFETY RULES FOR MACHINE TOOLS

Since different cutting tools and machining procedures are used on various machine tools, the safety precautions for each may vary. The following are general safety rules for any machine tool:

- Gears, pulleys, belts, couplings, ends of shafts having keyways, and other revolving or reciprocating parts should be guarded to a height of 6 feet above the floor. The guards should be removed only for repairing or adjusting the machine and must be replaced before operating it.
- Safety setscrews should be used in collars and on all revolving or reciprocating members of the machine tool or its equipment.
- Do not operate any machine tool without proper lighting.
- Never attempt to operate any machine tool until you fully understand how it works and know how to stop it quickly.
- Never wear loose or torn clothing and secure long hair, since these items can become caught in revolving machine parts. Ties should be removed and shirt sleeves should be rolled up above the elbow.
- Gloves should never be worn when operating machinery except when absolutely necessary.
- Always stop the machine before cleaning it or taking measurements of the workpiece.
- Do not lubricate a machine while it is in motion. Injury to the operator and damage to the machine may result from this practice.
- Never remove metal chips, turnings, or shavings with your hands; they may cause a serious cut. If the shavings are long, stop the machine and break them with pliers or a bent rod, and then brush chips off the machine. Remove cast-iron chips, which break into small pieces, with a brush. Never wipe away chips when the machine is operating.
- Always wear safety glasses or goggles while operating machine tools. Also, wear respiratory protection if operation creates hazardous dust. All persons in the area where power tools are being operated should also wear safety eye protection and respirators as needed.
- Know where fire extinguishers are located in the shop area and how to use them.
- Never wear jewelry while working around machine tools. Rings, watches, or bracelets may be caught in a revolving part which could result in the hand being pulled into the machine.
- Avoid horseplay. Tools are very sharp and machines are made of hard steel. An accidental slip or fall may cause a serious injury.
- Never use compressed air without a safety nozzle to clean machines or clothing. It will blow sharp, dangerous metal chips a long distance.
- Keep the floor around machines free of tools, stock, oil, grease, and metal chips. Tripping over metal on the floor, especially round bars, can cause dangerous falls. Wipe up all oil, grease, and cutting fluid spills on the floor as soon as possible to prevent a fall. Metal chips are very sharp and can easily become embedded in the soles of shoes, making them very slippery, especially when walking on a concrete floor.
- Never place tools or other materials on the machine table. Cluttering up a machine with tools or materials creates unsafe working conditions. Use a bench or table near the machine for this purpose.
- Always use a rag when handling sharp cutters such as milling cutters and end mills.

TC 9-524

- Do not expose power tools to rain or use in damp or wet locations.
- Always secure the workpiece. Use clamps or a vise. It is safer than using your hands, and it frees both hands to operate the tool
- Do not abuse electrical cords. Never carry a tool by its cord or yank it to disconnect it from a receptacle. Keep electrical cords away from heat, oil, and sharp edges. Have damaged or worn power cords and strain relievers repaired or replaced immediately.
- Remove adjusting keys and wrenches. Form a habit of checking to see that keys and wrenches are removed from tools before turning them on.
- Do not operate any machine tool while under the influence of drugs, alcohol, or any medication that could cause drowsiness.

SAFETY COLOR CODE MARKINGS AND SIGNS

USE OF PAINT

All maintenance shops and work areas should be marked with the correct colors to identify hazards, exits, safe walkways, and first-aid stations. It is acceptable to use material other than paint, such as decals and tapes, in the appropriate, similar colors. Listed below are the main colors authorized for use in maintenance shops.

Red color markings should be used to identify the following equipment or locations:

- Fire alarm boxes (pull boxes).
- Fire blanket boxes.
- Fire extinguishing containers.
- Fire extinguishers, unless painting is unnecessary. For large areas and when the extinguisher is not readily visible to the area occupants, use red on the housing wall or support above the extinguisher to show its location.
- Fire hose locations.
- Fire pumps.
- Fire sirens.
- Sprinkler piping.
- Fire buckets.
- Fire reporting telephone stations.
- Store all idle tools in a safe, dry place.
- Provide visitors to the work area required personnel protection equipment.
- An exception may be made to comply with local laws or when current facilities provide green exit signs.
- Emergency stop buttons for electrical machinery.
- Emergency stop bars on hazardous machines.
- Yellow color markings should be used to identify the following equipment or locations:
 - Industrial areas where particular caution is needed, such as handrails, guardrails, bottom edge of overhead doors, or top and bottom treads of stairways.
 - Fire hydrant barrels.
 - Caution signs.
 - Piping systems containing flammable material.
 - Waste containers for highly combustible material.
 - A hazardous area or a safe aisle within a hazardous area.

- Lower pulley blocks and cranes.
- Coverings and guards for guy wires.
- Pillars, posts, or columns that are physical or shop hazards.
- Fixtures suspended from ceilings or walls that extend into normal operating areas.
- Corner markings for storage piles.
- Exposed and unguarded edges of platforms, pits, and wells.

Green color markings normally on a white color background should be used for the following equipment or locations:

- First-aid equipment.
- First-aid dispensaries.
- Stretchers.
- Safety starting buttons on machinery.
- Safety instruction signs.

Black and white are the basic colors for designating housekeeping and interior traffic markings. The following are examples of where solid white, solid black, single-color striping, alternate stripes of black and white, or black and white squares will be used.

- Locations and width of aisles in nonhazardous areas.
- Dead ends of aisles or passageways.
- Directional signs.
- Locations of refuse cans.
- White corners of rooms or passageways.
- Clear floor area around first-aid, fire-fighting, and their emergency equipment.

Blue color markings are used on the outside of switch boxes electrical controls that are the starting point or power source for hazardous electrical machinery or equipment.

Orange markings are used to designate dangerous parts of machines or energized equipment, including electrical conduits, which may cut, crush, shock, or injure.

CATEGORIES OF SIGNS

Signs are placed in categories according to their purpose. Use the examples in the following paragraphs as guides when choosing the correct sign design to display a message. In overseas commands, the use of International Standard Safety Signs is encouraged and authorized.

WORDING OF SIGNS

Ensure that the wording of any sign-

- Is concise and easy to read.
- Contains enough information to be easily understood.
- Is designed for the message to be carried in a picture when appropriate.
- Is a positive rather than a negative statement when appropriate.
- Is bilingual with the second language common to the local personnel when appropriate.

SIGN INSPECTION AND MAINTENANCE

Signs should be inspected regularly and maintained in good condition. They should be kept clean, well illuminated, and legible. Replace or repair damaged or broken signs. All signs will be designed with rounded or blunt corners and with no sharp projections. Put the ends or heads of bolts or other fastening devices where they will not cause a hazard.

SELECTION OF SIGN SIZE

When choosing a sign, consider dimensions that will permit economical use of standard size material. Base the size of the sign on the following:

- Location at which the sign will be placed.
- Character of the hazard involved.
- Purpose of the sign.
- Distance from which the sign should be legible.

REQUIRED SIGN COLORS

All signs require a predominant color based on the sign's purpose. Below are the five types of signs and their predominant color.

- Danger signs: RED.
- Caution signs: YELLOW.
- Safety instruction signs: GREEN.
- Directional signs: BLACK.
- Informational signs: A variety of colors may be used, except for red, yellow, or magenta (purple).

DANGER SIGNS

Danger signs should only be used when immediate hazard exists. There will be no variations in the type or design of signs posted to warn of specific danger. All personnel will be instructed that danger signs indicate immediate danger and that special precautions are necessary.

CAUTION SIGNS

Caution signs should be used only to warn against potential hazards or to caution against unsafe practices. All personnel will be instructed that a caution sign indicates a possible hazard against which proper precautions will be taken.

DIRECTIONAL SIGNS

Directional signs should be used in sufficient numbers to indicate the way to stairways, fire escapes, exits, and other locations.

Many other safety media are available for use in military maintenance shops.