Part 66 Cat. B1 Module 7

MAINTENANCE PRACTICES

Volume 1

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7.1. SAFETY PRECAUTIONS – AIRCRAFT AND WORKSHOP

Good housekeeping in hangars, shops, and on the flight line is essential to safety and efficient maintenance. The highest standards of orderly work arrangements and cleanliness should be observed during the maintenance of aircraft.

When dealing with a particular system, component or procedure the understanding of the safety aspects that apply to that task are needed. Each personnel involved in maintenance should be aware of the safety aspects as they can lead to unexpected consequences.

Where continuous work shifts are established, the outgoing shift should remove and properly store personal tools, roll away boxes, all work stands, maintenance stands, hoses, electrical cords, hoists, crates, and boxes that are superfluous to the work to be accomplished.

Basic Rules

The basic safety on the workplace starts with very simple rule – working and pedestrian zones should be separated. Pedestrian walkways or fire lanes should be painted around the perimeter inside the hangars. This should be done as a safety measure to prevent accidents and to keep pedestrian traffic out of work areas.

Electrical Safety

Every aircraft maintenance shop uses electrical power for day to day activities. Besides many useful functions, it can injure or kill if mishandled. Therefore, it is the responsibility of everyone that uses electrical power to be aware of the safety procedures regarding it.

The human body conducts electricity. Furthermore, electrical current passing through the body disrupts the nervous system and causes burns at the entry and exit points. Common 110/120-volt AC house current used in U.S.A. or 220/380-volt used in Europe is particularly dangerous because it affects nerves in such a way that a person holding a current-carrying wire is unable to release it. Since water conducts electricity, you must avoid handling electrical equipment while standing on a wet surface or wearing wet shoes. The water provides a path to ground and heightens the possibility of electric shock.

Consider how a typical electric drill (that has an AC motor inside a metal housing) creates an electrical hazard. One wire is connected to the power terminal of the motor, and the other terminal connects to ground through a white wire. If there are only two wires in the cord and the power lead becomes shorted to the housing, the return current flows to ground through the operator's body. However, if the drill motor is wired with a three-conductor cord, return current flows through the third (green) wire to ground.

Most shop equipment operating on 110/120-volt or 220-volt single-phase alternating current utilizes

Types of Fire vs. Extinguishing Agent

Class A fires respond best to water or water type extinguishers which cool the fuel below combustion temperatures. Class B extinguishers are effective but not equal to the wetting / cooling action of the Class A extinguisher.

Class B fires respond to carbon dioxide (CO_2), halogenated hydrocarbons (Halons) and dry chemicals, all of which displace the oxygen in the air thereby making combustion impossible. Foam is effective, especially when used in large quantities. Water is ineffective on class B fires and will cause the fire to spread.

Class C (US) or E (EU) fires involving electrical wiring, equipment, or current respond best to carbon dioxide (CO_2) which displaces the oxygen in the atmosphere making combustion improbable.

The CO_2 equipment must be equipped with a non-metallic horn to be approved for use on electrical fires. Two reasons for this must be considered:

- The discharge of CO_2 as through a metal horn can generate static electricity. The static discharge could reignite the fire;
- The metal horn if in contact with the electrical current would transmit that current to the extinguisher operator.

Halogenated hydrocarbons are very effective on *Class C / E* (US / EU) fires. The vapour reacts chemically with the flame to extinguish the fire. Dry chemicals are effective but have the disadvantage of contaminating the local area with powder. Also, if used on wet and energized electrical equipment, it may aggravate current leakage.

Water, wet water or foam is not acceptable agents for use on liquid or electrical equipment fires

Class D fires respond to application of dry powder, which prevents oxidation and the resulting flame. Application may be from an extinguisher or scoop or shovel. Special techniques are needed in combating fires involving metal. Manufacturer’s recommendations should be followed at all times. Areas which could be subjected to metal fires should have the proper protective equipment installed.

Under no conditions use water on a metal fire
It will cause the fire to burn more violently and can clause explosions

Fire Extinguishing Agents

A fire is extinguished by either cooling the fuel below its kindling temperature or by depriving it of oxygen. All fire extinguishers work on one of these principles.

Water and Water Based Agents

Water can only be used for Class A fires, such as aircraft cabin fires, where electricity is not involved. Most modern water-type extinguishers consist of a container of water in which an antifreeze material has been mixed. The water is propelled from the extinguisher by a charge of carbon dioxide. Once the extinguisher is activated, all of the propellant is discharged and a new cartridge must be installed when the extinguisher is serviced.
Water extinguishes fires by cooling the fuel below the combustion temperature. Soda-acid and foam act on a fire the same as water by lowering the temperature. Foam has some effect on a petroleum base fire by preventing oxygen from getting to the fire.

Dry Chemical Agents

Sodium bicarbonate is the main chemical in use for extinguishing ***petroleum products*** and ***energized electrical equipment***.
The dry chemicals extinguish a fire by smothering it, cutting off oxygen, and the blanket of dry chemicals prevents re-flash fires. It also affords the operator some protection from the heat. All dry chemicals are non-conductors of electricity.

Dry chemicals are not suitable for using at home and offices as can reduce visibility and cause breathing problems

Gaseous Agents

Carbon dioxide (CO_2): The carbon dioxide gas excludes oxygen from the fire and the fire dies out. Since carbon dioxide is heavier than air and is electrically nonconductive, it ***is effective on*** both ***petroleum products*** and ***energized equipment***. Furthermore, carbon dioxide extinguishers are particularly well-suited for engine intake and carburettor fires, since they leave no residue.

Never use *CO_2* extinguishers on combustible metal fires as the cooling effect of the carbon dioxide on the metal can cause an explosive reaction of the metal

7.2 WORKSHOP PRACTICES

Company own or lease all necessary tools and equipment to perform the approved scope of work. It is responsible for acceptance of tool and equipment, and the level of manufacturers recommended special tools and ground support equipment as listed in the aircraft and engine maintenance manuals, and that level is sufficient for the aircraft work to be undertaken.

Tool and Equipment Usage

Tool and Equipment Classification

All tools and equipment are classified as:

- Standard tools;
- Specific tools;
- Ground support equipment (GSE).

In other hand tools and equipment are subdivided on tools or equipment which should be:

- Calibrated;
- Inspected;
- Serviced.

Tool Acceptance

Any tool or equipment received from outside sources has to be inspected.

After acceptance, Tool / Equipment List (**Fig. 2-1**) should be updated and tool / equipment shall be marked like (sample markings) **XX-XXX,** where **XXX** – item number as per Tool / Equipment List.

TOOL / EQUIPMENT LIST

Note 1: The given change dated ………… cancels all previous.

Note 2: Vertical lines are put on the left edge of pages to show the location of revised items.

No	Description of tool / equipment	P/N, S/N (if applicable)	Calibration interval (months)	Last calibration	Next calibration	Remarks

Figure 2-1. A sample (minimal) Tool / Equipment List

Tools / GSE concerned by calibration are usually described in Maintenance Organization Exposition (MOE). After acceptance tools / GSE are identified with a Company mark and being send to store.

Loaned Tools / GSE, marked with operator / owner symbols may be used for maintenance only if they are included in tool / equipment list, signed by Quality Manager.

Rejection of Tool / Equipment

If the tool / equipment didn't pass through acceptance the Tool / GSE unserviceable tag will be used and item placed to quarantine area till final decision will be done by Company.

Tool and equipment (including alternate tools) are used by the competent personnel, who have been trained to use them. However, when these tools or equipment are "specific", their technical instructions or operation manual allowing knowing how to use them always accompanies them.

When requested, a specific training is performed by Company. Only identified tool can be used during maintenance.

Tool and Equipment from Store

All tools and some GSE are stocked within the store.

When tool / GSE are served, tool register is updated by Shift Leader and signed by the Loaner.

The "Tool distribution register" normally includes:

- Name of the person receiving the tool;
- Marking of the tool, part number, serial number (if applicable);
- Where the tool is going to be used (tail number of the aircraft);
- Date and time of delivery[4];
- Date and time of return.

When the tool / GSE are returned to the store the Shift Leader is responsible to check number, condition and identification of the tool / GSE.

Use of Tool / GSE by Staff

Tool / GSE must remain in their original package, where it's applicable, during transportation or when not in use.

It is responsibility of the user to verify that:

- Tool / GSE is serviceable before using;
- Tool is marked.
- Next inspection date has not been exceeded;
- Tool is still serviceable before return the tool to the store.

[4] No tool / GSE are delivered to maintenance if expiration date is reached.

Prior to use, it must be ensured that the precision and tolerance of the tool / GSE are adequate for the work to be performed, as per the Task Card or AMM requirements. The GSE operation manual should be available for the user.

CAUTION 1: When tool / GSE were missed the Shift Leader is responsible to organize looking for missed tool / GSE. In order to assure that tool / GSE were not left on the aircraft Lost tool or GSE report must be filled.

CAUTION 2: When tool / GSE were broken it must be mark with Tool / GSE Unserviceable Tag and removed from use.

The validity of measuring instruments (MI) utilized is ensured with control of calibration intervals, fulfilment of requirements of calibration methods, keeping up by Company.

Company's ability to demonstrate maintenance conformity relies on the following principles:

- Required accuracy is achieved by MI;
- Every MI is identified, registered, calibrated, tagged and used appropriately;
- Recalibration of MI is carried out at fixed intervals according schedule, taking into account specific activities and usage of MI, manufacturer's recommendations, intensity of deterioration or referring to the subsequent verification list of MI prepared by the National Standards Board;
- Measurement standards used are traceable to the national or international standards.

NOTE: ***Company is responsible for calibration records keeping***

Re-calibration period of 12 months is set for MI which does not fall to the legal metrology field, and if otherwise the manufacturer of the MI, Company or National Aviation Authority (NAA) does not recommended.

NOTE: Calibration intervals are described in Tool / Equipment list (**Fig. 2-1**).

NOTE: Company is responsible for control of calibration intervals, arranging calibration of MI and updating of the Tool / Equipment List (**Fig. 2-1**).

Measurements and their Principles

Estimation

Suppose that two numbers to be added resulted from measurement. The 1st number was measured with a ruler marked off in tenths of an inch and was found, to the nearest tenth of an inch, to be *2.3* inches. The 2nd number measured with a precision rule was found, to the nearest thousandth of an inch, to be *1.426* inches.

These measurements require estimation between marks on the rule, and estimation between marks on any measuring instrument is subject to human error. Experience has shown that the best the average person can do with consistency is to decide whether a measurement is more or less than halfway between marks. The correct way to state this fact mathematically is to say that a measurement made with an instrument marked off in tenths of an inch involves a maximum probable error of *0.05* inch (five hundredths is one-half of one tenth). By the same reasoning, the probable error in a measurement made with an instrument marked in thousandths of an inch is *0.0005* inch.

Precision

In general, the probable error in any measurement is one-half the size of the smallest division on the measuring instrument. Thus the precision of a measurement depends upon how precisely the instrument is marked. It is important to realize that precision refers to the size of the smallest division on the scale; it has nothing to do with the correctness of the markings.

In other words, to say that one instrument is more precise than another does not imply that the less precise instrument is poorly manufactured. In fact, it would be possible to make an instrument with very high apparent precision, and yet mark it carelessly so that measurements taken with it would be inaccurate.

From the mathematical point, the precision of a number resulting from measurement depends upon the number of decimal places; that is, a larger number of decimal places mean a smaller probable error. In *2.3* inches the probable error is *0.05* inch, since *2.3* actually lies somewhere between *2.25* and *2.35*. In *1.426* inches there is a much smaller probable error of *0.0005* inch. If we add *2.300 + 1.426*:

$$\begin{array}{r} 2.300 \\ +1.426 \\ \hline 3.426 \end{array}$$

and get an answer in thousandths, the answer, *3.726* inches, would appear to be precise to thousandths; but this is not true since there was a probable error of *.05* in the 1st addend.

Also *2.300* appear precise to thousandths but in this example it is precise only to tenths. It is evident that the precision of a sum is no greater than the precision of the least precise addend. The precision

Fundamental deviation	The *minimum* difference in size between a component and the basic size. This is identical to the upper deviation for shafts and the lower deviation for holes. If the fundamental deviation is greater than zero, the bolt will always be smaller than the basic size and the hole will always be wider. Fundamental deviation is a form of allowance, rather than tolerance
International Tolerance grade	A standardised measure of the *maximum* difference in size between the component and the basic size

The next (**Fig. 2-2**) gives graphical explanation to the terms given above.

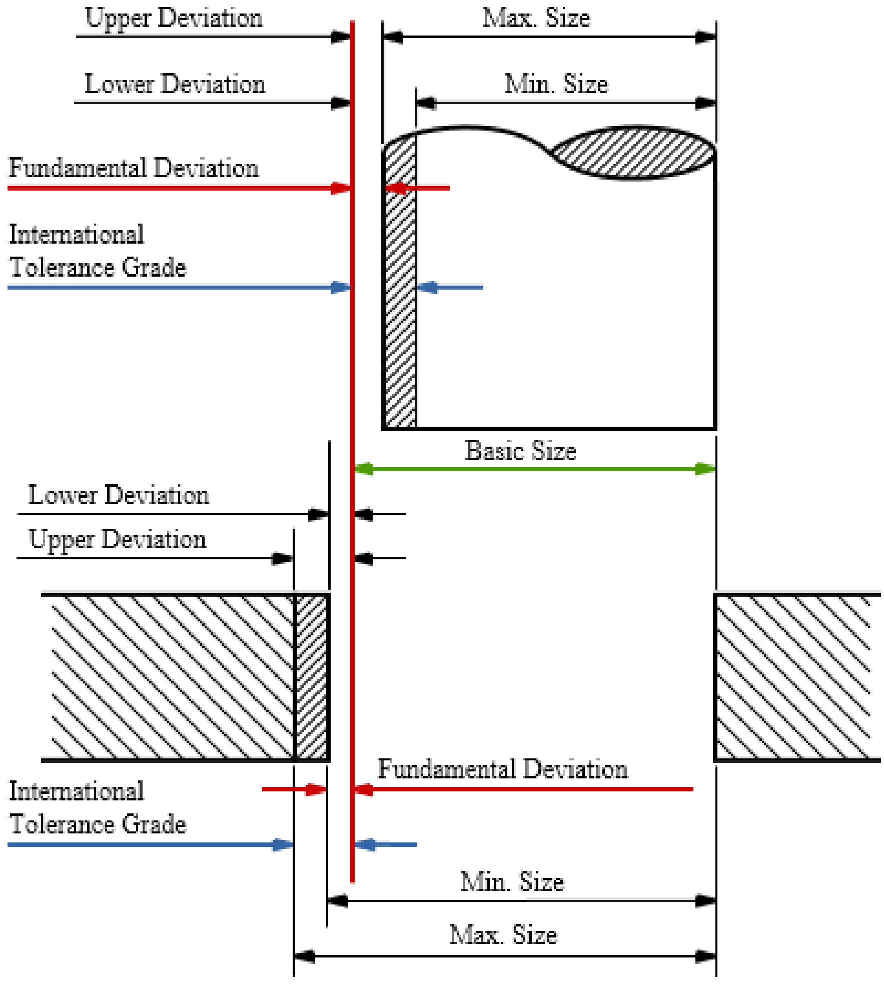

Figure 2-2. Basic size, fundamental deviation and IT grades compared to minimum and maximum sizes of the shaft and hole

For example, if a shaft with a nominal diameter of 10 mm is to have a sliding fit within a hole, the shaft might be specified with a tolerance range from 9.964 to 10 mm (i.e. a zero fundamental deviation, but a lower deviation of 0.036 mm) and the hole might be specified with a tolerance range from 10.04 mm to 10.076 mm (0.04 mm fundamental deviation and 0.076 mm upper deviation). This

7.3 TOOLS

The basic knowledge required in using the most common hand tools and measuring instruments used in aircraft repair work is outlined here. This information, however, cannot replace sound judgment on the part of the individual. There are many times when ingenuity and resourcefulness can supplement the basic rules. A sound knowledge is required of these basic rules and of the situations in which they apply.

Pounding Tools

Pounding tools include different types and weights of hammers and mallets, each with a very specific use. Since misuse of pounding tools can result in damage to aircraft components and injury to personnel, it is important to use these tools properly.

Such pounding device as a hammer consists of head and a handle. The flat portion of the head is called the *face* (**Fig. 3-1**), and the other end is known as the peen, the latter being used for heading rivets and similar peening or drawing operations.

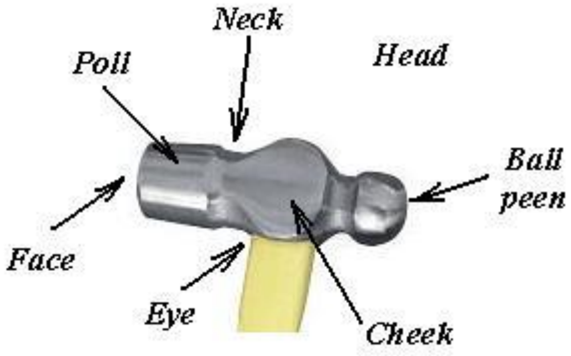

Figure 3-1. Hammer head

The hole for the handle is the *eye*. If the handle is made of wood than the eye in the hammer head is made with a slight taper in both directions from the centre. After the handle is inserted in the head, a steel wedge is driven into the end. This expands the taper of the handle in the eye and wedges the handle in both directions.

Peen Hammers

The ball peen hammers (**Fig. 3-2A**) ranges in weight from one ounce to two or three pounds. One hammer face is always flat while the other is formed into the shape of a ball. The flat hammer face is used for pounding, but should not be used to drive a nail. The ball end of the hammer is typically used to peen over rivets in sheet metal work. However, this is not the method used for securing rivets in aircraft sheet metal work.

When using a hammer, it should be held near the end of the handle with the face of the hammer parallel to the work. A grip just tight enough to control the blow is best. The correct way to hold a hammer is shown in **Fig. 3-7**.

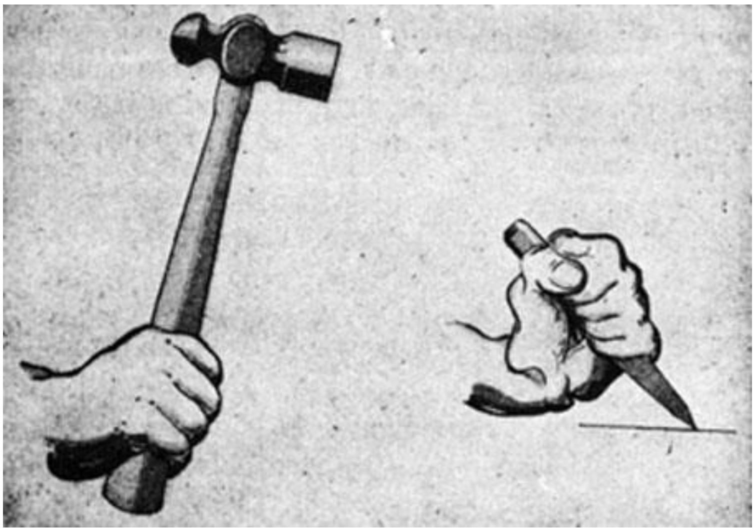

Figure 3-7. How to hold a hammer

Keep the hands and the hammer handle free from grease and oil, otherwise the hammer may slip from the grasp. It should also be remembered that oil or grease on the hammer face may cause it to slip off the work and lead to a painful bruise. Do not ruin the hammer handle by using it for pounding or prying purposes.

Screwdrivers

The screwdriver can be classified by its shape, type of blade, and blade length. It is made for only one purpose, i.e., for loosening or tightening screws or screw head bolts. When using the common screwdriver (**Fig. 3-8**), select the largest screwdriver whose blade will make a good fit in the screw which is to be turned. A common screwdriver must fill at least 75 % of the screw slot. If the screwdriver is the wrong size, it cuts and burrs the screw slot, making it worthless. A screwdriver with the wrong size blade may slip and damage adjacent parts of the structures.

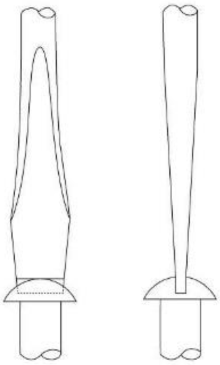

Figure 3-8. The common (slot) screwdriver

When using a screwdriver on a small part, always hold the part in the visa or rest it on a workbench. Do not hold the part in the hand, as the screwdriver may slip and cause serious personal injury.

The ratchet or spiral screwdriver is fast acting in that it turns the screw when the handle is pulled back and then pushed forward. It can be set to turn the screw either clockwise or counter clockwise, or it can be locked in position and used as a standard screwdriver. The ratchet screwdriver is not a heavy-duty tool and should be used only for light work.

CAUTION: When using a spiral or ratchet screwdriver, extreme care must be used to maintain constant pressure and prevent the blade from slipping out from the slot in the screw head. If this occurs, the surrounding structure is subject to damage.

Using Screwdrivers

The tip of a screwdriver blade should be ground so that the sides of the blade are parallel, and the blade sides should gradually taper out to the shank body, as shown in **Fig. 3-11**. If the end of the blade is damaged, it can be made serviceable again by means of a grinding wheel. First grind the tip straight and at a right angle to the shank. After the tip is ground square, dress off from each face a little at a time. Keep the faces parallel for a short distance or have them taper in a slight amount. Never grind the faces so that they taper to a sharp edge at the tip.

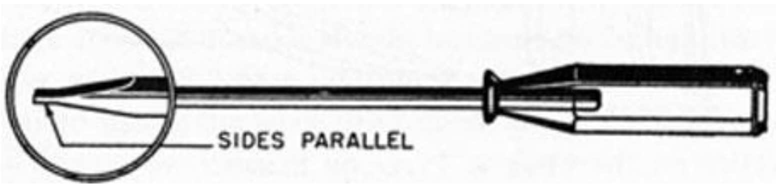

Figure 3-11. Correctly ground tip

CAUTION: Do not use a screwdriver to check an electrical circuit where the amperage is high.

The electrical current may be strong enough to form an arc and melt the screwdriver blade. It is also bad practice to try to turn a screwdriver with a pair of pliers or to use it as a chisel.

CAUTION: Do not hold work in the hand while using a screwdriver.

If the blade slips, it can cause a bad cut. Hold the work in a vise, secure it with a clamp, or stand it firmly on a solid surface. If such precautions are impossible, take care to have no part of your body in front of the screwdriver blade. That safety rule applies to any sharp or pointed tool.

Interlocking-joint or Tongue-and-Groove Water Pump Pliers

Interlocking-joint pliers are commonly called water pump pliers because they are often used to tighten the packing gland nut around a water pump shaft. These pliers have several curved grooves that make up a series of interlocking joints (**Fig. 3-13**).

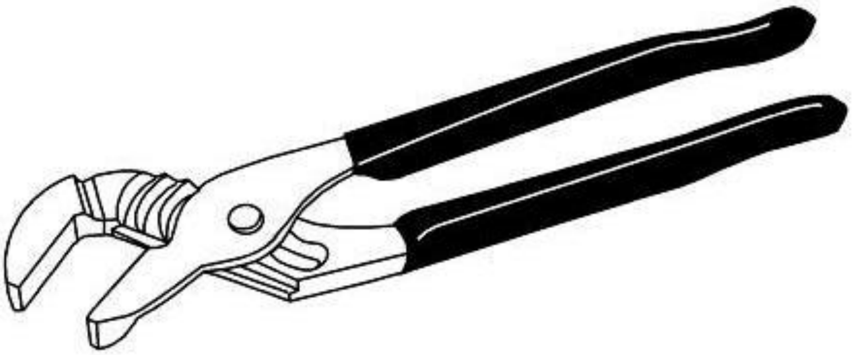

Figure 7.3.13. Interlocking-joint (water pump) pliers

Furthermore, the length of the handles allows a great deal of force to be applied to the jaws. Interlocking joint pliers are available in lengths from around five inches up to about 20 inches.

Vise-Grip™ Pliers

Vise-Grip is the registered trade name of the Petersen Mfg. Co for special compound-action type pliers. The opening of these jaws is adjustable by a knurled screw located in the end of the pliers handles (**Fig. 3-14**).

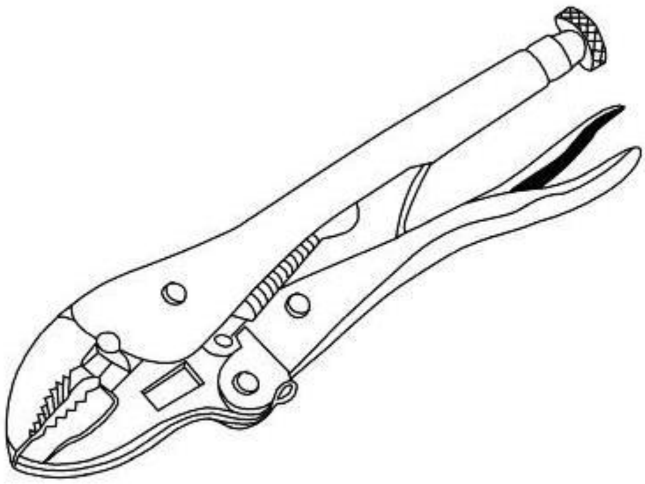

Figure 3-14. Vise-Grip™ pliers

When these handles are squeezed together compound leverage multiplies the effort and applies a tremendous force to the jaws. A toggle action clamps the jaws together so they will not open when the handles are released. The jaws are released by a small lever in one of the handles. Vise-Grip pliers

Box-End Wrenches

Exceptionally tight nuts can spread the jaws on even the best open-end wrench. To break the torque on tight nuts a box-end wrench is used. Box-end wrenches have a six-or twelve-point opening attached to each end and offset from the axis of the handle by about 15 degrees (**Fig. 3-29**).

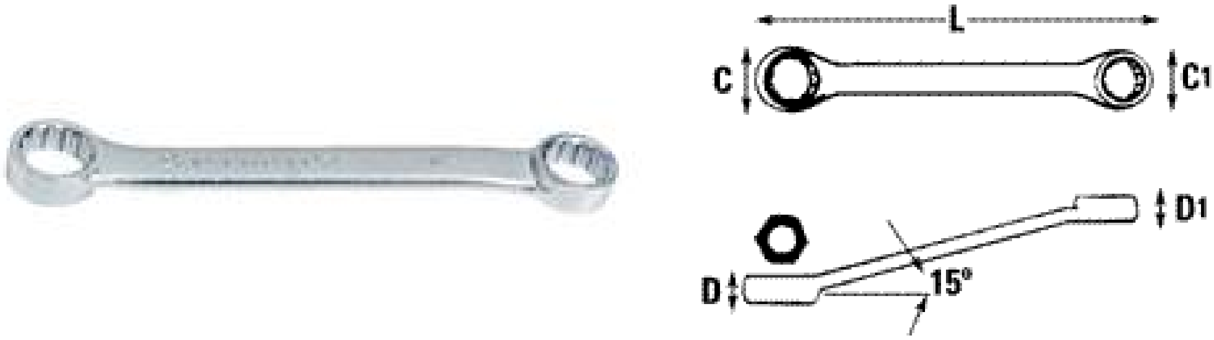

Figure 3-29. Box-end wrenches

Box-end wrenches are popular tools because of their usefulness in close quarters. They are called box wrenches since they box, or completely surround the nut or bolt head. Practically all box-end wrenches are made with 12 points so they can be used in places having as little as 15° swing.

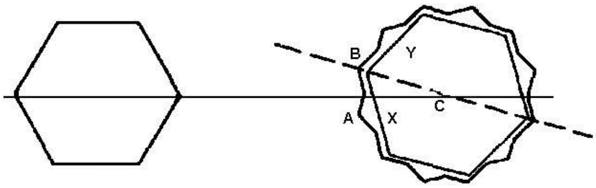

Figure 3-30. Box-end wrench use

In **Fig. 3-30**, point A on the illustrated double broached hexagon wrench is nearer the centre line of the head and the wrench handle than point B, and also the centre line of nut C. If the wrench is inverted and installed on nut C, point A will be centred over side "Y" instead of side "X". The centre line of the handle will now be in the dotted line position. It is by reversing (turning the wrench over) the position of the wrench that a 15° arc may be made with the wrench handle.

Although box-end wrenches are ideal to break loose tight nuts or pull tight nuts tighter, time is lost turning the nut off the bolt once the nut is broken loose. Only when there is sufficient clearance to rotate the wrench in a complete circle can this tedious process be avoided.

Combination Wrench

The disadvantage of a box-end wrench is the limitation of always having to lift and reposition the wrench in order to continue loosening a fastener. On the other hand, an open-end wrench is much easier to slip off and onto a nut. The combination wrench (**Fig. 3-31**) has the advantage of both a box-end and an open-end wrench. This popular configuration has a box end broached on one end, and an

Special Wrenches

The category of special wrenches includes the spanner, torque, and alien wrenches.

Allen Wrench

Most headless setscrews are the alien type and must be installed and removed with an Allen wrench. Allen wrenches are six-sided bars in the shape of an L (**Fig. 3-40**). They range in size and fit into a hexagonal recess in the setscrew.

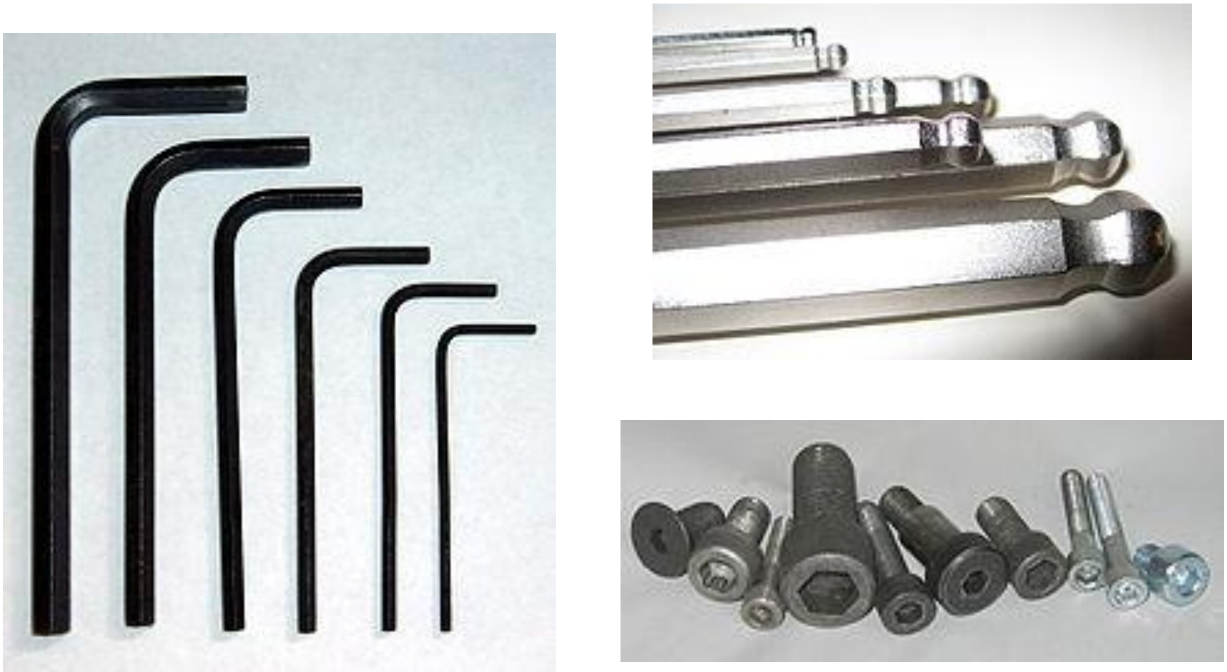

Figure 3-40. Allen wrenches and socket head screws

Some features of hex keys are:

- The tool is simple, small and light;
- The contact surfaces of the screw or bolt are protected from external damage;
- There are six contact surfaces between bolt and driver;
- The tool can be used with a headless screw;
- The screw can be inserted into its hole using the key;
- Torque is constrained by the length and thickness of the key;
- Very small bolt heads can be accommodated;
- The tool can be manufactured very cheaply, so one is often included with products requiring end-user assembly;
- Either end of the tool can be used to take advantage of reach or torque.

Using a hex wrench on a socket that is too large may result in damage to the fastener or the tool. An example would be using a 5 mm tool in a 5.5 mm socket. Because hex-style hardware and tools are

Chisels

A chisel (**Fig. 3-48**) is a hard steel cutting tool which can be used for cutting and chipping any metal softer than the chisel itself. It can be used in restricted areas and for such work as shearing rivets, or splitting seized or damaged nuts from bolts.

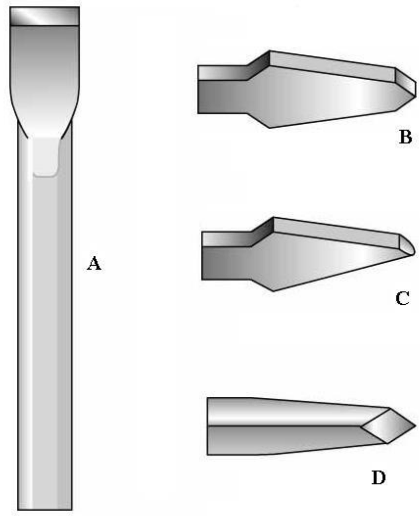

Figure 3-48. A flat head cape (A), round-nose (B, C), and diamond-point (D)metal chisel heads

When using a chisel, hold it firmly in one hand. With the other hand, strike the chisel head squarely with a ball-peen hammer.

Flat Chisels

The flat or cold chisel is the most common type of chisel used by the aviation technician. Flat chisels are made from square or octagonal stock, ranging from $^{5}/_{16}$ inch to $^{11}/_{16}$ inch across. The cutting edge of a flat chisel is forged so it is slightly wider than the shank and is ground to an angle of approximately 70 degrees. This angle allows the chisel to cut or shear metal.

To use a flat chisel, the cutting edge is held flat against the material (**Fig. 3-49**), and the depth of the cut is controlled by varying the angle between the chisel and the work. The cutting edge of a flat chisel is ground slightly convex, so that the greatest stress from a hammer blow is directed into the centre of the chisel. Thus, the lesser stresses are transmitted to the sides of the cutting edge.

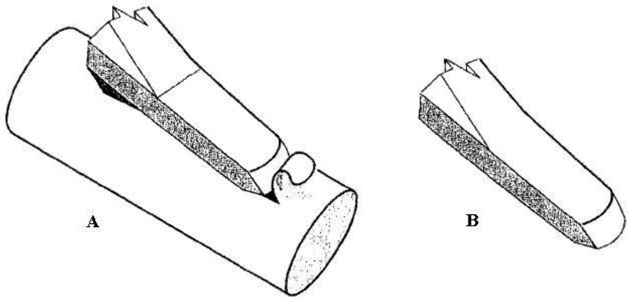

Figure 3-49. Directing flat chisel (A) and the cutting edge (B) of flat chisel

When cutting wire or round stock with a cold chisel, the following procedure is recommended:

1. Mark with a scriber or file, or with chalk or colour pencil, the point at which the cut is to be made;
2. Hold the work in place on the anvil or other suitable support. (It is advisable to protect the anvil with a piece of scrap metal.)
3. Hold the chisel (**Fig. 7.3.55**) with the cutting edge on the mark and the body of the chisel in a vertical position.

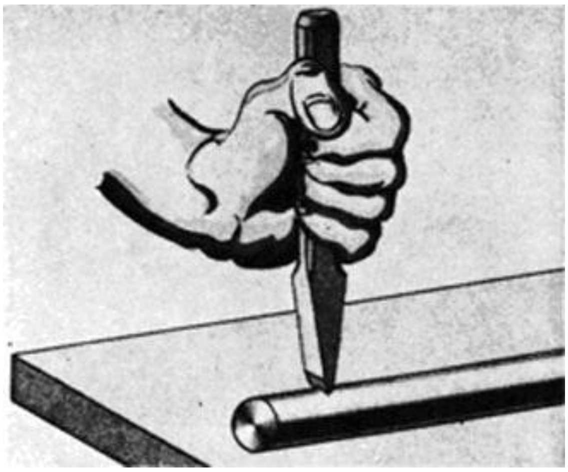

Figure 7.3.55. Cutting round stock with cold chisel

4. Strike the chisel a light blow with the hammer, and then examine the chisel mark on the work to make certain that the cut is at the desired point.
5. Drive the chisel into the work with vigorous blows. The last few strokes, however, should be made lightly in order to avoid unnecessary damage to the supporting surface.

Heavier work can be cut in much the same way, except that the cut is made about halfway through the stock from one side, then the work turned over and the cut finished from the opposite side.

The cutting of sheet or plate metal with a cold chisel should be avoided whenever possible, as stretching of the metal invariably results. However, when no other means are available, the best procedure is as follows:

1. With a scriber, draw a straight line on the work where the cut is to be made.
2. Grip the work firmly in a vise with the scribed line even with or just below the top of the vise jaws (**Fig. 3-56**). The waste metal should extend above the jaws. In some cases it is better to place the metal between two pieces of angle iron and clamp the whole set-up in the vise. The angle iron then protects the tops of the vise jaws.

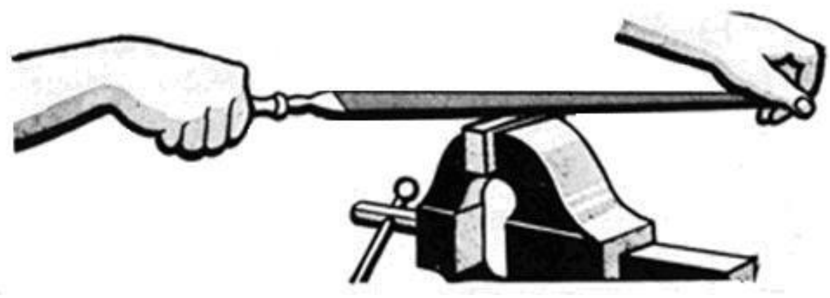

Figure 7.3.63. Correct way to hold file

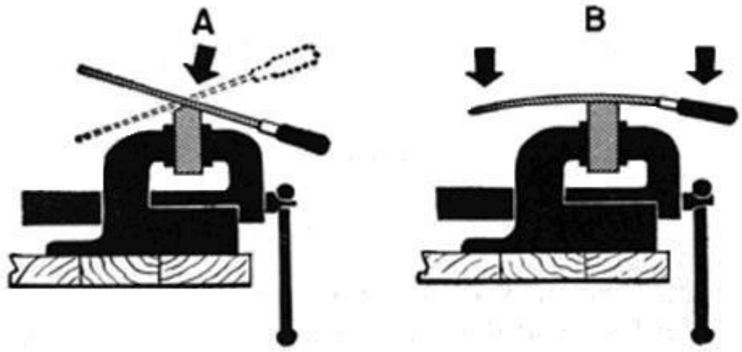

Figure 3-64. Effect of too much speed (A) and too much pressure (B)

Apply pressure on the forward stroke only. Unless the file is lifted from the work on the return stroke, it will become dull much sooner than it should. (This does not apply, however, when filing very soft metals, such as lead or aluminum. On soft work, pressure on the return stroke helps to keep the cuts in the file free of removed metal.)

When round surfaces are filed, best results are obtained by working as shown in **Fig. 3-65**, a rocking motion being used.

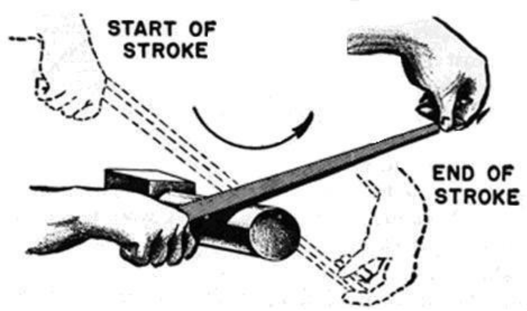

Figure 3-65. Filing round surfaces

Surfaces and edges are often *draw-filed* to make them smooth and true. In draw-filing, hold the file at right angles to the work (**Fig. 3-66**), and move the file sidewise along the work. A single-cut smooth file should be used. Pressure is heaviest on the stroke made toward the body and very light on the return. Keep the hands as close together as possible to prevent bending the file, and watch the ends jump and individual teeth will be broken. The right and wrong angles for various kinds of work are shown in **Fig. 3-76**.

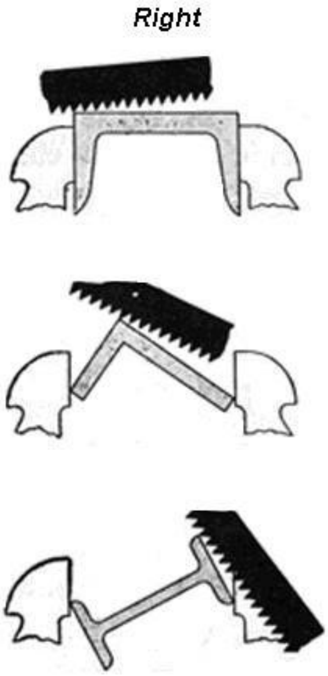

Figure 3-76. Starting hacksaw cuts

Start the cut with a light, steady, forward stroke. At the end of the stroke, relieve the pressure and draw the blade straight back. After the first few strokes make each one as long as the hacksaw frame will allow, thus preventing the middle teeth from overheating and wearing rapidly.

Use just enough pressure on the forward stroke to make each tooth remove a small amount of metal. As the teeth point forward and the forward edges do the cutting, it is not necessary to use pressure on the back stroke.

When sawing alongside a scribed line, remember to stay just outside that line. Use long steady strokes, about 40 to 50 strokes per minute. If hacksaw blades are worked too fast, the heat that is generated may draw the temper and make the- blade soft and useless.

Working too fast also may break some of the teeth, cramp and break the blade, or produce ragged and crooked cuts.

When near the end of the cut, slow down still more, so that the saw can be controlled when the stock is sawed through. When finished with the saw, clean the chips from the blade, loosen the tension, and return the hacksaw to its proper place.

A hacksaw should be hung up when not in use. It should not be kept in a drawer with other tools or where metallic objects will strike the blade teeth. Wiping the blade with an oily rag will prevent rusting.

Construction of Twist Drill

Twist drills are made of carbon steel or high-speed alloy steel. Carbon steel drills are satisfactory for the general run of work and are less expensive, although they may lose their hardness if heated excessively. High-speed drills are used on tough metals and at high speeds. They will keep on cutting when red hot, but should be cooled in still air; if cooled quickly they may crack or split.

A twist drill is made up of three parts: the shank, the body, and the point (**Fig. 3-81**). The shank is the portion held in a chuck. Drills used in aircraft maintenance all have straight shanks (**Fig. 3-81A**); while drills turned by large drill presses typically have tapered shanks (**Fig. 3-81B**).

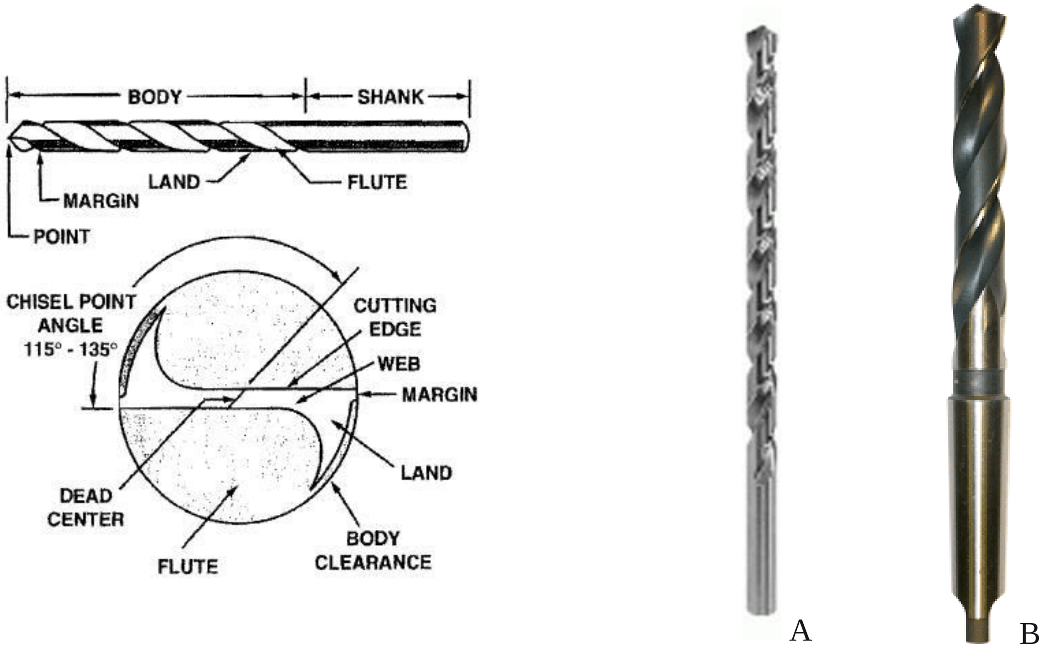

Figure 7.3.81. Construction of twist drill and straight (A) and tapered (B) shanks twist drills

The body of a twist drill has spiral flutes milled from the point to the shank. Twist drills are available with either 2, 3, or 4 flutes (the spiral grooves formed along the sides), but drills having 3 or 4 flutes are used for following smaller drills or for enlarging cored holes, and are not suitable for drilling into solid stock.

The spiral flutes provide several advantages:

1. They cause chips formed while drilling to curl tightly so that they occupy the minimum amount of space;
2. They form channels through which such chips can escape from the hole;
3. They allow the lubricant, when one is used, to flow easily down to the cutting edge of the drill.

Figure 3-94. Taps

The taper tap is used to begin the tapping process, because it is tapered back for six to seven threads. This tap cuts a complete thread when it is cutting above the taper and is the only tap needed when tapping holes that extend through a material. The plug tap supplements the taper tap for tapping holes in thick stock, but tapers for only the first three to five threads. The bottoming tap is not tapered and is used to cut full threads to the bottom of a blind hole.

Using Taps

Taps are held in tap wrenches while they are being used. There are two types of tap wrenches, the *T-handle* for small taps and restricted spaces (**Fig. 3-95**), and the *adjustable* tap wrench for general use and larger taps (**Fig. 3-96**).

Figure 3-95. T-hand tap wrench

Angle Grinder

An ***angle grinder***, also known as a ***side*** or ***disc grinder*** is a handheld power tool used for cutting, grinding and polishing (**Fig. 3-104**).

Figure 3-104. Angle or disk grinder

Angle grinders can be powered by an electric motor, petrol engine or compressed air. The motor drives a geared head at a right-angle on which is mounted an abrasive disc or a thinner cut-off disc, either of which can be replaced when worn. Angle grinders typically have an adjustable guard and a side-handle for two-handed operation. Certain angle grinders, depending on their speed range, can be used as a sander, employing a sanding disc with a backing pad or disc. The backing system is typically made of hard plastic, phenolic resin, or medium-hard rubber depending on the amount of flexibility desired.

Angle grinders may be used both for removing excess material from a piece or simply cutting into a piece. There are many different kinds of discs that are used for various materials and tasks, such as cut-off discs (diamond blade), abrasive grinding discs, grinding stones, sanding discs, wire brush wheels and polishing pads. The angle grinder has large bearings to counter side forces generated during cutting, unlike a power drill, where the force is axial.

Angle grinders are widely used in metalworking and construction, as well as in emergency rescues. They are commonly found in workshops, service garages and auto body repair shops. There is a large variety of angle grinders to choose from when trying to find the right one for the job. The most important factors in choosing the right grinder are the disc size and how powerful the motor is. Other factors include power source (pneumatic or electric), rpm, and arbour size. Generally disc size and power increase together. Disc size is usually measured in inches or millimetres. Common disc sizes for angle grinders in the U.S.A. include 4, 4.5, 5, 6, 7, 9 and 12 inches. Discs for pneumatic grinders

Combination Sets

The combination set (**Fig. 3-110**), as its name implies, is a tool that has several uses. It can be used for the same purposes as an ordinary tri-square, but it differs from the tri-square in that the head slides along the blade and can be clamped at any desired place. The level and scriber are combined with the square or stock head. The stock head slides in a central groove on the blade or scale, which can be used separately as a rule.

The spirit level in the stock head makes it convenient to square a piece of material with a surface and at the same time tell whether one or the other is plumb or level. The head can be used alone as a simple level.

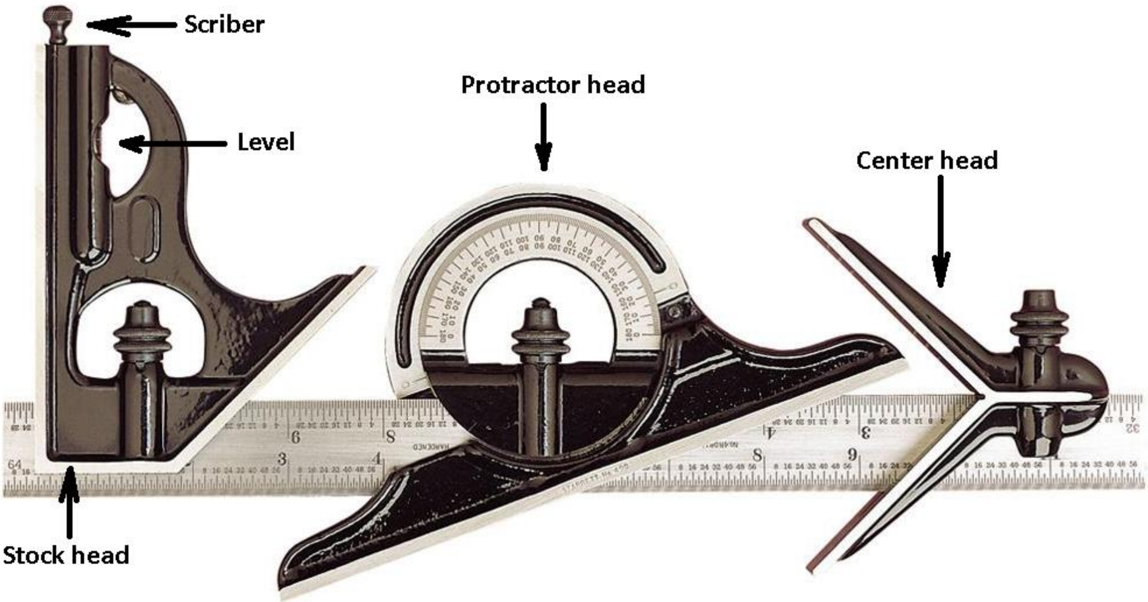

Figure 7.3.111. Combination set

The combination of square head and blade can also be used as a marking gage to scribe lines at a 45° angle, as a depth gage, or as a height gage.

A convenient scriber is held frictionally in the head by a small brass bushing.

The centre head is used to find the centre of shafts or other cylindrical work. The protractor head can be used, to check angles and also may be set at any desired angle to draw lines.

Electrical General Test Equipment

Voltmeter

A voltmeter is an instrument used for measuring the electrical potential difference between two points in an electric circuit. Analogue voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analogue to digital converter.

Portable instruments, usually equipped to also measure current and resistance in the form of a multimeter, are standard test instruments used in electrical and electronics work. Any measurement that can be converted to a voltage can be displayed on a meter that is suitably calibrated; for example, pressure, temperature, flow or level in a chemical process plant.

General-purpose analogue voltmeters may have an accuracy of a few percent of full scale, and are used with voltages from a fraction of a volt to several thousand volts. Digital meters can be made with high accuracy, typically better than 1%. Specially calibrated test instruments have higher accuracies, with laboratory instruments capable of measuring to accuracies of a few parts per million. Meters using amplifiers can measure tiny voltages of microvolts or less.

Analogue Voltmeter

A moving coil galvanometer (**Fig. 3-123**) can be used as a voltmeter by inserting a resistor in series with the instrument. It employs a small coil of fine wire suspended in a strong magnetic field. When an electric current is applied, the galvanometer's indicator rotates and compresses a small spring. The angular rotation is proportional to the current through the coil. For use as a voltmeter, a series resistance is added so that the angular rotation becomes proportional to the applied voltage.

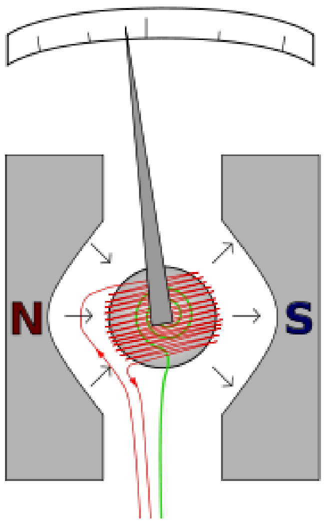

Figure 3-123. A moving coil galvanometer of the d'Arsonval type.

7.4. AVIONICS GENERAL TEST EQUIPMENT

Avionic general test equipment is the equipment of daily use by category B1.1 or B2 maintenance engineers.

Pitot-static Leak Testing

Leak testing is done using variety of testers for checking low-pressure pipelines as used on aircraft manometric instrument systems including engine pressure ratio systems. It comprises of three elements:

- Main block (**Fig. 4-1A**);
- Pitot adapter (**Fig. 4-1B**);
- Static port adapter (**Fig. 4-1C**).

The control valve allows the selection of pressure from the pump to a pitot system, suction to a static system and a pressure/suction release position. The adapters can be supplied separately but they are normally supplied as part of a kit containing an assortment of adaptors and fittings to connect it to various sizes of pitot heads and static connections.

A


B

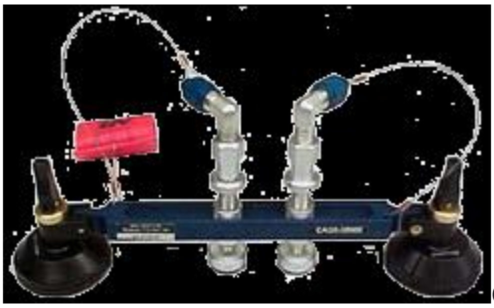
C

Figure 4-1. Pitot-static leak tester (A), Pitot adapters (B) and Static port adapter (C)

Safety Ohmmeter

This specialised tester (**Fig. 4-6**) has been developed for testing the insulation resistance of circuits through which, for reasons of safety, the testing current must not under any circumstances exceed a specified value; it is supplied primarily for determining the insulation resistance of circuits which control explosive charges or pyrotechnic devices. The tester operates on the standard principle applied to general purpose (high voltage) insulation testers, but the design.is such that the testing current supplied by the tester to the circuit under investigation is restricted to a maximum of l0mA.

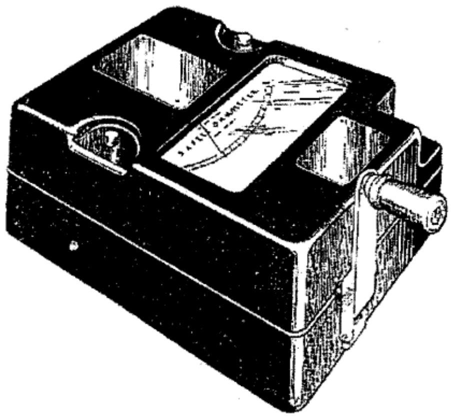

Figure 4-6. Safety Ohmmeter

The generator is of the conventional two-pole permanent magnet type, driven through reduction gears by a handle, which folds back into the case when not in use. The armature has a single high resistance winding, the ends of which connect to a split ring commutator with carry over bars and a resistance/capacitance smoothing circuit is fitted across the brushes.

An output voltage of 30 volts is available at a handle speed of 160 rpm providing the „leakage" current. That mean the current through the deflecting circuit when the latter is completed through a resistance under test, is less than l0mA - if the insulation resistance under investigation is unduly low, the testing voltage is automatically reduced (by reasons of increased voltage drop in the armature winding) to restrict the leakage current to the prescribed maximum. A 1 000 000 ohm test resistor is supplied with the tester: this resistor provides a convenient means of checking the calibration of the instrument and for checking purposes it is connected directly across the test terminals to simulate an insulation resistance.

Pre-use Checks and Insulation Testing Procedure

1. Visual Inspection;
2. Check Standards Room Authorisation Label;
3. Check for Serviceability as follows:
   - Push button versions - carry out battery check;
   - With test leads apart, operate tester - pointer should indicate infinity;
   - With test leads connected together, operate tester pointer should indicate zero.

Precautions

1. Before insulation tests can be performed satisfactorily, certain test conditions must prevail. Details of these conditions and the minimum insulation resistance values will be found on the job card or in the appropriate manual.
2. Aircraft equipment which contains voltage sensitive devices will have CAUTION notices indicating that the equipment must not be subjected to:
   - An insulation test under any circumstances;
   - An insulation test voltage in excess of specific value.

Insulation Testing Procedure Fundamentals

Generally, the testing value for insulation testing should be approximately twice the designed operating voltage of the apparatus of circuit that is to be tested. In any case the servicing schedules for general aircraft equipment stipulate test values of 250 V, even if the normal operating voltage is nominally 24 V, and special procedures, requiring the use of specialised testing equipment, are prescribed for special aircraft circuits and components such as detonator systems, ignition systems etc.

CAUTION: Under no circumstances should an insulation tester be applied to a circuit or component unless the latter has been effectively ISOLATED from all other sources of electrical supply

Testers must be kept away from magnetic influence (other than normal terrestrial magnetism) while tests are being made.

CAUTION: Under no circumstances should a tester be placed on a pole piece or bed plate of an electrical machine, even if the latter is completely disconnected from its source of supply and it is advisable to position the instrument as far as possible from „live" heavy current cables when tests are being made

7.5 ENGINEERING DRAWINGS, DIAGRAMS AND STANDARDS

The exchange of ideas is essential. This exchange is carried on by the oral or written word; but under some conditions, the use of these alone is impractical because misunderstanding and misinterpretation arose frequently. A written description of an object can be changed in meaning just by misplacing a comma; the meaning of an oral description can be completely changed by the use of a wrong word.

To avoid these possible errors, to describe objects industry uses drawings, called the Draftsman's Language.

Drawing, as we use it, is a method of conveying ideas concerning the construction or assembly of objects. This is done with the help of lines, notes, abbreviations, and symbols. It is very important that the aviation mechanic who is to make or assemble the object understand the meaning of the different lines, notes, abbreviations, and symbols that are used in a drawing.

Prints are the link between the engineers who design an aircraft and the men who build, maintain, and repair it. A print may be a copy of a working drawing for an aircraft part or group of parts, or for a design of a system or group of systems.

A print shows the various steps required in building anything from a simple component to a complete aircraft. They are drawn to scale but not so exact than to scale measurements directly measuring lines on a print. Another factor that affects direct scaling from is paper shrinking or stretching.

Working Drawings

Working drawings must give such information as size of the object and all of its parts, its shape and that of all of its parts, specifications as to the material to be used, how the material is to be finished, how the parts are to be assembled, and any other information essential to making and assembling the particular object.

Working drawings may be divided into three classes:

1. Detail drawings;
2. Assembly drawings, and
3. Installation drawings.

Detail Drawing

A detail drawing is a description of a single part, given in such a manner as to describe by lines, notes, and symbols the specifications as to size, shape, material, and methods of manufacture that are to be used in making the part. Detail drawings are usually rather simple; and, when single parts are small, several detail drawings may be shown on the same sheet or print (**Fig. 5-1A**). When a detail drawing is made, it is carefully and accurately drawn to scale and dimensioned.

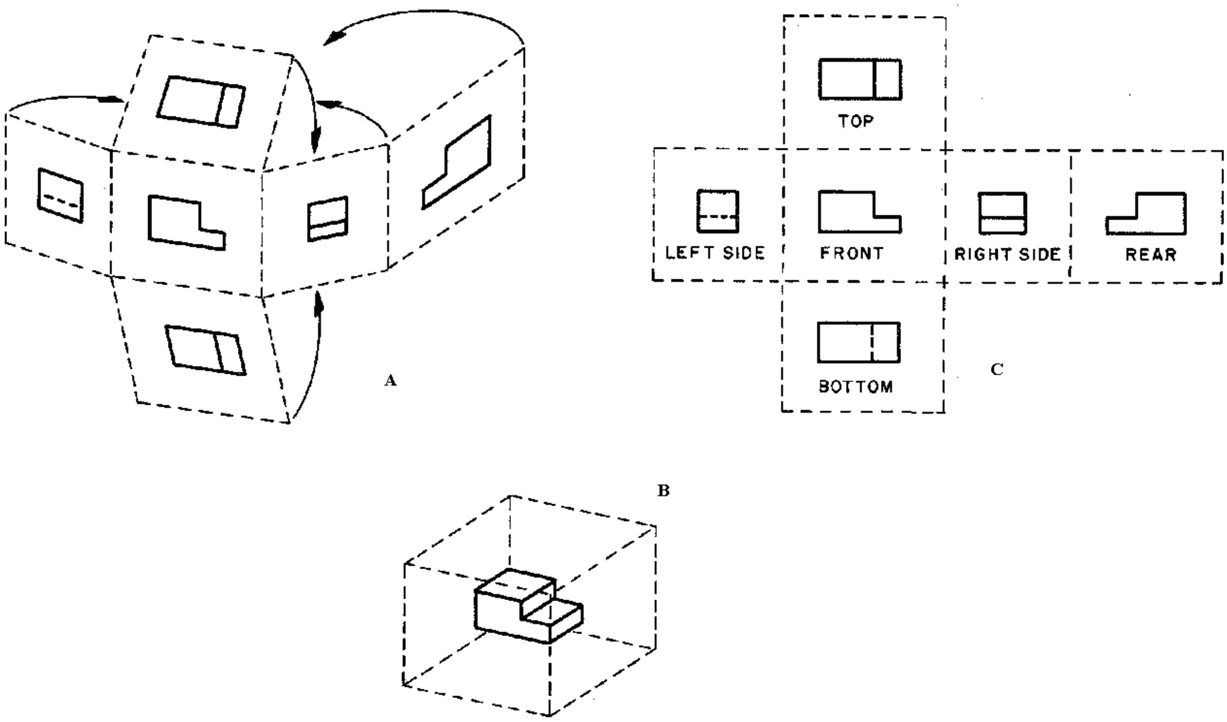

Figure 5-7. (A) Object, (B) Rotated and (C) Orthographic projection

Regardless of the number of views used, the arrangement is generally as shown in **Fig. 5-7**, with the front view being the principal one. If the right-side view is shown, it will be to the right of the front view. If the left-side view is shown, it will be to the left of the front view. The top and bottom views, if included, will be shown in their respective positions relative to the front view.

One-view drawings are commonly used for objects of uniform thickness, such as gaskets, shims, and plates. A dimensional note gives the thickness as shown in **Fig. 5-8**. One-view drawings are also commonly used for cylindrical, spherical, or square parts if all the necessary dimensions can be properly shown in one view.

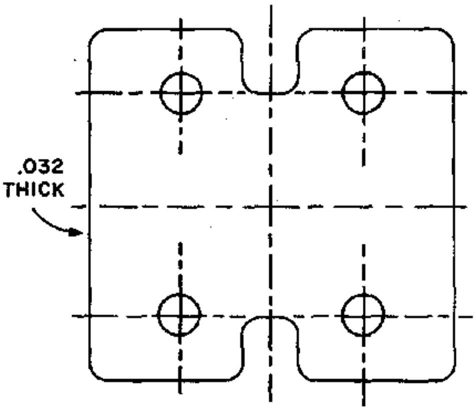

Figure 5-8. One-view drawing

Most drawings use three widths, or intensities, of lines: thin, medium, or thick. These lines may vary somewhat on different drawings, but there will always be a noticeable difference between a thin and a thick line, with the width of the medium line somewhere between the two.

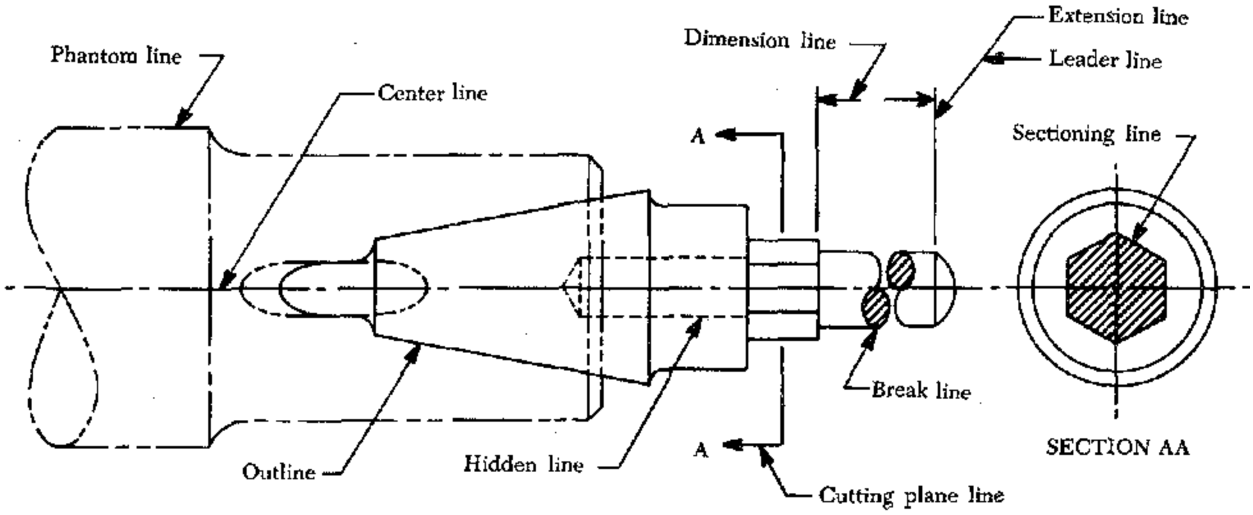

Figure 5-16. Correct uses of lines

Centre Lines

Centre lines are made up of alternate long and short dashes. They indicate the centre of an object or part of an object. Where centre lines cross, the short dashes intersect symmetrically. In the case of very small circles, the centre lines may be shown unbroken.

Dimension Lines

A dimension line is a light solid line, broken at the midpoint for insertion of measurement indications, and having opposite pointing arrowheads at each end to show origin and termination of a measurement. They are generally parallel to the line for which the dimension is given, and are usually placed outside the outline of the object and between views if more than one view is shown.

All dimensions and lettering are placed so that they will read from left to right. The dimension of an angle is indicated by placing the degree of the angle in its arc. The dimensions of circular parts are always given in terms of the diameter of the circle and are usually marked with the letter D or the abbreviation DIA following the dimension.

The dimension of an arc is given in terms of its radius and is marked with the letter R following the dimension. Parallel dimensions are placed so that the longest dimension is farthest from the outline and the shortest dimension is closest to the outline of the object. On a drawing showing several views, the dimensions will be placed upon each view to show its details to the best advantage.

In dimensioning distances between holes in an object, dimensions are usually given from centre to centre rather than from outside to outside of the holes. When a number of holes of various sizes are

Capital letter (A, B, C, etc.) on the principal view refer to a detail view located elsewhere on the diagram. That detail view is an enlarged drawing of a portion of a system. The numbers on the various views are referred to as call outs, and serve to identify each component.

Installation diagrams are used extensively in aircraft maintenance and repair manuals and are used in identifying and locating components and understanding the operation of various systems.

Schematic Diagram

Schematic diagrams do not indicate the location of individual components in the aircraft, but do locals component with respect to each other within the system. **Fig. 5-20** is a schematic diagram of an air conditioning system for a light airplane. This diagram shows the main components of the system and the direction the refrigerant flows. The different types of shading identify the pressure inside the lines.

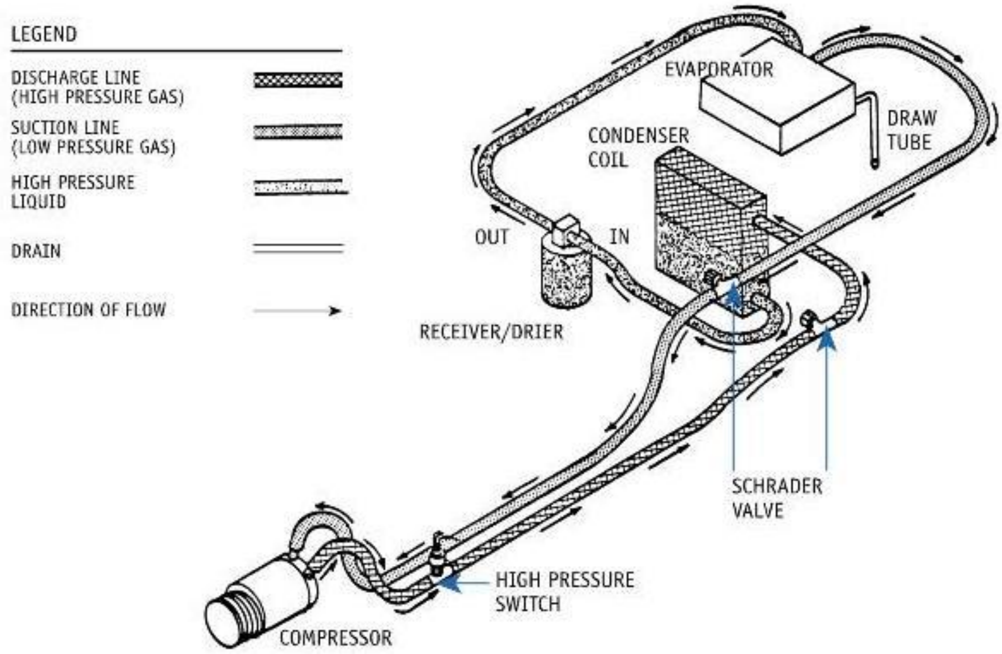

Figure 5-20. Schematic diagram of an aircraft air conditioning system

Schematic diagrams, like installation diagrams, are used extensively in aircraft manuals and are of great help when troubleshooting a system.

Drawing Sketches

A sketch is a simple, rough drawing that is made rapidly and without much detail. The basic shapes in use are triangle, cube, circle, cylinder, cone and sphere. Sketches may take many forms-from a simple pictorial presentation to a multi-view orthographic projection.

A sketch is frequently drawn for use in manufacturing a replacement part. Such a sketch must provide all necessary information to those persons who must manufacture the part.

7.6 FITS AND CLEARANCES

Dimensions, Allowances and Tolerances

In hand and machine fitting the term fitting means putting parts together so that they touch or join with each other in such a way that either one part will turn inside another; one will slide upon another; or that the parts will hold tightly together so that they cannot move upon each other. To achieve the particular type of fit required, the parts may be machined, filed, ground lapped or scraped. Examples of fitted parts are shafts fitted to a bearing, a piston running in a cylinder, a propeller splined to its shaft or a bolt fitting into a nut.

Most fitting was at one time carried out by hand and required great skill and judgment. With the use of high developed machine tools capable of producing precision work of accuracy and uniformity, hand fitting has become superseded. It still has a part to play, however, in teaching basic skills and in many cases where individual work is required.

Interchangeability

By using modern methods individual parts are made in great quantities by carefully planned processes using special tools, jigs and fixtures. Uniformity in size and shape is maintained by use of gauges and templates. By this uniformity the parts can be manufactured as exact replicas of each other and therefore each similar part can be interchanged.

Dimensions

Mass production has long been the basis of the approach to the most economic methods of manufacturing and the complete replacement of a defective item is common practice in the maintenance of aircraft and aerospace components.

For this reason, limits are imposed on the manufacturing processes, to ensure that, if any two mating parts are manufactured to the dimensions as stated on the relevant drawings, then the parts will assemble without need of further major adjustments and in the least time possible.

The limits are based on the allowances and tolerances imposed on the dimensions of the manufactured parts. These dimensions will be given the accuracy required by the designer of the respective parts. The basic size of dimension is given with tolerances expressed as a plus/minus range.

Allowances

An allowance is a difference in dimension that is necessary to give a particular „class of fit” between two parts. If, for example (and using a typical limit system), a shaft were required to locate with a corresponding hole in a component. Then, to assist in the economy of manufacture, either the hole or

Baseline and Continued Tolerances

Baseline tolerances (**Fig. 6-2B**) do not „stack-up". Continued (or „chained") tolerances (**Fig. 6-2A**) „stack up" and are cumulative.

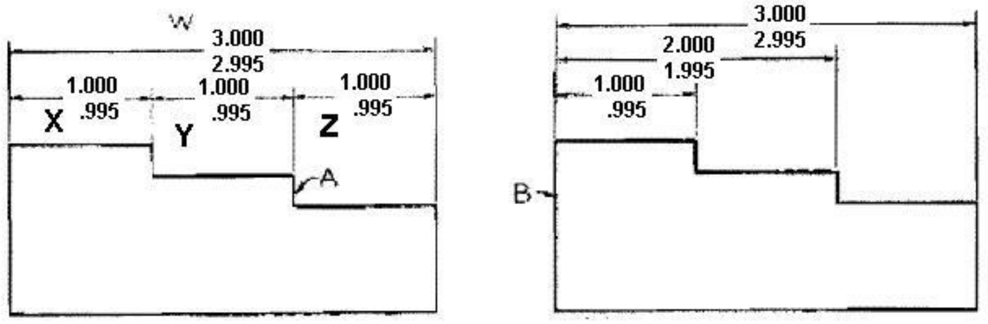

Figure 6-2. Cumulative (A) and baseline (B) dimensions

Drill Sizes for Holes

The size of hole to be drilled depends upon the purpose of that hole. A hole drilled for a rivet with a specific diameter would differ from those drilled to take a screw thread, or the plain shank of a bolt, of the same diameter. Similarly the size of a hole which is to accommodate a shaft will depend on the size of the shaft and on the manner in which the hole/shaft combination is to be used.

Additionally, if the hole is to be reamed, then it must be drilled slightly smaller than its nominal size, to allow for the metal removed by the reamer. Drill sizes (as discussed in the Tools topic) are fixed and can be found on charts that list each standard drill size, together with other columns such as clearance and tapping sizes. These charts may also include equivalent sizes displayed in metric, fractional, letter and in the number/letter system.

Classes and Standards of Fits and Clearances

Classes of Fit

The relationship between the bolt hole and the bolt (or indeed two mating parts) determines the classification of fit, namely:

Clearance fit	Has limits of size defined such that a clearance always results when mating parts are assembled
Interference fit	Has limits of size so prescribed that an interference always results when mating parts are assembled (**Fig. 6-3A**)
Transition fit	has limits of size so prescribed that either a clearance or interference may result when mating parts are assembled (**Fig. 6-3B**)

7. ELECTRICAL WIRING INTERCONNECTION SYSTEM (EWIS)

The satisfactory performance of any modern aircraft depends to a very great degree on the continuing reliability of electrical systems and subsystems. Improperly or carelessly installed or maintained wiring can be a source of both immediate and potential danger. The continued proper performance of electrical systems depends upon the knowledge and technique of the mechanic who installs, inspects, and maintains the electrical wire and cable of the electrical systems.

The electrical systems especially wire harnesses of modern aircraft could be damaged by:

- Vibration from a mechanical source (engine, flap drive motor, fuel pump, gear mechanism, and etc.);
- Environmental conditions (heat, cold, fuel, dirt, moisture and hydraulic fluid);
- Incorrect installation (clamp that is loose, clamp that is the incorrect size, wire harness branch that is made incorrectly, the incorrect quantity of wire harness ties or installed plastic tie straps, wire harness tension that is too loose or too tight).

Continuity

That means the aircraft wire harnesses require more attention to their continuity, insulation and bonding.

A *continuity test* is the checking of an electric circuit to see if current flows (that it is in fact a complete circuit). A continuity test is performed by placing a small voltage (wired in series with an LED or noise-producing component such as a piezoelectric speaker) across the chosen path. The circuit is "open" if electron flow is inhibited by broken conductors, damaged components, or excessive resistance.

Devices that can be used to perform continuity tests include multimeter which measure current and specialized continuity testers which are cheaper, more basic devices, generally with a simple light bulb that lights up when current flows.

An important application is the continuity test of a bundle of wires so as to find the two ends belonging to a particular one of these wires; there will be a negligible resistance between the "right" ends, and only between the "right" ends.

NOTE: This test should be done when current is **NOT** present. Always unplug the device or turn off the main circuit breaker before attempting a continuity test. Always test your test equipment for proper operation before use.

The continuity test is done to determine whether a circuit is open or closed. For example, a wall switch is closed when it is turned to the "on" position and it is open when it is turned off. An open circuit cannot conduct electricity. A closed circuit has continuity.

though the connection were being made to the structure. If it is necessary to remove the tab for any reason, the rivets should be replaced with rivets one size larger, and the mating surfaces of the structure and the tab should be clean and free of anodic film.

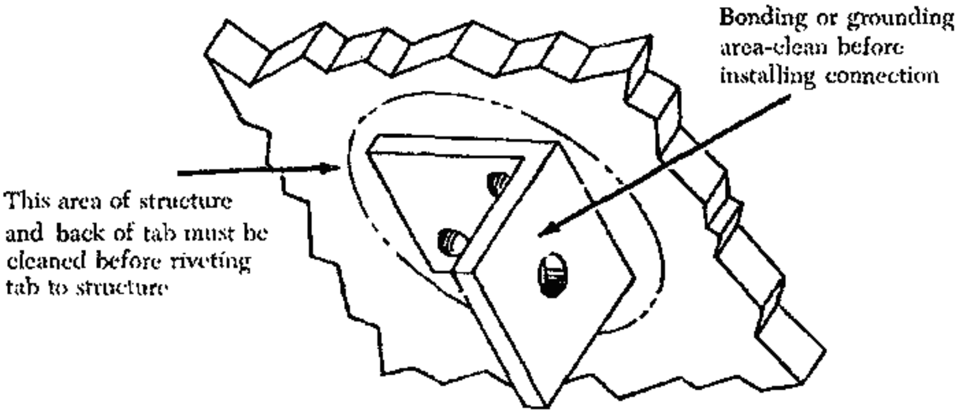

Figure 7-10. Bonding or grounding tab riveted to structure

Bonding or grounding connections can be made to aluminium alloy, magnesium, or corrosion-resistant steel tubular structure as shown in **Fig. 7-11**, which shows the arrangement of hardware for bonding with an aluminium jumper. Because of the ease with which aluminium is deformed, it is necessary to distribute screw and nut pressure by means of plain washers.

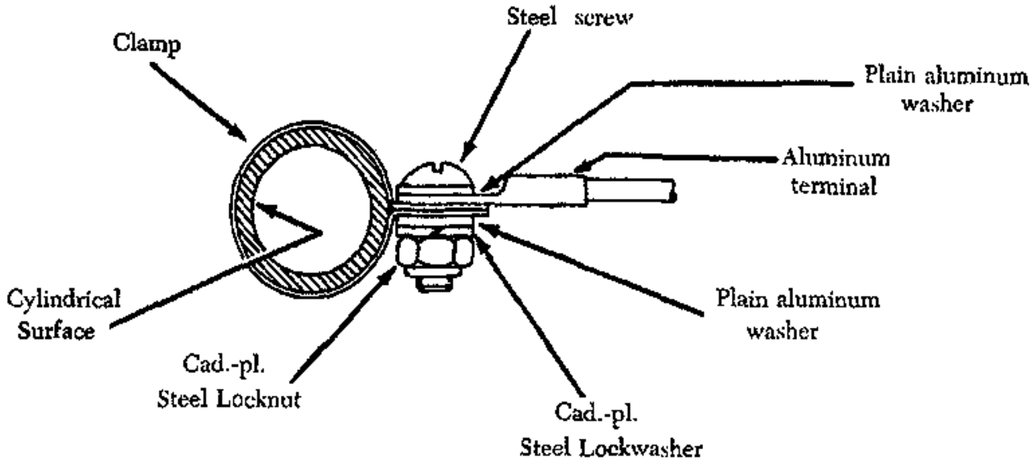

Figure 7-11. Bonding or grounding connections to a cylindrical surface

Hardware used to make bonding or grounding connections should be selected on the basis of mechanical strength, current to be carried, and ease of installation. If connection is made by aluminium or copper jumpers to the structure of a dissimilar material, a washer of suitable material should be installed between the dissimilar metals so that any corrosion will occur on the washer.

Hardware material and finish should be selected on the basis of the material of the structure to which attachment is made and on the material of the jumper and terminal specified for the bonding or

Splicing with Solder and Potting Compound

When neither a permanent splice nor a terminal lug is available, a broken wire can be repaired as shown on **Fig. 7-19**.

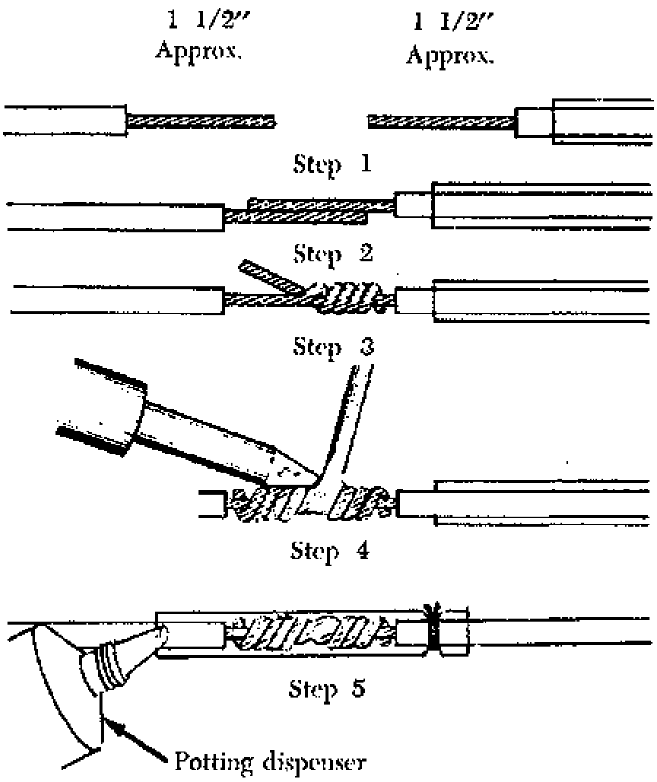

Figure 7-19. Repairing broken wire by soldering and potting

The steps of such repair are:

1. Install a piece of plastic sleeving about 3 in. long, and of the proper diameter to fit loosely over the insulation, on one piece of the broken wire;
2. Strip approximately 1-1/2 in. from each broken end of the wire;
3. Lay the stripped ends side by side and twist one wire around the other with approximately four turns;
4. Twist the free end of the second wire around the first wire with approximately four turns. Solder the wire turns together, using 60/40 tin-lead resin-core solder;
5. When solder is cool, draw the sleeve over the soldered wires and tie at one end. If potting compound is available, fill the sleeve with potting material and tie securely;
6. Allow the potting compound to set without touching for 4 hrs. Full cure and electrical characteristics are achieved in 24 hrs.

Single-Cord Lacing

Fig. 7-29 shows the steps in lacing a wire bundle with a single cord.

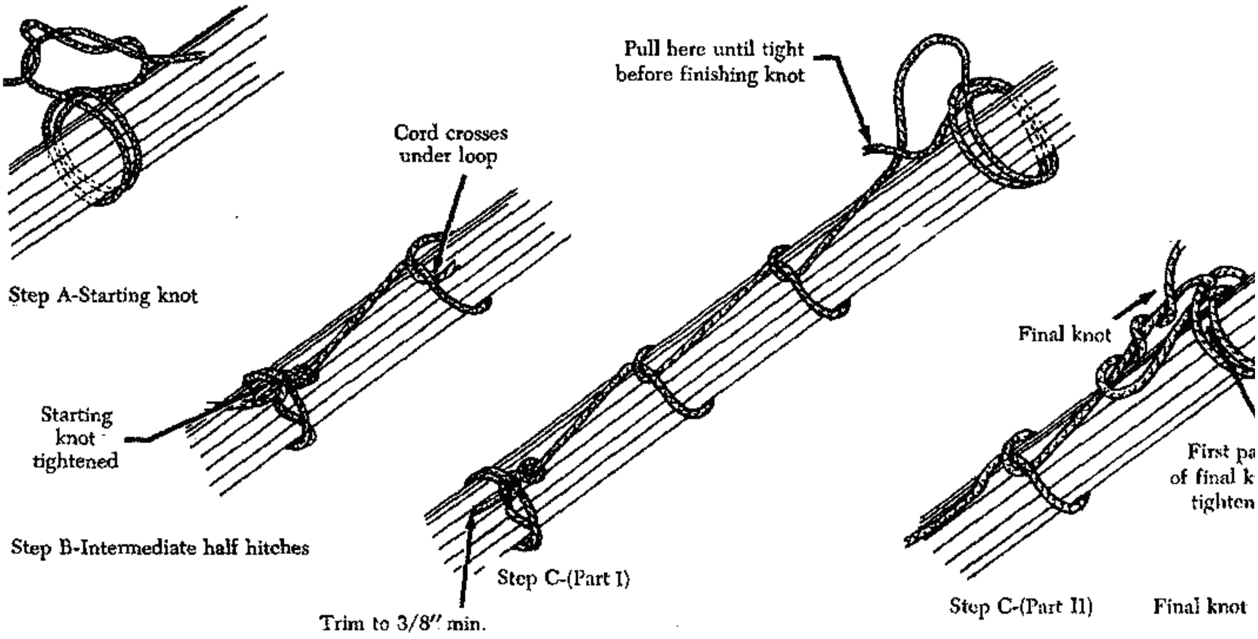

Figure 7-29. Single-cord lacing

The lacing procedure is started at the thick end of the wire group or bundle with a knot consisting of a clove hitch with an extra loop. The lacing is then continued at regular intervals with half hitches along the wire group or bundle and at each point where a wire or wire group branches off. The half hitches should be spaced so that the bundle is neat and secure. The lacing is ended by tying a knot consisting of a clove hitch with an extra loop. After the knot is tied, the free ends of the lacing cord should be trimmed to approximately 3/8 in.

Double-Cord Lacing

Fig. 7-30 illustrates the procedure for double-cord lacing. The lacing is started at the thick end of the wire group or bundle with a bowline-on-a-bight knot (**Fig. 7-30A**).

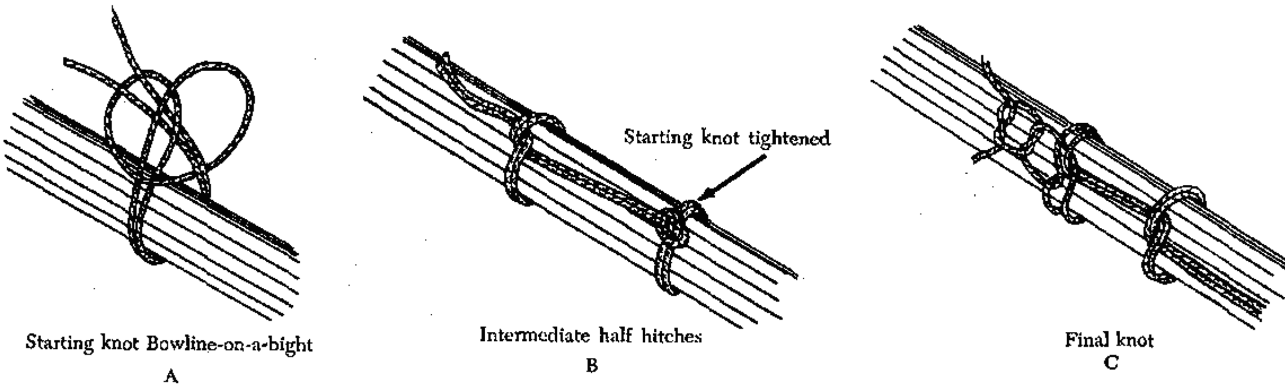

Figure 7-30. Double-cord lacing

Fig. 7-41 shows some typical mounting hardware used in installing cable clamps.

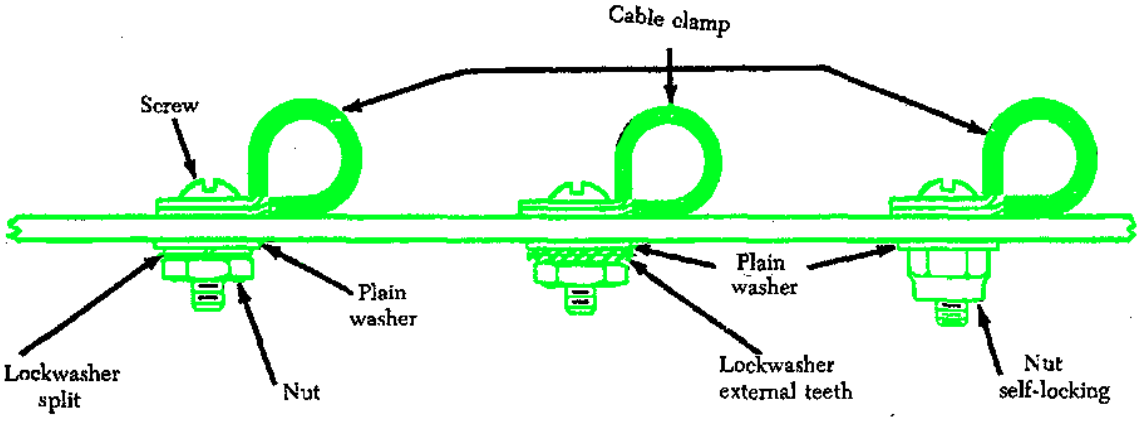

Figure 7-41. Typical mounting hardware for cable clamps

Be sure that wires are not pinched in cable clamps. Where possible, mount them directly to structural members, as shown in **Fig. 7-42**.

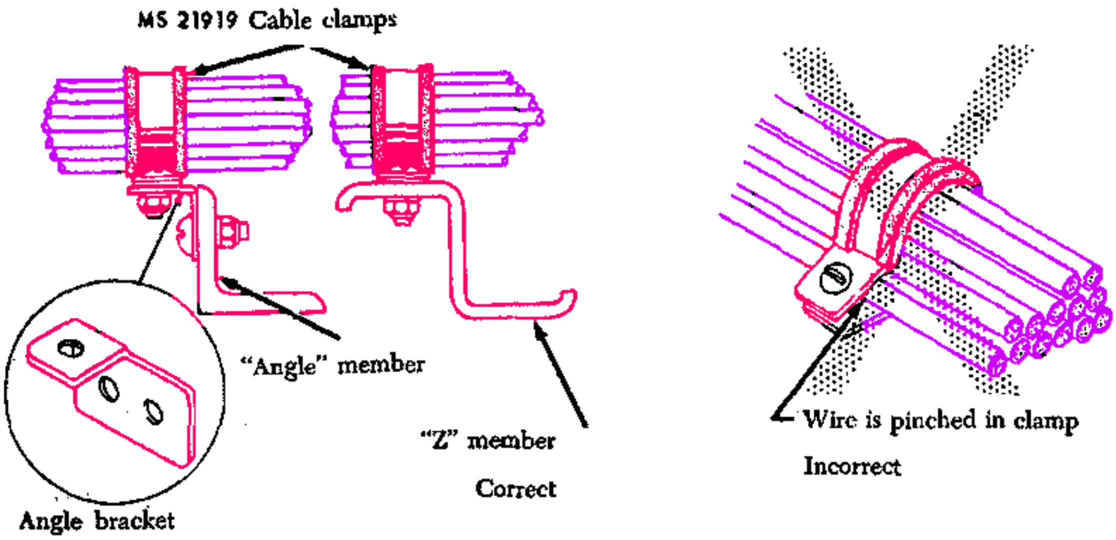

Figure 7-42. Mounting cable clamp to structure

Clamps can be used with rubber cushions to secure wire bundles to tubular structures as shown in **Fig. 7-43**. Such clamps must fit tightly but should not be deformed when locked in place.

Nevertheless the replacement of a damaged wire or a damaged cable is recommended, the repair of a damaged wire or a damaged cable with a splice is a satisfactory alternative unless it is specified differently in the applicable repair conditions or in the applicable repair procedure.

These conditions are applicable:

- The general conditions for the repair or wire and cable;
- All splice assemblies must have a sealed configuration;
- The maximum number of new splices that a wire can have is three (**Fig. 7-47**);

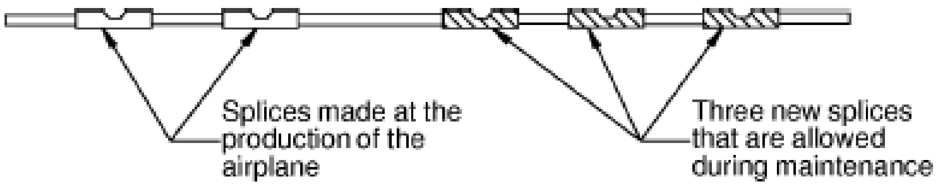

Figure 7-47. Three new splices are allowed

- It is permitted to remove three or more splices and replace them with two new splices (**Fig. 7-48**);

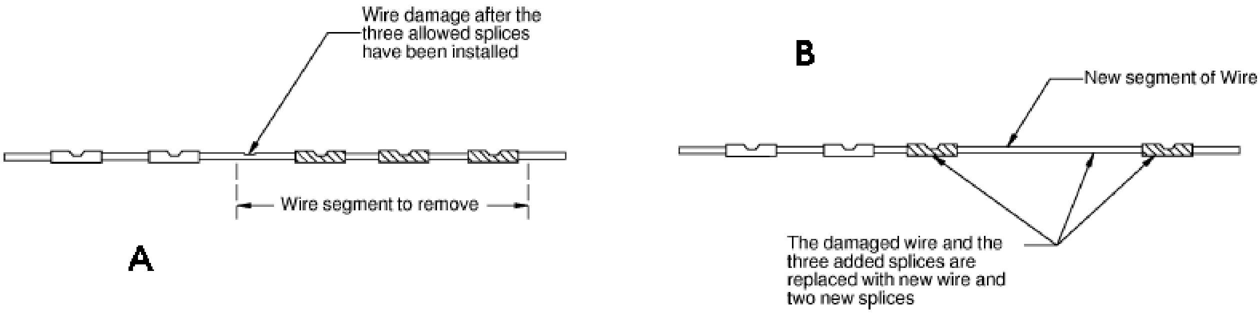

Figure 7-48. When there is one more damage in addition to already repaired three

- When the repair of more than one wire in a wire harness is necessary, the minimum distance between the end of the splice on one wire and the opposite end of the splice on an adjacent wire must be 0.25 inch (**Fig. 7-49**);

Figure 7-49. The location of the splices when it is necessary to keep the diameter of the wire harness

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7.8. RIVETING

In considering a typical riveted joint it should be understood that the plate resists shear, bearing and tensile loads while the rivet resists shear and bearing loads only.

Thus the requirements for riveted joints are specific.

CAUTION: At no time should the rivets be in tension, as this tends to burst them apart with a load they are not designed to withstand

Strength of Joints

The factors that govern the strength of a joint are:

1. Plate specification. This will be of such a material and gauge as to successfully withstand tensile and bearing loads;
2. Rivet specification. This will be selected to withstand shear loads. In cases where the specification of the rivet is not given, use a rivet of the same material as the plate, with a diameter of 3 $\times$ T where T is the thickness of one of the sheets;
3. Rivet pitch. This is important as too great pitch will result in insufficient rivets to take the shear loads and too small pitch will result in lowering the resistance of the plate to tensile loads.

Types of Rivet Spacing

There are three main types of rivet spacing in riveted joints. The simplest one is the single chain - used chiefly on attachment and lightly stressed joints (**Fig. 8-1**)

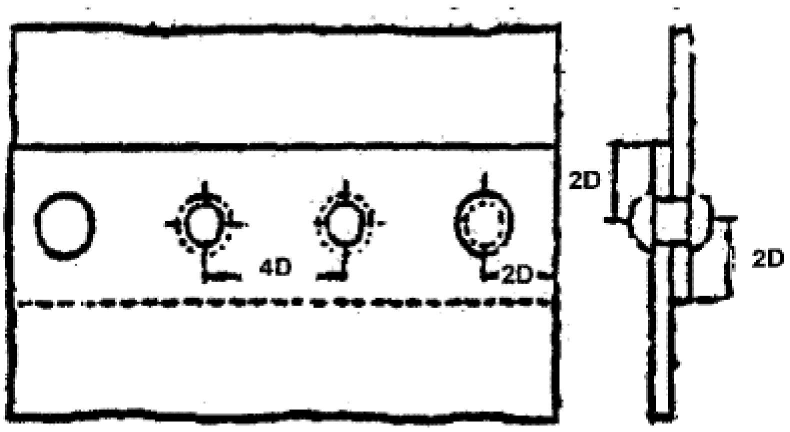

Figure 8-1. Single row rivet spacing and land

Guide to Rivet Pitch and Position

It should be understood that when working to a repair scheme as laid down in the particular aircraft repair manual, the rivet pitches and positions given there must be strictly adhered to even if they conflict with one or more of the following statements:

a) The rivet pitch of a joint will depend on the function to be performed by that joint. The rivet pitch is the distance between each rivet;

b) If it is merely an attachment joint, then the pitch will be 8-10D;

c) Joints subjected to high stress, the pitch should not be more than 4D and under no circumstances less than 3D;

d) Rivets should never be placed nearer than 2D from the edge of a plate (the land);

e) The distance between adjacent rows of rivets, known as the spacing should be 3-4D.

Rivet Clearance

The clearance (**Fig. 8-6**), is the difference between the size of the hole and the rivet diameter; rivet holes are normally drilled 0.003 in. oversize.

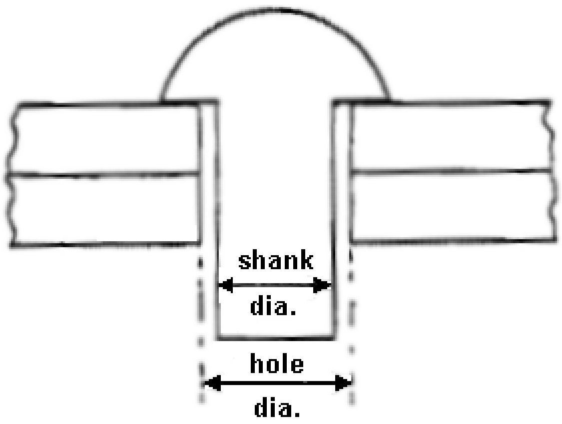

Figure 8-6. Rivet clearance

Clearance is necessary, particularly with light alloys to prevent puckering of the sheet owing to the metal s reading when the rivet head is formed.

CLEARANCE = hole ∅ – shank ∅

Rivet Grip Length

This is the length of rivet shank (**Fig. 8-7**) taken up by the combined thickness of the sheets being joined.

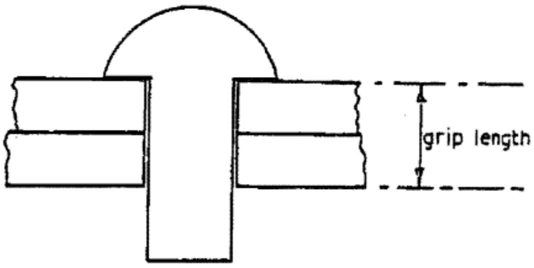

Figure 8-7. Grip length

To determine the length of rivet to be used add the rivet allowance to the rivet grip length. Have a trial on scrap metal of the same thickness and specification.

Allowances for Riveting

When fitting a rivet, sufficient shank must be left protruding above the plate to take up the clearance and form the head. Failure to observe this precaution leads to many riveting faults.

The allowance for rivet heads are expressed in terms of the diameter of the rivet shank and are dependent on the material specification of the rivet and gauge of sheet being riveted (**Fig. 8-7**). If two plates of different thickness A and B are riveted together, the rivet thickness (shank diameter) must be of $3 \times T$ where T is the thickness of one of the sheets.

A rivet (**Fig. 8-8**) is driven (the bottom part of the rivet on the right) 1.5D wide and 0.5D high. It must first extend through the grip length plus 1.5D when A + B equals grip length.

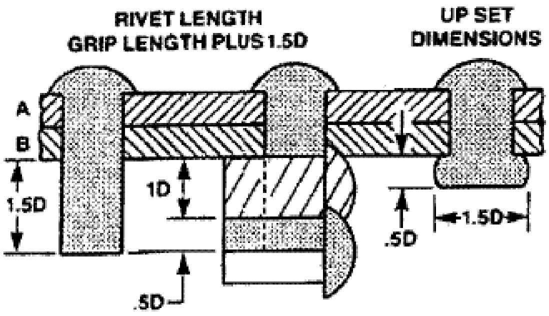

Figure 8-7. Rivet allowance

Typical values of allowance are:

Snap Head	*1.5D*
Countersunk	*0.75D*
Reaction	*1.5D*

Some precautions to be observed when using a rivet gun are:

1. Never point a rivet gun at anyone at any time. A rivet gun should be used for one purpose only-r-to drive or install rivets;
2. Never depress the trigger mechanism unless the set is held tightly against a block of wood or a rivet;
3. Always disconnect the air hose from die rivet gun when it will not be in use for any appreciable length of time.

Squeeze Riveters

The squeeze method of riveting is limited since it can be used only over the edges of sheets or assemblies where conditions permit, and where the reach of the squeeze riveter is deep enough. There are three types of rivet squeezers — hand (**Fig. 8-18**), pneumatic, and hydraulic.

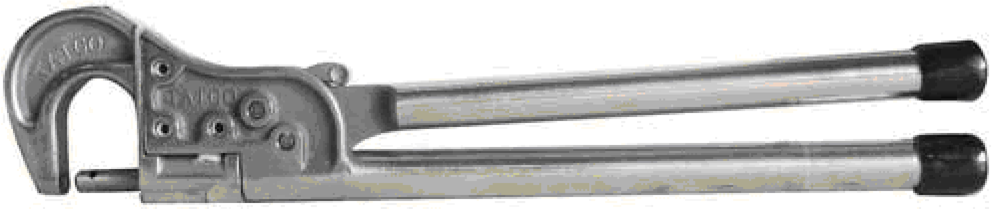

Figure 8-18. Hand rivet squeezer

They are basically alike except that in the hand rivet squeezer, compression is supplied by hand pressure; in the pneumatic rivet squeezer, by air pressure; and in the pneumo-hydraulic, by a combination of air and hydraulic pressure. One jaw is stationary and serves as a bucking bar; the other jaw is movable and does the upsetting. Riveting with a squeezer is a quick method and requires only one operator.

Squeeze riveters are usually equipped with either a C-yoke or an alligator yoke. Yokes are available in various sizes to accommodate any size of rivet. The working capacity of a yoke is measured by its gap and its reach. The gap is the distance between the movable jaw and the stationary jaw; the reach is the inside length of the throat measured from the centre of the end sets.

End sets for squeeze riveters serve the same purpose as rivet sets for pneumatic rivet guns and are available with the same type heads. They are interchangeable to suit any type of rivet head. One part of each set is inserted in the stationary jaw, while the other part is placed in the movable jaws. The manufactured head end set is placed on the stationary jaw whenever possible. However, during some operations, it may be necessary to reverse the end sets, placing the manufactured head end set on the movable jaw.

Solid Riveting Procedure (Snap Head)

a) Mark out rivet positions using pencil on light alloys and centre pop centre of rivet position, drill the holes to the correct clearance size;

b) Clean the joining surfaces removing all burrs from the drilled holes. It may be a requirement to put a jointing compound between the surfaces to reduce the possibility of corrosion;

c) To prevent movement during riveting join the surfaces together temporarily using skin or sheet grip pins (**Fig. 8-23**) at regular intervals along the joint.

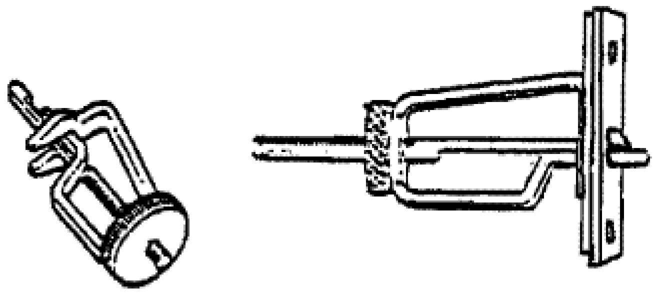

Figure 8-23. Sheet grip pins

d) Insert the correct length of rivet, support the head in the dolly (**Fig. 8-24A**) and place the set over the rivet shank (**Fig. 8-24B**). Lightly tap the set to draw the sheets of metal close together and bring the pre-formed head hard against the metal sheet (**Fig. 8-24C**).

e) Remove the set and strike the rivet centrally (**Fig. 8-24C**) to spread the rivet shank in the hole.

f) Using the snap, form the second head of the rivet to the correct shape (**Fig. 8-24D**).

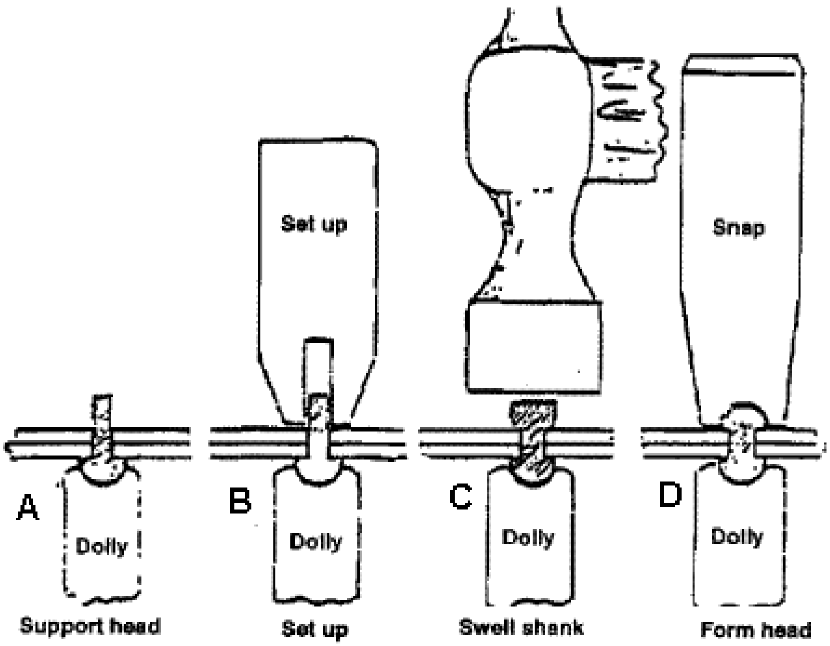

Figure 8-24. Rivet procedure using snap

Bearing Failure

If the rivet is excessively strong in shear, bearing failure occurs in the sheet at the edge of the rivet hole. The application of large rivets in thin sheets brings about such a failure. In that case, the sheet is locally crushed or buckled, and the buckling destroys the rigidity of the joint Vibrations, set up by engine operation or by air currents in flight, may cause the buckled portion to flutter and the material to break off close to the rivet head. If buckling occurs at the end of the sheet, a tear-out may result. In either case, replacement of the sheet is necessary.

Head Failure

Head failure may result from complex loadings occurring at a joint, causing stresses of tension to be applied to the rivet head. The head may fail by shearing through the area corresponding to the rivet shank, or, in thicker sheets, it may fail through a prying action which causes failure of the head itself. Any visible head distortion is cause for replacement. This latter type of head failure is especially common in blind rivets.

Rivet Installation Faults

Before commencing any type of riveting job, the operator should whenever possible, make a "dummy run" by forming rivets in some spare piece of metal of corresponding thickness.
The view of fault rivets is presented on **Fig. 8-29**.

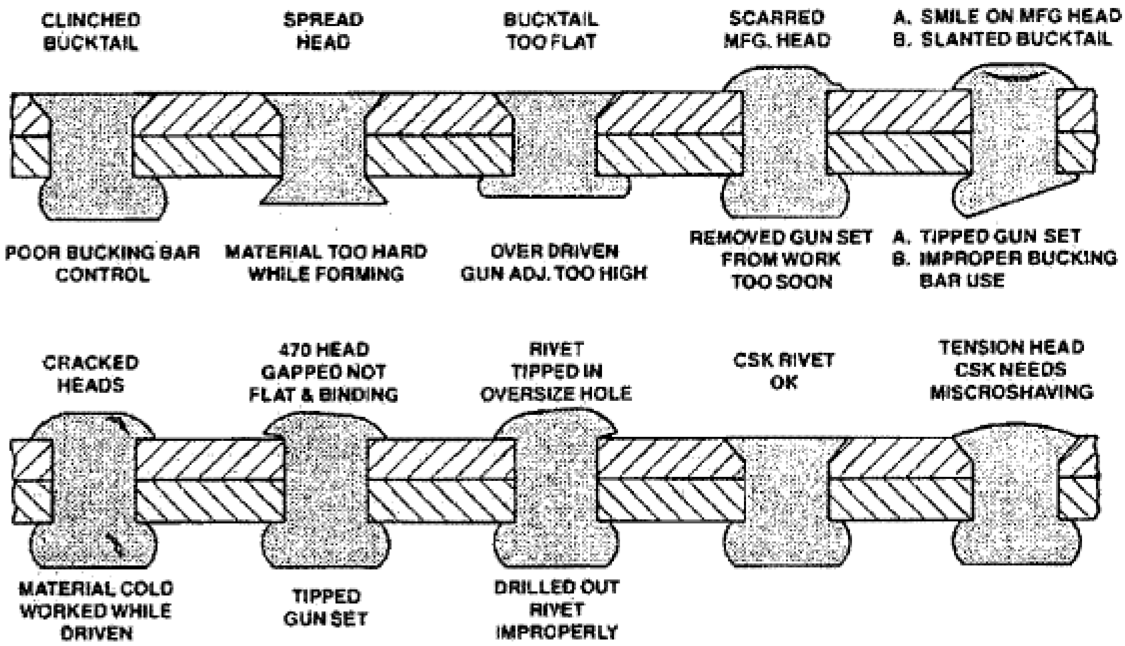

Figure 8-.29. Rivet faults