ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL FOUR

INSTRUCTIONAL GUIDE

SECTION 3

EO C470.03 – IDENTIFY AVIATION HARDWARE

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-804/PG-001, *Proficiency Level Four Qualification Standard and Plan*, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

The activity in TP 1 uses learning stations. Learning stations are a form of group work, where the cadets learn by sorting through the information presented. When setting up learning stations, ensure there is enough room for each cadet to be comfortable and adequate space for writing down information. When the cadets arrive at a learning station, all required information shall be available. These stations should be placed closely together to minimize time for movement; however, far enough apart to avoid interruptions from other groups. For this lesson, set up four learning stations for aviation hardware.

Photocopy the Aviation Hardware Handout located at Attachment A (one per cadet), Aviation Hardware Information Sheets located at Attachments B–E (one attachment per station), and the Aviation Hardware Identification Worksheet located at Attachment F (one per cadet).

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An in-class activity was chosen for this lesson as it is an interactive way to provoke thought and stimulate interest among cadets.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the cadet shall have identified aviation hardware.

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IMPORTANCE

It is important for cadets to be able to identify aviation hardware as each type of hardware has a specific application. Using the correct type of aviation hardware during maintenance activities and the manufacturing of aircraft and aircraft components ensures that the design specifications and safety tolerances are maintained. Using the incorrect type of aviation hardware could jeopardize the safety of the aircrew, passengers, and personnel on the ground.

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Teaching point 1 **Conduct an activity where the cadets will identify aviation hardware.**

Time: 25 min Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets identify aviation hardware.

RESOURCES

- Pen / pencil,
- Aviation Hardware Handout located at Attachment A,
- Aviation Hardware Information Sheets located at Attachments B–E,
- Aviation Hardware Identification Worksheet located at Attachment F, and
- Aviation Hardware Identification Worksheet Answer Key located at Attachment G.

ACTIVITY LAYOUT



If samples of aviation hardware are available, place them at the appropriate learning station.

ACTIVITY INSTRUCTIONS

1. Brief cadets on activity instructions, to include:
   a. time limit for each station (five minutes),
   b. direction of rotation between stations,
   c. signal for rotation,
   d. explanation of Aviation Hardware Information Sheets, and
   e. an overview of the Aviation Hardware Identification Worksheet.
2. Distribute the Aviation Hardware Identification Worksheet located at Attachment F (to each cadet).
3. Divide the cadets into four groups and assign a number to each group.
4. Have groups move to the learning station which corresponds to their group number.
5. Have the cadets complete the Aviation Hardware Identification Worksheet while rotating from station to station every five minutes.

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It is important to circulate around the room to facilitate the activities and help the cadets as required. If possible, assign other instructors to aid with the supervision and facilitation.

6. Once each group has been to each station, have one cadet from each group share the information they recorded from the station they just completed with the rest of the cadets. In most cases, the groups will have recorded the same information for each station. If a group has listed different information, have them share their answers.

SAFETY

Nil.

CONFIRMATION OF TEACHING POINT 1

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' completion of the Aviation Hardware Identification Worksheet will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

Nil.

CLOSING STATEMENT

Aviation hardware comes in a variety of types, each with a specific application. Using the correct type of aviation hardware during the manufacture and maintenance of aircraft and aircraft components is important to ensure that the safety of the aircrew, passengers, and personnel on the ground is not compromised.

INSTRUCTOR NOTES / REMARKS

Cadets who are qualified Advanced Aviation Technology – Aircraft Manufacturing and Maintenance may be able to assist with this lesson.

REFERENCES

C3-136 ISBN 0-88487-207-6 Sanderson Training Systems. (2001). *A&P technician airframe textbook*. Englewood, CO: Jeppesen Sanderson Inc.

C3-137 ISBN 0-88487-203-3 Sanderson Training Systems. (2000). *A&P technician general textbook*. Englewood, CO: Jeppesen Sanderson Inc.

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AVIATION HARDWARE HANDOUT

Aviation hardware refers to the different types of fasteners and small items used during the manufacture and maintenance of aircraft and aircraft components. Although many of these items are small in size, their importance is large.

With more than 30 000 different fasteners available for aviation applications, it is important to be able to identify the different types of aviation hardware as their correct use is paramount for the safe and efficient operation of aircraft.

Aviation hardware comes in a variety of shapes and sizes, as well as in a variety of materials. Over the years, there have been many different ways to standardize the description of aviation hardware.

AMS (Aeronautical Material Specifications)	AN (Air Force–Navy)
AND (Air Force–Navy Design)	AS (Aeronautical Standard)
ASA (American Standards Association)	ASTM (American Society for Testing and Materials)
MS (Military Standard)	NAF (Naval Aircraft Factory)
NAS (National Aerospace Standard)	SAE (Society of Automotive Engineers)

Note. From A&P Technician General Textbook (p. 8-2), by Jeppesen Standard Training Products, 2000, Englewood, CO: Jeppesen Sanderson Training Systems.

Figure A-1 Aviation Hardware Specifications and Standards Codes

The two most common specification and standard identification systems used in aviation today are the Air Force–Navy (AN) and Military Standards 20 (MS20) systems. Both systems use a similar coding method to describe the physical characteristics of aviation hardware (eg, rivets, bolts, nuts, etc). An example of this is shown in Figure A-2. While there are minor differences between different systems, the same piece of hardware can be described by different systems (eg, an AN365 self-locking nut is the same as a MS20365 self-locking nut).

Rivet Designation	**Physical Characteristics**	
AN470-AD4-5	AN	Specification and standard (Air Force–Navy system)
	470	Head style (universal head)
	AD	Material code (2117 aluminum alloy)
	4	Diameter (4/32 inch)
	5	Length (5/16 inch)

Note. Created by Director Cadets 3, 2009, Ottawa, ON: Department of National Defence.

Figure A-2 Rivet Specification Decoded

Although there are many different types of fasteners used in aviation, there are five main categories:

- bolts (includes washers and nuts),
- rivets,
- special fasteners,
- machine screws, and
- turnlock fasteners.

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Each category has its own unique terminology, although some terms may have similar meanings, as well as special tools and procedures for installation and removal.

Fasteners are used in two distinct applications in aviation: structural and non-structural. When used as a structural fastener, it is especially important that the correct hardware is used as the hardware forms part of the structure of the aircraft and is expected to be able to carry a specific load without failing.

Examples of structural fasteners include:

- bolts connecting the wing spar to the fuselage,
- rivets connecting the wing skin to the wing ribs, and
- bolts connecting the landing gear to the fuselage.

Examples of non-structural fasteners include:

- turnlock fasteners on inspection covers and cowlings,
- machine screws on interior panels, and
- bolts holding instruments in place in the instrument panel.

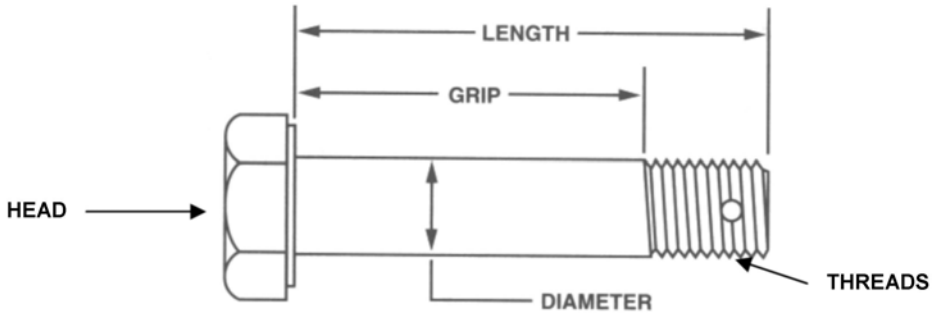
Aircraft plans, parts manuals, and repair manuals all include very specific details on the exact type of aviation hardware to be used. Builders and maintenance personnel must not substitute alternate hardware without ensuring that design specifications are not compromised.

When compared to standard or automotive hardware, aviation hardware is manufactured to higher standards, generally has a higher strength rating, and may come with a variety of finish or coating option. While non-aviation hardware may be legal for use on home-built aircraft, most associations strongly recommend the use of aviation hardware.

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BOLTS

A bolt is designed to hold two or more items together. Bolts come in a variety of sizes, shapes, materials and strengths so that the correct fastener can be used for each application. Bolts are used for both structural and non-structural applications.



Note. From A&P Technician General Textbook (p. 8-17), by Jeppesen Standard Training Products, 2000, Englewood, CO:Jeppesen Sanderson Training Systems.

Figure B-1 AN (Airforce Navy) Bolt Dimensions

Standard AN Bolt Classification

Standard bolts classified using the AN system, are classified using the diameter and length, and additional modifiers (eg, material, drilled holes) are added. Diameters are indicated in 1/16-inch increments and length in 1/8-inch increments.

For example, an AN4-7 bolt has a diameter of 4/16 inch (1/4 inch) and a length of 7/8 inch. The length of the bolt is also known as the dash number. Dash numbers of eight and nine (-8 and -9) are not used. This means that a bolt length of 1 inch is represented with -10 (2 inches is -20, 3 inches is -30). For example, an AN5-22 bolt has a diameter of 5/16 inch and is 2-2/8 inches long (2-1/4 inches).

The material used for the bolt is indicated by replacing the dash with letters to indicate the material (the dash indicates that the bolt is made of cadmium-plated nickel steel). A corrosion-resistant bolt is represented with the letter C. Aluminum alloy bolts use the letters DD.

Standard bolts have a hole drilled in the threaded portion for a cotter pin (to keep the nut from coming off). To indicate a bolt without a hole, the letter A is added to the end of the bolt number (eg, AN5-22A). To indicate a bolt that has a hole drilled in the head (for locking wire), the letter H is inserted after the diameter (eg, AN6H34).

Threads

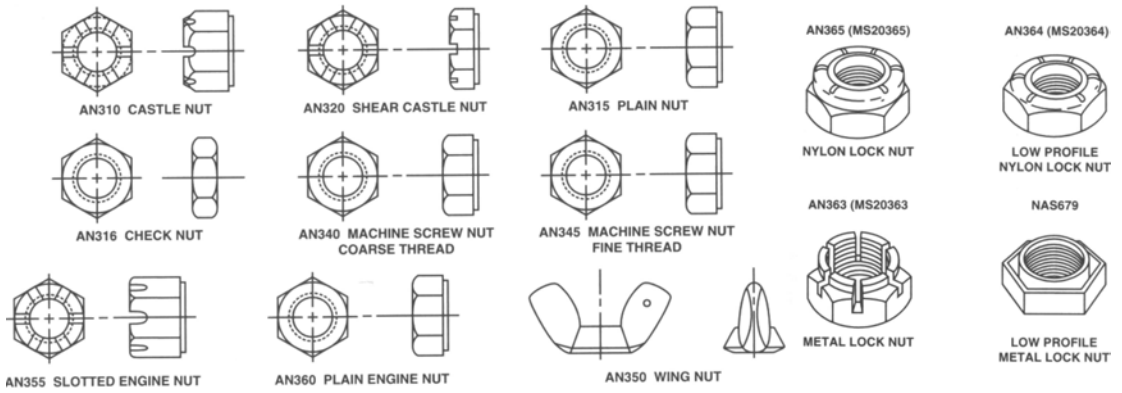
Threads are classified by the number of threads per inch (the number of times the threads rotate [number of turns] around a 1-inch length of a given diameter bolt or screw). Different standards for threads are American National Coarse (NC), American National Fine (NF), American Standard Unified Coarse (UNC), and American Standard Unified Fine (UNF).

Threads are also designated by the class of fit (from one to five). A Class 1 thread is a loose fit (the nut may be turned all the way from start to finish with just your fingers). A Class 5 thread is a tight fit (the nut requires a wrench from start to finish). Most aviation bolts are fine threaded with a Class 3 fit.

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Nuts and Washers

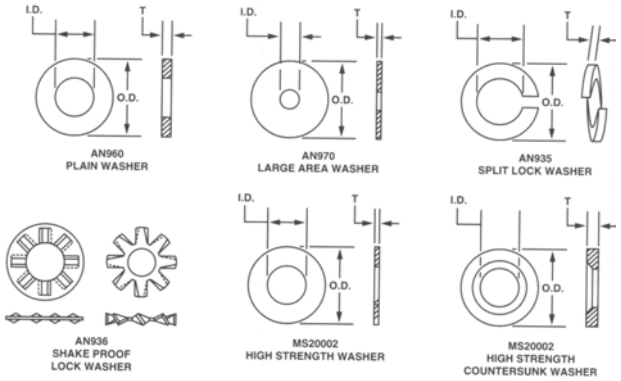
Nuts are threaded onto the end of the bolt to prevent it from coming out. In some applications, the nut may also carry a load. Due to the vibrations experienced in a typical aircraft, most nuts must be locked onto the bolts. To keep the nut from coming loose, a cotter pin can be inserted through the hole in the bolt (a castle nut is used in this type of application) or a lock nut (nylon or metal) is used.



Note. From A&P Technician General Textbook (p. 8-21), by Jeppesen Standard Training Products, 2000, Englewood, CO:Jeppesen Sanderson Training Systems.

Figure B-2 Standard Aircraft Nuts

Washers are used to ensure that the bolt fits properly, to prevent the nut and / or bolt head from damaging the parts, and in the case of lock washers, to help prevent the nut from coming loose.



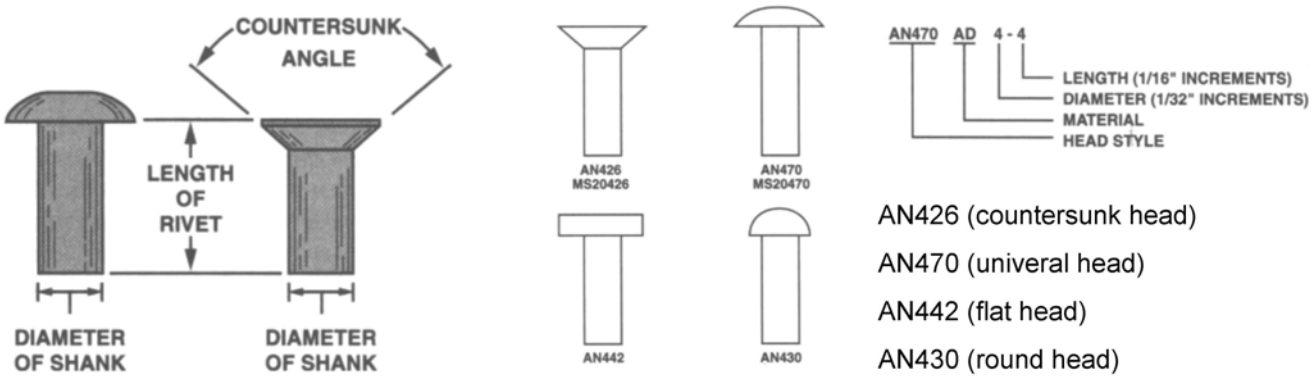
Note. From A&P Technician General Textbook (p. 8-30), by Jeppesen Standard Training Products, 2000, Englewood, CO:Jeppesen Sanderson Training Systems.

Figure B-3 Aircraft Washers

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RIVETS

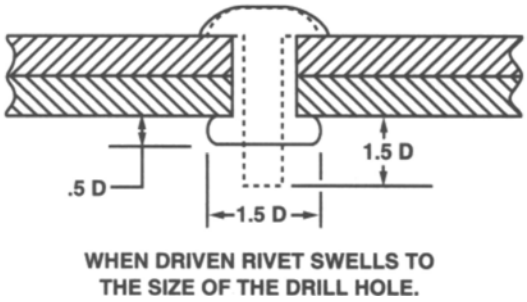
Rivets are used to join metal parts together, especially sheet metal parts (eg, attaching the metal skin of the wing to the metal ribs in the wing). When installed properly, rivets create a joint at least as strong as the material being joined.



Note. From A&P Technician Airframe Textbook (p. 2-36), by Jeppesen Standard Training Products, 2000, Englewood, CO: Jeppesen Sanderson Training Systems.

Figure C-1 Dimensions and AN Designations

The general process for installing a rivet is to drill a hole slightly larger than the initial diameter of the rivet in the two pieces being joined. The rivet is inserted into the hole, and both ends of the rivet are carefully pressed together using special tools (a rivet gun on the head, and a bucking bar on the opposite end). The shank of the rivet swells to fill the hole, and the end of the rivet flattens out.



Note. From A&P Technician Airframe Textbook (p. 2-36), by Jeppesen Standard Training Products, 2000, Englewood, CO:Jeppesen Sanderson Training Systems.

Figure C-2 Before and After Driving a Rivet

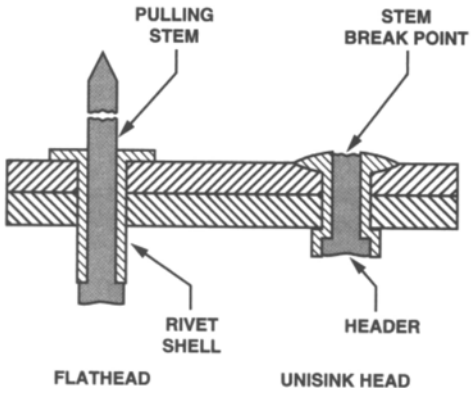
Special Rivets

Standard rivets require access to both ends of the rivet to properly install it. Special rivets that only require access to one end have been developed for use in areas of the aircraft where it is not possible to access both ends of the rivet. These special rivets are also known as blind rivets and come in a variety of styles, usually identified by a brand name (eg, Huck-Lok, CherryLOCK, CherryMAX, Olympic-Lok).

Pop Rivets

Pop rivets are a type of special rivet (blind rivet). Although very common in non-aviation applications, pop rivets have limited uses in aviation. They are never used for structural applications, except as a temporary way to line up parts while installing permanent rivets.

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Note. From A&P Technician Airframe Textbook (p. 2-40), by Jeppesen Standard Training Products, 2000, Englewood, CO:Jeppesen Sanderson Training Systems.

Figure C-3 Pop Rivets

Cleco Fasteners

Prior to installing rivets, the parts need to be properly aligned and held in place. The most common method for doing this is by clamping the parts together. One of the most common clamping devices used in aviation is the Cleco fastener. A Cleco fastener is basically just a removable rivet.



Note. From "Cleco Pliers, Cleco Tool for Cleco Fasteners", William Lees Sons Ltd. Retrieved March 24, 2009, from http://www.skinpins.com/toolsC200pliers.html

Figure C-4 Cleco Pliers and Cleco Fasteners

A Cleco fastener is inserted into a hole (that will eventually hold a rivet) using a special pair of pliers and clamps the metal pieces together. Once the pieces are properly aligned (usually with a Cleco fastener in each rivet hole) the Cleco fasteners are removed one at a time and replaced by the permanent rivet.

Cleco fasteners come in different sizes that correspond to common rivet sizes. Each size is colour coded for easy identification.

Rivet / Cleco Diameter	Rivet Diameter Dash Number	Colour
3/32 inch	-3	Silver
1/8 inch	-4	Copper
5/32 inch	-5	Black
3/16 inch	-6	Brass
1/4 inch	-8	Copper

Note. From A&P Technician Airframe Textbook (p. 2-34), by Jeppesen Standard Training Products, 2000, Englewood, CO: Jeppesen Sanderson Training Systems.

Figure C-5 Cleco Fastener Diameters and Colours

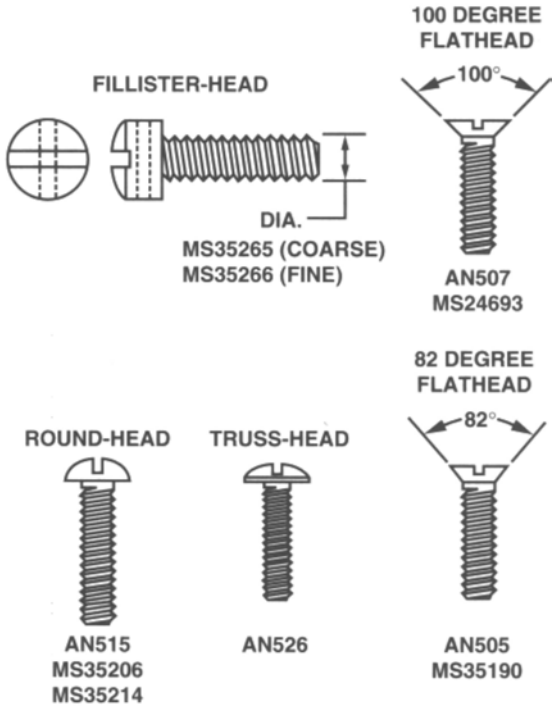
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SCREWS

Screws are a very common threaded fastener in aviation and there are three basic classifications: machine screws, structural screws, and self-tapping screws. Screws generally have a loose fitting thread (eg, Class 2) and may have either a clearly defined grip length that is partially threaded or be threaded along their entire length. While most screws have heads designed to accept a screwdriver, some have heads that require a wrench.

Machine Screws

Machine screws are generally used for attaching fairings, inspection plates, fluid line clamps, and other light structural parts. Machine screws are usually threaded along their entire length and are available with national coarse or national fine threads. These screws may be made of several different types of materials and may be coated or treated in various ways.



Note. From A&P Technician General Textbook (p. 8-27), by Jeppesen Standard Training Products, 2000, Englewood, CO:Jeppesen Sanderson Training Systems.

Figure D-1 Machine Screws

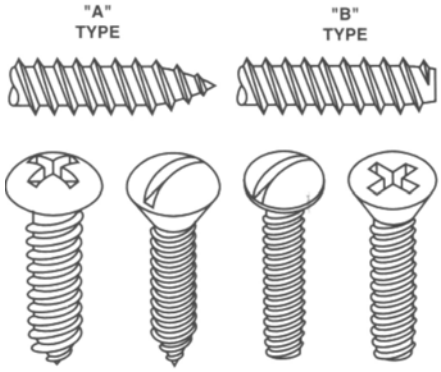
Structural Screws

Structural screws are very similar to standard bolts. They are heat treated and have the same shear strength as a bolt of the same size. Shank tolerances are similar to bolts and the threads are national fine.

Self-Tapping Screws

Self-tapping screws are used to hold thin sheets of metal, plastic, or plywood together. They have a coarse thread and come with a sharp (Type A) or blunt (Type B) point.

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Note. From A&P Technician General Textbook (p. 8-28), by Jeppesen Standard Training Products, 2000, Englewood, CO:Jeppesen Sanderson Training Systems.

Figure D-2 Self-Tapping Sheet Metal Screws

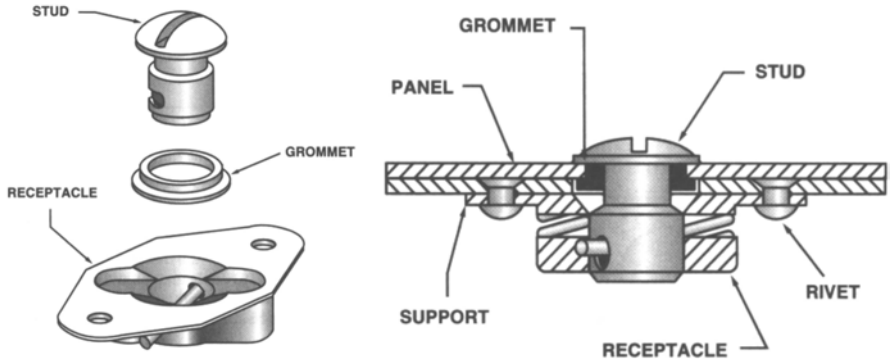
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TURNLOCK FASTENERS

Turnlock fasteners are used when quick and easy removal or opening of access panels, doors, and cowlings is required. There are three common types, each identified by their trade or brand name: Dzus, Airloc, and Camlock.

Dzus Fastener

Dzus (pronounced Zeus) fasteners are commonly found on cowling and inspection panels that must be frequently opened. The stud is mounted on the cowling or panel, and fits into the receptacle when the parts are aligned (closed). A quarter turn of the stud opens or closes the fastener. When closed, the stud grips a spring in the receptacle which keeps it closed.

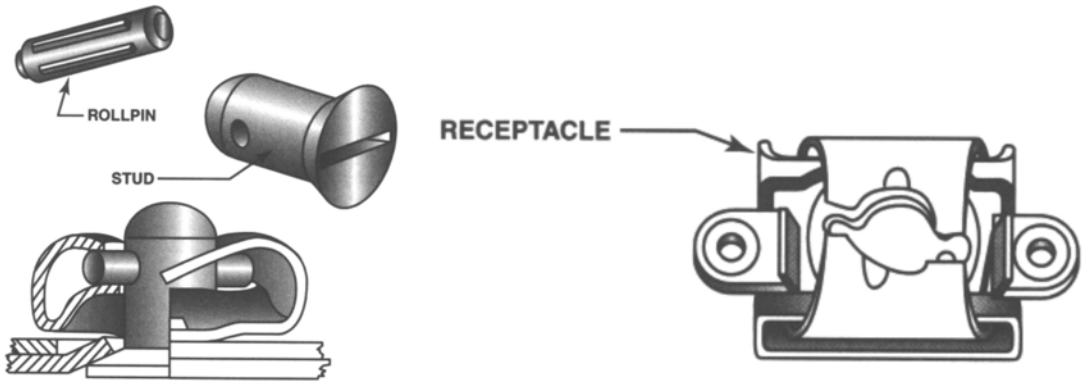


Note. From A&P Technician Airframe Textbook (p. 2-49), by Jeppesen Standard Training Products, 2000, Englewood, CO:Jeppesen Sanderson Training Systems.

Figure E-1 Dzus® Fastener

Airloc Fasteners

Airloc fasteners use a stud that has a pin, as opposed to Dzus fasteners that have a notch in the pin. When turned, the pin engages the spring in the receptacle. These fasteners are used in the same applications as Dzus fasteners.



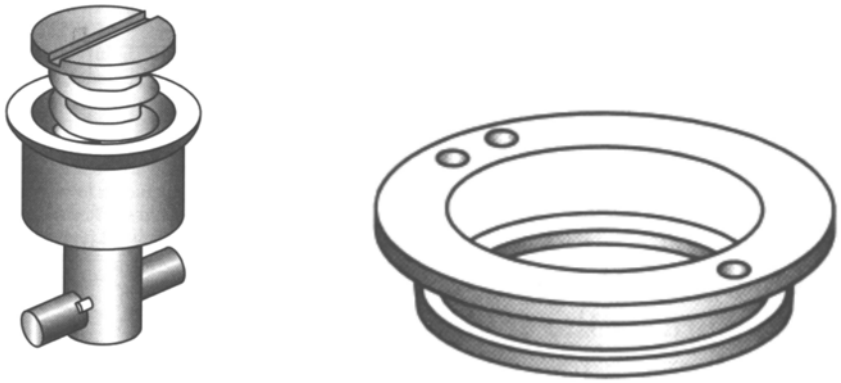
Note. From A&P Technician Airframe Textbook (p. 2-50), by Jeppesen Standard Training Products, 2000, Englewood, CO:Jeppesen Sanderson Training Systems.

Figure E-2 Airloc® Cowling Fastener

Camlock Fasteners

Camlock fasteners have a stud assembly that includes a spring and a pin. When the stud is pressed into the receptacle, the spring compresses and allows the pin to be rotated into position in the receptacle. When the stud is released, the spring expands, and holds the pin in place in a groove in the bottom of the receptacle.

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Note. From A&P Technician Airframe Textbook (p. 2-50), by Jeppesen Standard Training Products, 2000, Englewood, CO:Jeppesen Sanderson Training Systems.

Figure E-3 Camlock® Cowling Fastener

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AVIATION HARDWARE IDENTIFICATION WORKSHEET

Aviation Hardware

What two specification and standard identification systems are the most common?

_____, and

_____.

Bolts

Identify the aviation hardware shown below:







_____ _____ _____

An AN7-12 bolt:

- has a length of _____ inch(es),
- has a diameter of _____ inch(es),
- is made of _____, and
- _____ a hole drilled in the head for lock wire.

An AN3-13A bolt:

- has a length of _____ inch(es),
- has a diameter of _____ inch(es),
- is made of _____, and
- _____ a hole drilled in the threads for a cotter pin.

Rivets

Identify the aviation hardware shown below:





_____ _____

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An AN442AD4-4 rivet:

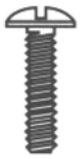
- has a length of _____ inch(es),
- has a diameter of _____ inch(es), and
- has a _____ head.

Pop rivets _____ used for structural applications.

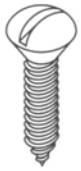
_____ are used when there is not easy access to both ends of the rivet.

Screws

Identify the aviation hardware shown below:



_____

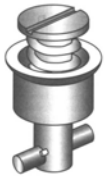


_____

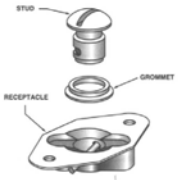
Most screws are installed using a _____. Some screws may require a _____ to install them.

Turnlock Fasteners

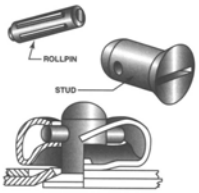
Identify the aviation hardware shown below:



_____



_____



_____

Most turnlock fasteners only need to be turned _____ to be opened or closed.

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Verify against the official publication.

AVIATION HARDWARE IDENTIFICATION WORKSHEET ANSWER KEY

Aviation Hardware

What two specification and standard identification systems are the most common?

__**AIR FORCE–NAVY (AN)**_____, and

__**MILITARY STANDARDS 20 (MS20)**_____.

Bolts

Identify the aviation hardware shown below:



AIRCRAFT BOLTS



NYLON LOCK NUT



PLAIN WASHER (AN690)

An AN7-12 bolt:

- has a length of __**1-1/4**___ inch(es),
- has a diameter of __**7/16**____ inch(es),
- is made of _**CADMIUM-PLATED NICKEL STEEL**_, and
- _**DOES NOT HAVE**_____ a hole drilled in the head for lock wire

An AN3-13A bolt:

- has a length of _**1-3/8**____ inch(es),
- has a diameter of __**3/16**____ inch(es),
- is made of _**CADMIUM-PLATED NICKEL STEEL**_, and
- _**DOES NOT HAVE**_____ a hole drilled in the threads for a cotter pin.

Rivets

Identify the aviation hardware shown below:



ROUND HEAD RIVET (AN430)



CLECO FASTENER

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Verify against the official publication.

An AN442AD4-4 rivet:

- has a length of __**1/4**_____ inch(es),
- has a diameter of __**1/8**_____ inch(es), and
- has a __**FLAT**____ head.

Pop rivets __**ARE NOT**_____ used for structural applications.

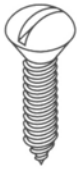
_**SPECIAL (BLIND) RIVETS**_____ are used when there is not easy access to both ends of the rivet.

Screws

Identify the aviation hardware shown below:



MACHINE SCREW

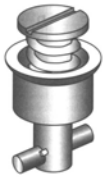


SELF-TAPPING SCREW

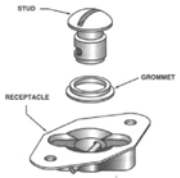
Most screws are installed using a __**SCREWDRIVER**_____. Some screws may require a __**WRENCH**_____ to install them.

Turnlock Fasteners

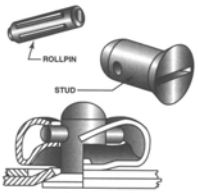
Identify the aviation hardware shown below:



DZUS FASTENER



CAMLOCK FASTENER



AIRLOC FASTENER

Most turnlock fasteners only need to be turned _**ONE QUARTER OF A TURN**__to be opened or closed.

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Verify against the official publication.