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ABSTRACT

This self-paced student training module on fastening devices is one of a number of modules developed for Pre-apprenticeship Phase 1 Training. Purpose of the module is to enable students to identify various nails, screws, and other anchoring devices and to describe under which conditions they are best used. The module may contain some or all of the following: a cover sheet listing module title, goal, and performance indicator; study guide/checklist with directions for module completion; introduction; information sheets providing information and graphics covering the module topic(s); self-assessment; self-assessment answers; post assessment; and post-assessment answers. (YLB)

INDIVIDUALIZED LEARNING SYSTEMS

PRE-APPRENTICESHIP PHASE 1 TRAINING

FASTENING DEVICES

Goal:

Upon completion of this module, the student will be able to identify various nails, screws and other anchoring devices, and will be able to describe under which conditions they are best used.

Performance Indicators:

The student will demonstrate knowledge of the subject by successfully completing a Self Assessment and a Post Assessment exam.

Study Guide

To successfully complete this module, complete the following tasks in the order listed. Check each one off as you complete it.

1. ____ Read the Goal and Performance Indicators on the cover of this module. This will inform you of what you are expected to gain from completing this module and how you will demonstrate that knowledge. Read the Introduction section to understand why this module is important.

2. ____ Study the Information section of this module to acquire the knowledge necessary to complete the Self and Post Assessment exams.

3. ____ Complete the Self Assessment exam and compare your answers with those on the Self Assessment Answer Sheet on the page immediately following the exam. Re-study or ask your instructor for help on any questions you have trouble with. The Self Assessment exam will help you determine how well you are likely to do on the Post Assessment.

4. ____ Complete the Post Assessment exam and turn your answers in to your instructor. It is recommended that you score 90% or better on the Post Assessment before going on to the next module.

Introduction

Fasteners of many kinds are used in every skilled trade and technical occupation. The purpose of this module is to acquaint the apprentice with the various types of fastening devices in common use, to indicate the size designations that apply for each type, and to present the information needed for making the correct choice of fastener for doing the job at hand in the best and easiest way. Fasteners described include nails, screws, and anchoring devices of many types.

Information

NAILS

Widely used kinds of nails include common wire nails, box nails, finish nails, casing nails, clinch nails and flooring brads, which are all essentially a piece of wire with one end flattened for the head and the other end pointed. Cut nails and tacks differ from wire nails in that they are made from flat metal sheets.

Nails are made of various metals, including steel, brass, copper, stainless steel and aluminum. Coatings and treatments are often applied to nails to increase holding power, reduce corrosion, and improve appearance; nails may be cement coated, acid etched, galvanized, cadmium plated, blued, nickel plated or chromium plated. Some nails are especially hardened for use in concrete or masonry, while others are annealed (softened) so that they can be riveted. Some common types of nails, nail points, and nail heads are shown in Fig. H-1.

Most nails are still sized by the old penny system, which is supposedly based on the pound weight per thousand. The letter "d" employed in nail size designations is the English abbreviation for penny. The lengths and gage numbers (diameter designations) of nails of various penny sizes are given in Table 4. The smaller the diameter of the nail, the higher the gage number. Nails longer than six inches are generally sized by inches; those smaller than 2d are sized by fractions of an inch. Certain types of nails--brads, felt roofing nails, hinge nails, plaster nails, and some others--are always sized by inches.

Recent changes in materials calling for different types of holding devices have brought about the development of "improved" or threaded nails, which are threaded like screws but are driven with hammers. The wood fibers are forced into the grooves between the threads when the nail is driven in. Once such a nail is driven, the threads prevent it from being pulled or forced out of the wood. Threaded nails can be substituted for wood screws in many cases, thus saving the

time that would be required for boring holes. Threaded nails are made in a wide range of types and sizes and are supplied in regular or hardened steel, copper, brass, commercial bronze, silicon bronze, and other materials and finishes. (See Fig. H-2.)

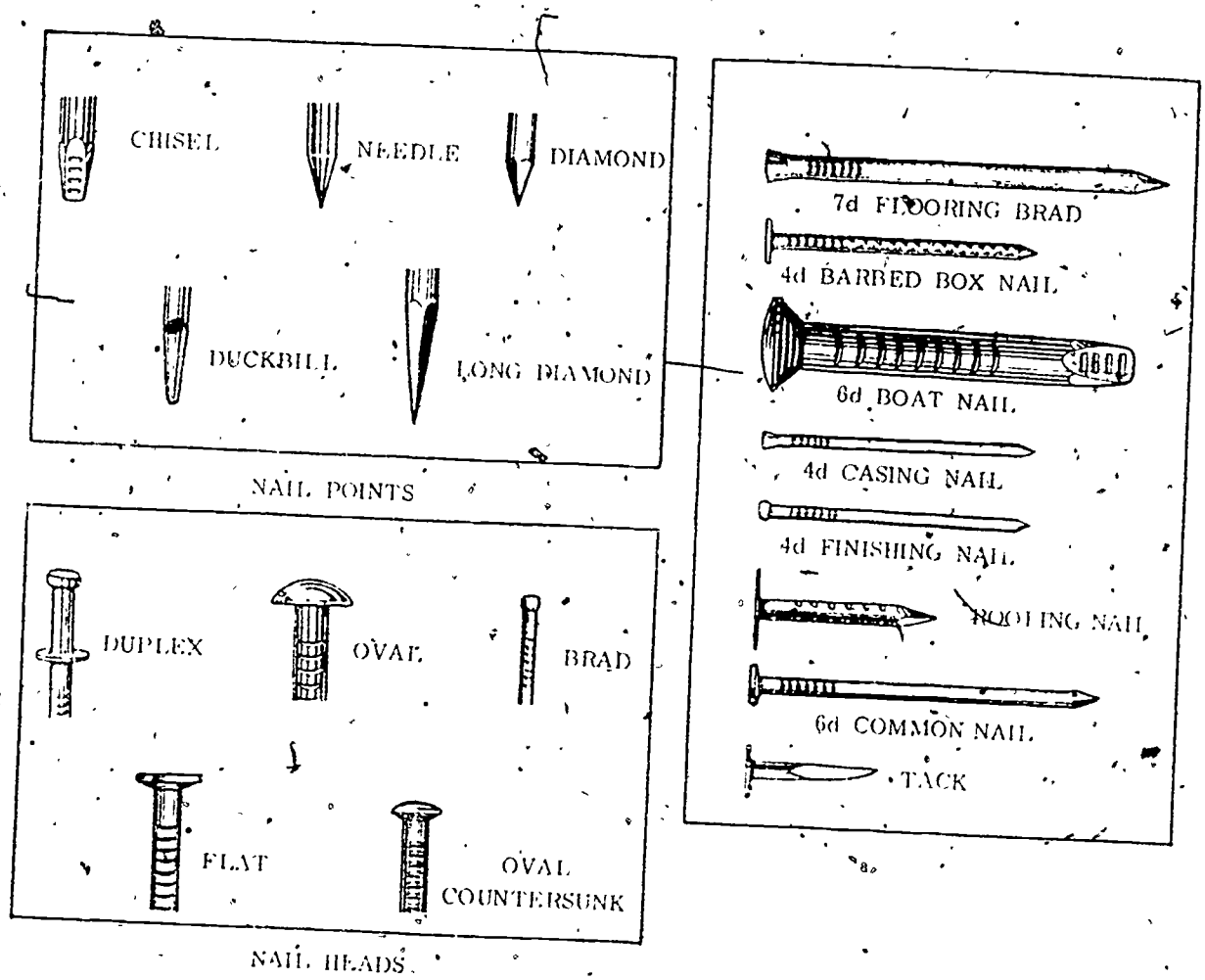


Fig. H-1. Common varieties of nails

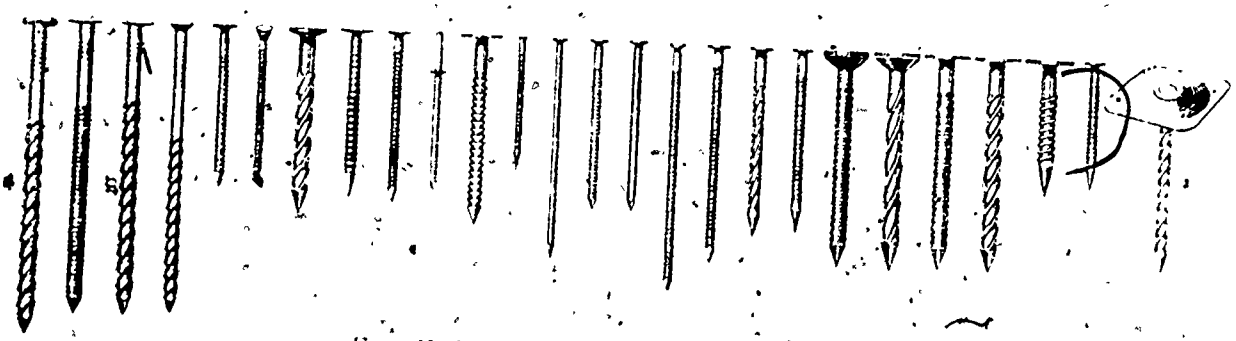


Fig. H-2. A selection of threaded nails

Sizes and Gages of Some Commonly Used Nails

Penny size	Length in inches*	Gage (Birmingham wire gage)			
		Common nails	Box and casing nails	Coated nails	Finish nails
2d	1	15	15-1/2	16	16-1/2
3d	1-1/4	14	14-1/2	15-1/2	15-1/2
4d	1-1/2	12-1/2	14	14	15
5d	1-3/4	12-1/2	14	13-1/2	15
6d	2	11-1/2	12-1/2	13	13
7d	2-1/4	11-1/2	12-1/2	12-1/2	13
8d	2-1/2	10-1/4	11-1/2	11-1/2	12-1/2
9d	2-3/4	10-1/4	11-1/2	11-1/2	12-1/2
10d	3	9	10-1/2	11	11-1/2
12d	3-1/4	9	10-1/2	10	11-1/2
16d	3-1/2	8	10	9	11
20d	4	6	9	7	10
30d	4-1/2	5	9	6	-
40d	5	4	8	5	-
50d	5-1/2	3	-	4	-
60d	6	2	-	3	-

*Coated nails are 1/8" shorter.

SCREWS

Next to nails, the most common fastening devices are screws. Three types of screws are considered here: wood, sheet metal and machine screws.

WOOD SCREWS

The threads of a wood screw are in the form of projecting spiral ribs that cut into the wood as the screw is turned in with a screwdriver. After the screw is inserted, the wood fibers close up and hold it tightly in place. Wood screws are usually threaded over only part of their length; the unthreaded part is called the shank. A wood screw has more holding power than a nail of the same size, and it can be removed more easily than a nail. On the other hand, wood screws are more expensive than nails, and it generally takes more time to drill a hole and then turn in a screw than to drive a nail. Wood screws are made of soft steel, copper, copper alloys, or aluminum. The steel screw may be plated or coated to retard corrosion or match the finish of hardware.

Wood screws are made in a wide range of lengths and diameters. The shank diameter, or gage, is indicated by a number, from 0 to 24; the higher the number, the greater

the diameter (just the opposite of the gage of wire nails). Standard wood screws are available in lengths from 1/4 in. to 5 in. and are designated according to the shape of the head as flat, round or oval. Some screw heads have a single slot for the screwdriver; others have a recessed cross slot, known as a Phillips head. (See Fig. H-3.)

The application of engineering principles to the design of fasteners has brought about the development of greatly improved screws for many special purposes. One such fastener is a self-drilling wood screw that has a sharp off-center slot cut into the point part way along the shank. (See Fig. H-4.) The sharp edge of the slot cuts threads into the wood as the screw turns; it also provides space for some of the wood shavings.

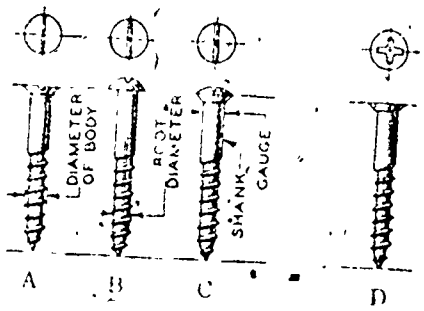


Fig. H-3. Wood screws (A) flat head, (B) round head, (C) oval head, all single-slotted; (D) flat head, Phillips cross slotted

Fig. H-4. A self-drilling wood screw

The selection of the right screw for the job depends on the same considerations as the choice of the right nail: the material or materials to be fastened, the stresses to which the construction will be subjected, the environmental conditions to which it will be exposed and the appearance desired for the finished work. For ordinary purposes where the work will not be exposed to moisture, the bright (uncoated) screw is used; when the screw is to be installed where it will come in contact with moisture, a coated or plated screw is preferred. The flat-head screw is used in work where the screw head is to be flush with the surface, or counter-sunk. The round-head screw is best if there is danger of splitting the wood when driving a flat-head screw into it; or if surface appearance is not a consideration. The oval-head screw is sometimes chosen for appearance and for the greater strength of the head. Phillips-head screws can be driven faster than screws with single-

slotted heads and with less danger of the screwdriver slipping; for these reasons, they are much used in production work. The drive screw, which has long spiral ribs and is designed to be driven in with a hammer, is used where speed and economy in fastening are important factors; it is most suitable for use with soft woods.

SHEET-METAL SCREWS

Sheet-metal screws are made of hardened steel and are self-tapping; that is, they cut or form threads as they are turned into a pilot hole that is molded, punched, drilled, or pierced in the material. They may have flat, round, oval or other type heads, with single slots or Phillips recessed slots. (See Fig. H-5.) Sheet-metal screws are identified by gage number (diameter) from 2 to 14 and by length from 1/8 in. to 2 in. or more.

MACHINE SCREWS

Brass or steel machine screws are used for the assembling of metal parts. Machine screws can be driven only into pre-drilled and threaded holes matching the screw gage or into mating nuts. They have slotted or socket heads, which may be round, oval, fillister, binding, pan, truss, flat or hexagonal. The screw body is uniform in diameter over its full length, and the screw tip is blunt. A few of the most common machine-screw styles are shown in Fig. H-6.

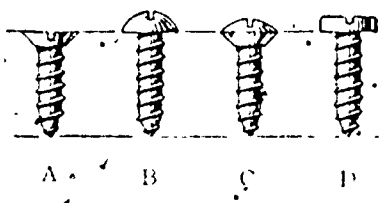


Fig. H-5. Sheet-metal screws: (A) flat head; (B) round head; (C) oval head; (D) binding head

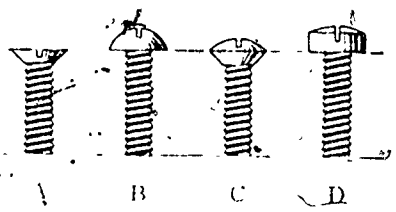


Fig. H-6. Machine screws: (A) flat head; (B) round head; (C) oval head; (D) fillister head

Machine screws are designated by size (determined by the diameter), number of threads to the inch, and length. Diameters less than 1/4 in. are designated by gage numbers ranging from 0 to 12 and from 1/4 in. to 1 in. by fractions of an inch. Two standard machine-screw thread series are used in the United States--National Coarse and National Fine. (See Table 5.)

TABLE 5

National Coarse and National Fine Screw Threads

Machine screw		Threads per inch	
Nominal size	Diameter (in.)	National coarse (NC)	National fine (NF)
#0	0.0600	--	80
#1	0.0730	64	72
#2	0.0860	56	64
#3	0.0990	48	56
#4	0.1120	40	48
#5	0.1250	40	44
#6	0.1380	32	40
#8	0.1640	32	36
#10	0.1900	24	32
#12	0.2160	24	28
1/4"	0.2500	20	28
5/16"	0.3125	18	24
3/8"	0.3750	16	24
7/16"	0.4375	14	20
1/2"	0.5000	13	20
9/16"	0.5625	12	18
5/8"	0.6250	11	18
3/4"	0.7500	10	16
7/8"	0.8750	9	14
1"	1.0000	8	14

ANCHORING DEVICES

A wide variety of anchoring devices are used as fasteners where nails or screws would be inappropriate in terms of holding power, permanence, or suitability for special fastening needs. Two common categories of anchoring devices are 1) bolts, nuts and studs and 2) shields, plugs and anchors.

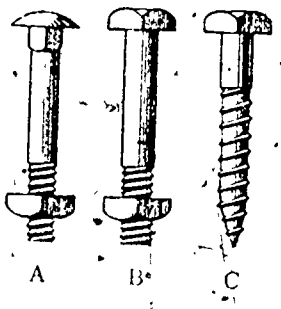
BOLTS, NUTS AND STUDS

Bolts, like screws, have threaded bodies. They differ from screws mainly in head styles and range of types and sizes. In general, bolts are not designed to be turned directly into the material, in the manner of self-tapping screws, but must be inserted into a pre-threaded hole or through a clearance hole and then into a mating nut. The bolt has an external or male thread; the nut an internal or female thread. Studs are similar to bolts and screws except that they are threaded from both ends; one end of the stud is screwed into a threaded hole, and the projecting end is fitted with a nut.

Bolts are designated by type, finish, thread size and pitch and length. Bolt-head and nut shapes include hexagonal, square, round, T-shaped and mushroom. The bolt head may be chamfered; the top of the head may be plain or slotted, and its base may be squared off or angled. The thread may cover the entire shank, or there may be an unthreaded portion extending to the base of the head. Just below the head there may be a neck that is square (often combined with a round head), ribbed, finned, elliptical, oval or keyed. Bolt ends are usually blunt. Bent bolts have radius bends, square bends, U bends, or eye bends in place of heads.

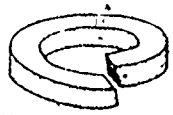
Three familiar types of bolts are illustrated in Fig. H-7. The carriage bolt has an oval, unslotted head and a square neck that engages the wood or other mterial and prevents the bolt from turning when the nut is applied. The machine bolt has a square or hexagonal unslotted head, which is held by a wrench while the nut is being tightened. A lag bolt (lag screw) is like a heavy wood screw except that it has an unslotted bolt head and must therefore be installed with a wrench instead of a screwdriver. It is often used in connection with an expansion shield.

Fig. H-7. Some familiar bolts:
A) carriage bolt; B) machine bolt; C) lag bolt or lag screw



Bolts are made for a wide range of purposes. There are self-locking bolts, tamper-proof bolts of special head design requiring matching tools for installation or removal, bolts that include preassembled washers, and self-sealing screws. Nylon bolts and nuts are used for some applications.

Cotter pins or lock washers are often used with bolts to prevent the nut from working loose. The cotter pin is thrust through a hole in the end of the bolt, and the two ends of the pin are then separated and bent back. The edges of a split-ring lock washer or the multiple edges of a toothed lock washer cut into the bolt head or nut to keep it tight. (See Fig. H-8.) Plain washers may be used under bolt heads or nuts to provide increased bearing surface.



SPLIT RING LOCK WASHER

COTTER PIN

TOOTHED LOCK WASHER

Fig. H-8. Devices used for securing nuts

SHIELDS, PLUGS AND ANCHORS

When a lag screw, a hanger bolt, or a machine bolt is to be driven into a masonry wall, an expansion shield of the proper size is first inserted into a hole drilled into the wall. The shield, a malleable-iron split casting with internal threads, expands when the bolt is driven in, thus exerting pressure against the sides of the hole and providing a secure anchor.

Other devices similar to the expansion shield are lead shields, plastic fiber expansion plugs, expansion anchors and toggle bolts. The lead shields and the expansion plugs are used with wood screws. (See Figs. H-9 and H-10.) Expansion anchors are used primarily to fasten fixtures to plaster walls, composition wallboard and drywall. As the screw is driven into the wall, the expansion anchor spreads and locks into place; the screw is then removed, inserted through the fixture, and re-driven into the anchor. Toggle bolts are used to fasten woodwork or fixtures to hollow walls and ceilings. The expanding section remains folded against the bolt until it is inserted into the drilled hole; it then pivots or spreads and bears against the inner side of the wall as the screw or nut is tightened. (See Fig. H-11.)

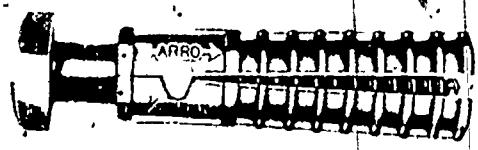
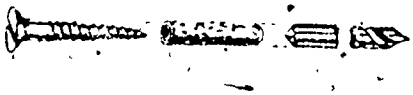
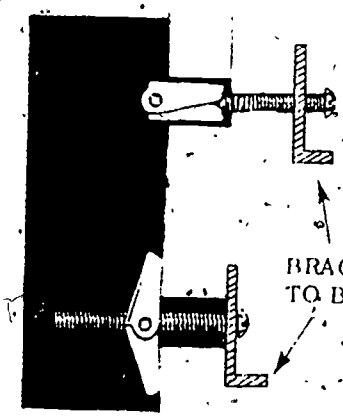


Fig. H-9.
Lead expansion shield (with lag bolt)



SELECT PROPER SIZE WOOD SCREW, FIBER PLUG AND TWIST DRILL. ONLY THE THREADED PORTION OF THE SCREW MUST ENTER THE PLUG

Fig. H-10. Installing a fiber plug



BRACKET OR OTHER ITEM TO BE FASTENED TO WALL

Fig. H-11. Spring-wing toggle bolt:
(A) inserted with wings folded;
(B) tightened, wings expanded

Self Assessment

After you have studied the material in the Information section, complete the exercises by writing the word that belongs in each space.

1. Besides the common wire nail, other widely used forms of wire nails are, _____, _____, _____ and _____.

2. Cut nails are made from flat _____ _____.

3. Most nails are still sized by the _____ system.

4. In nail designations, the letter "d" stands for _____.

5. In many cases, _____ nails can be used in place of wood screws.

6. Screws having _____ heads can be driven faster and with less danger of the screwdriver slipping than screws having single _____ heads.

7. Sheet-metal screws are self _____.

8. The two standard machine-screw thread series used in the United States are the _____ _____ and the _____ _____.

9. A lag bolt is like a heavy _____ _____ except that is has a(n) _____ bolt head.

10. Expansion _____ provide a means of anchoring lag bolts, hanger bolts, or machine bolts in masonry.

SELF ASSESSMENT ANSWER SHEET

1. box, finish, casing, clinch, brads

2. metal sheets

3. old penny

4. penny

5. threaded

6. rounded, flat

7. tapping

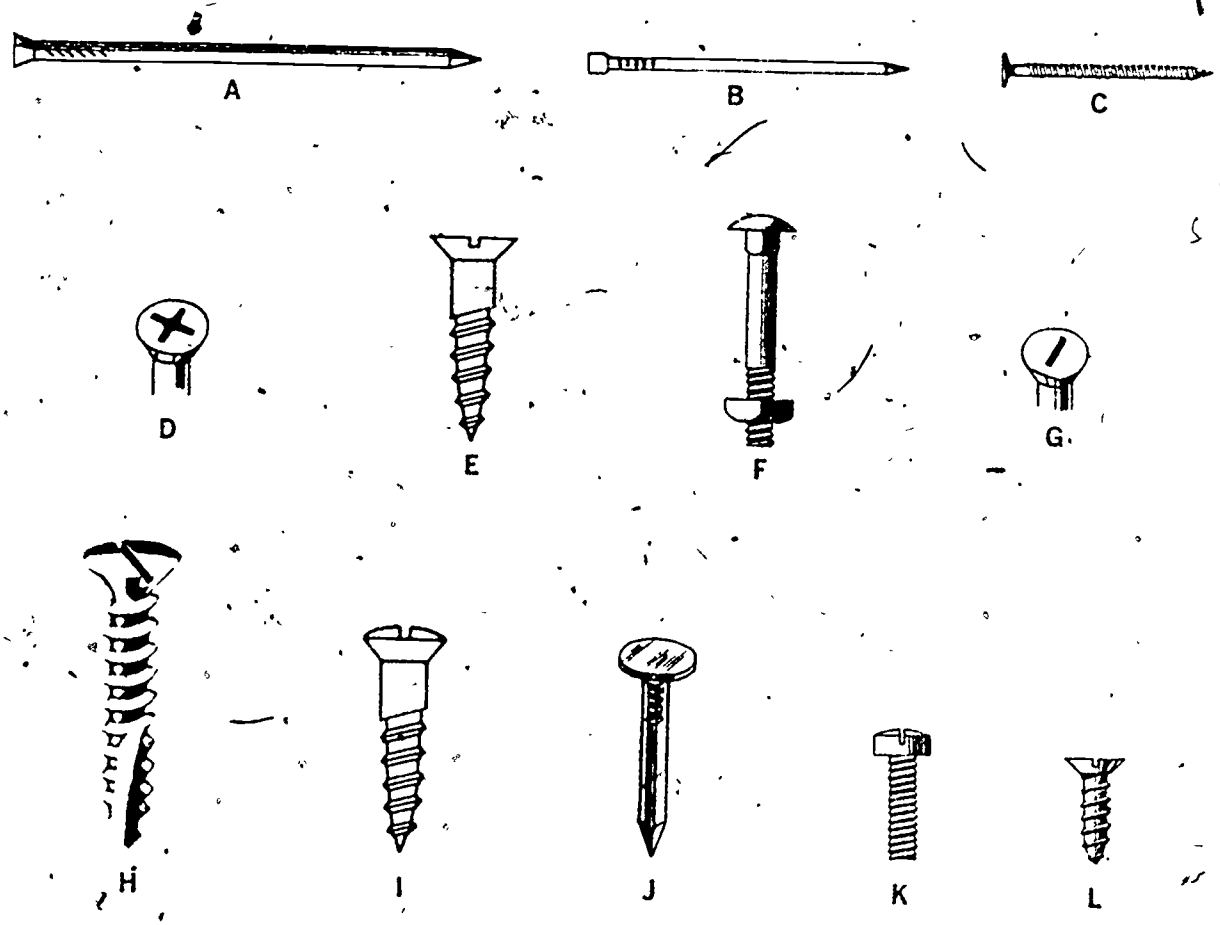
8. National Coarse, National Fine

9. wood screw, unslotted

10. shields

Post Assessment

An assortment of fastenion devices is shown on this page. In each space in the numbered column below, write the letter of the illustrated item that matches the item named in the column.



1. ____ finishing nail
2. ____ flat-head wood screw
3. ____ self-drilling wood screw
4. ____ roofing nail
5. ____ Phillips-head screw
6. ____ flat-head sheet-metal screw
7. ____ fillister-head machine screw

Listed below each numbered item are four possible answers or completing phrases. Decide which of the four is correct, or most nearly correct; then write the corresponding letter in the blank space to the left of that item.

8. ____ Most nails are sized by:

a. length
b. the gage system
c. the penny system
d. head diameter

9. ____ Nails over 6 in. long are generally sized by:

a. the penny system
b. length in inches
c. weight in pounds per thousand
d. gage number

10. ____ Which one of the following is not a wire nail?

a. box nail
b. casing nail
c. flooring brad
d. cut nail

11. ____ The number of threads per inch is specified when describing which one of the following kinds of screws?

a. wood screw
b. drive screw
c. machine screw
d. sheet-metal screw

12. ____ Wood screws are sized by:

a. number
b. length
c. diameter
d. weight per thousand

13. ____ A fastener that is like a heavy wood screw except that it's installed with a wrench instead of a screwdriver is a(n):

a. Phillips-head screw
b. stud bolt
c. expansion anchor
d. lag bolt

14. ____ Which one of the following need not be specified when ordering machine screws:

a. cotter pin
b. expansion shield
c. expansion plug
d. toggle bolt

15. ____ A device used in conjunction with lag bolt for fastening in masonry is a(n):

a. cotter pin
b. expansion shield
c. expansion plug
d. toggle bolt