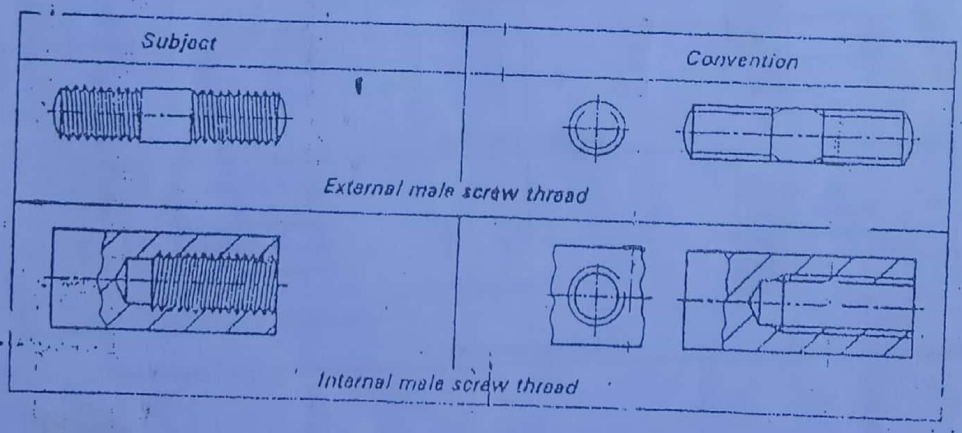
Abbreviations

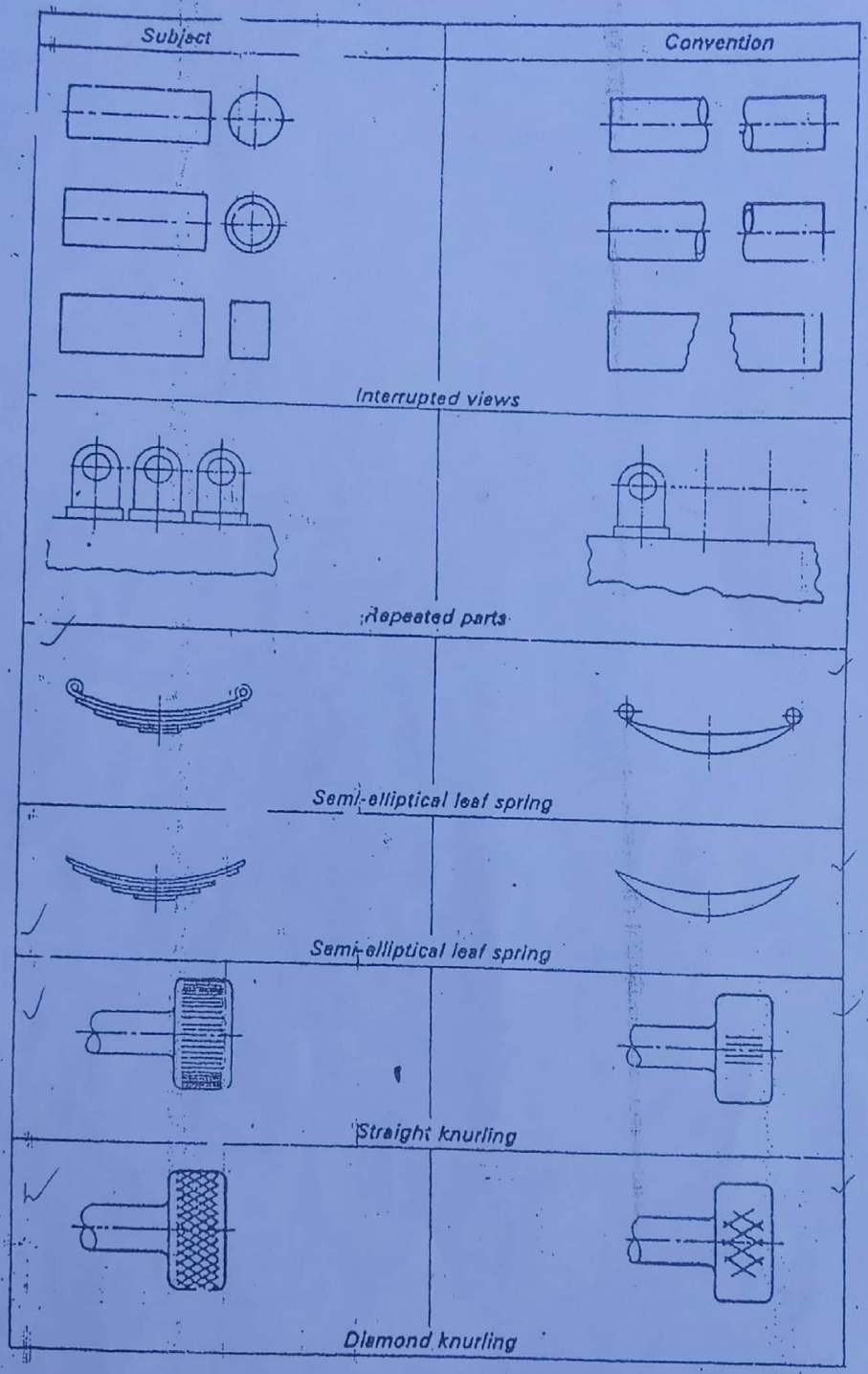
In order to shorten drawing notes we often use abbreviations, and the following list gives a selection of terms in accordance with current ISO Standards.

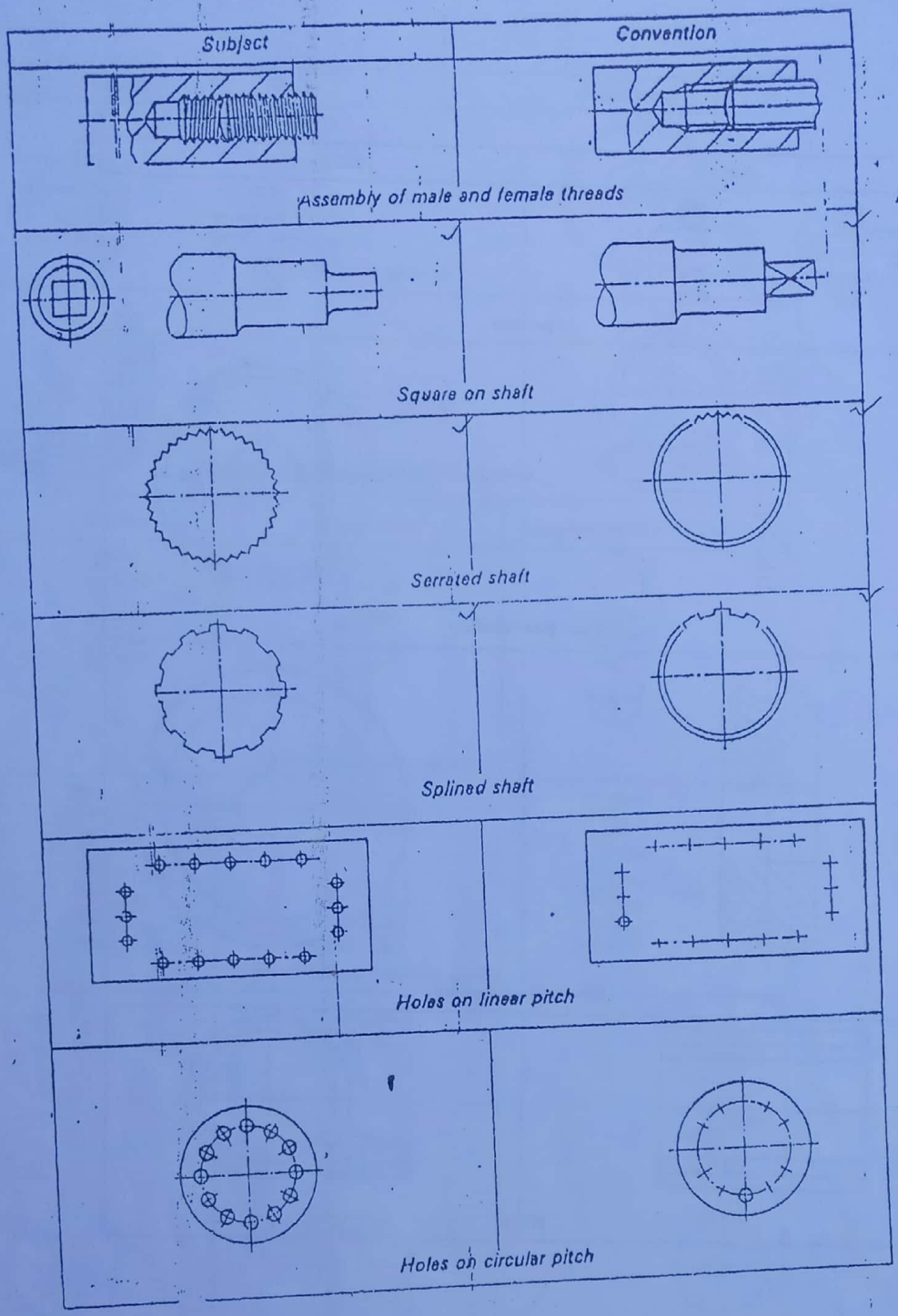
Term	*Abbreviation or symbol*
Across flats	A/F
Assembly	ASSY
Centres	CRS
Centre line	℄ or CL
Chamfered	CHAM
Cheese head	CH HD
Countersunk	CSK
Countersunk head	CSK HD
Counterbore	C'BORE
Cylinder or cylindrical	CYL
Diameter (in a note)	DIA
Diameter (preceding a dimension)	Ø
Drawing	DRG
External	EXT
Figure	FIG.
Hexagon	HEX
Hexagon head	HEX HD
Hydraulic	HYD
Insulated or insulation	INSUL
Internal	INT
Left hand	LH
Long	LG
Material	MATL
Maximum	MAX
Minimum	MIN
Number	NO.
Pattern number	PATT NO.
Pitch circle diameter	PCD
Pneumatic	PNEU
Radius (preceding a dimension capital letter only)	R
Required	REQD
Right hand	RH
Round head	RD HD
Screwed	SCR
Sheet	SH
Sketch	SK
Specification	SPEC
Spherical diameter (preceding a dimension)	SPHEREØ
Spherical radius (preceding a dimension Ø	SPHERE R
Spotface	S'FACE
Square (in a note)	SQ
Square (preceding a dimension)	□
Standard	STD
Undercut	U'CUT
Volume	VOL
Weight	WT

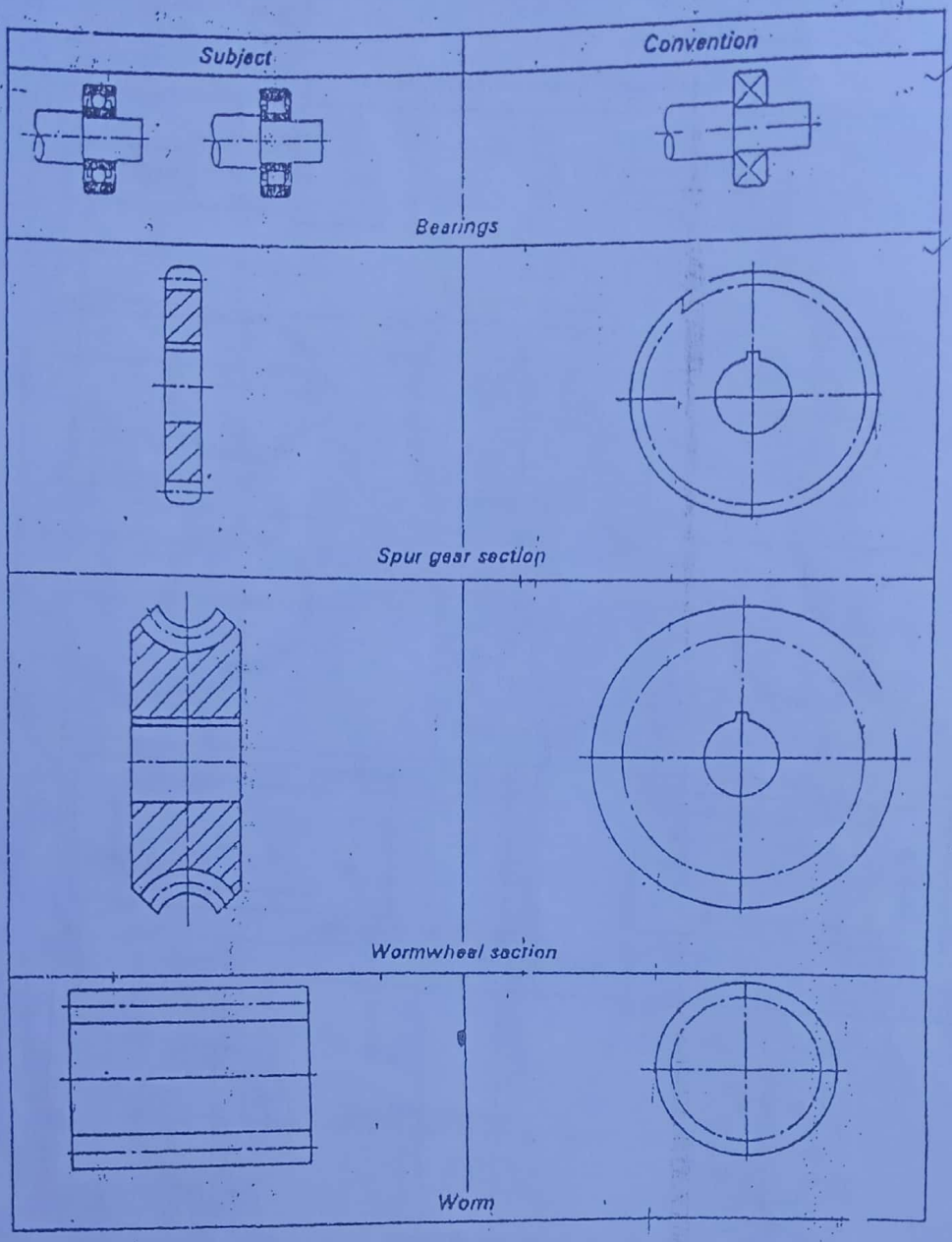
Conventional representation of common features

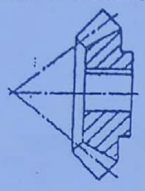
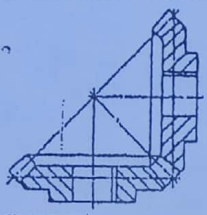
The following standardized conventions are used on drawings in cases where a complete description of the part would involve unnecessary or excessive drawing time or space.

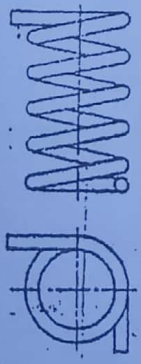
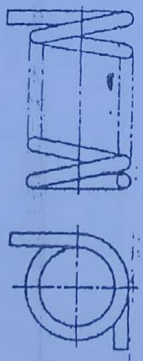
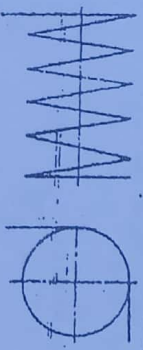








Subject	Convention
	
Bevel gear section	
	
Section through assembled bevel gears	

Subject	Convention	Diagrammatic representation
		
Cylindrical tension spring		
		
Cylindrical compression spring		
		
Cylindrical torsion spring		

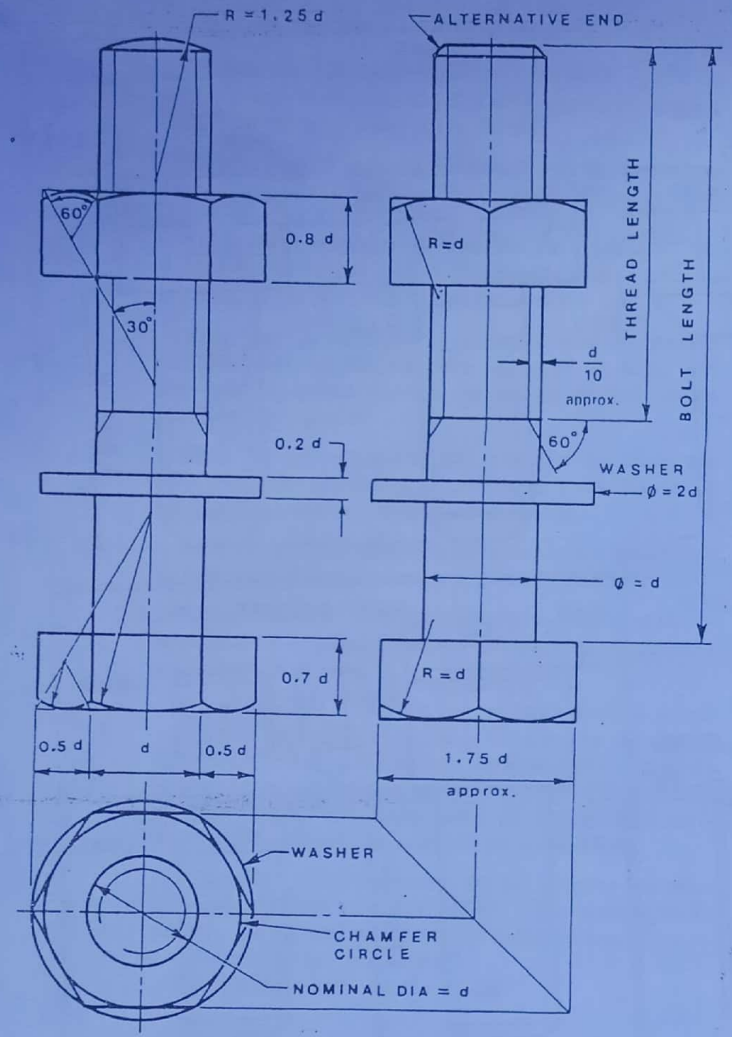


Fig. 10.3 Completed views of a nut and bolt showing thread run-outs

Screws

A screw has an external thread extending almost the whole length of the screw shank to the head.

Screws, like bolts, are used for fastening two or more parts together. One of the parts has a tapped hole and the other part has a clearance hole (see Fig. 10.5(e)). The screw is used by passing it through the clearance hole in one part to screw into the threaded hole in the other, so fastening both parts securely together.

Screws are not secured by a nut.

Apart from hexagonal heads, the following types of screw-head are the most regularly used:

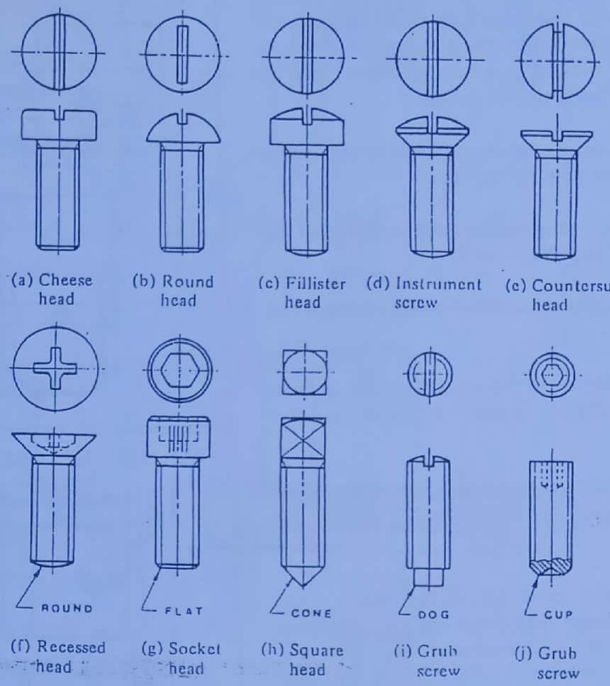


Fig. 10.4 Various types of screw

Cheese-head (a), *round-head* (b) and *fillister-head* (c) screws (Fig 10.4) are used regularly in engineering, whereas *instrument screws* (d) are used in instrument work. *Countersunk-head screws* (e) are used where a flush surface has to be maintained. *Recess-head screws* (f) need a special cross-shaped screwdriver for tightening. *Socket-head screws* (g) can be placed in counterbored holes to maintain a flush surface. They are tightened by means of a hexagonal wrench and are mainly used in tool-making. *Square-head set screws* (h) and headless *grub screws* (i) and (j) are used to prevent relative rotation or sliding movement between two components.

Flat pointed (g) or *cup-pointed* (j) screws are used where a contact with flat surfaces is required to prevent movement. *Cone-pointed screws* (h) bite into shafts, and *dog-pointed screws* (i) usually fit into slots.

Self-tapping screws (not shown) form their own thread when tightened.

289. *Machine Screws* ISO machine screws take the form shown in the diagrams. The proportions are given in terms of the shank diameter.

Countersunk head machine screws are used when a flush finish is required on the outer surface. The head is either slotted as shown, for use with a plain flat screwdriver, or recessed. A recessed head has a crossed closed slot requiring the use of a Philips screwdriver.

Raised countersunk head screws give a small projection of the head beyond the general surface.

Pan head screws require no countersinking and all the head projects beyond the plate surface.

Cheese head screws also give ahead projection beyond the plate surface.

Square Head Set Screw is often used to fix collars, gears and wheels to shafts, though the head can give imbalance.

Grub screws, slotted for screwdriver give a non-projection finish, and are useful for fixing collars, wheels, gib strips.

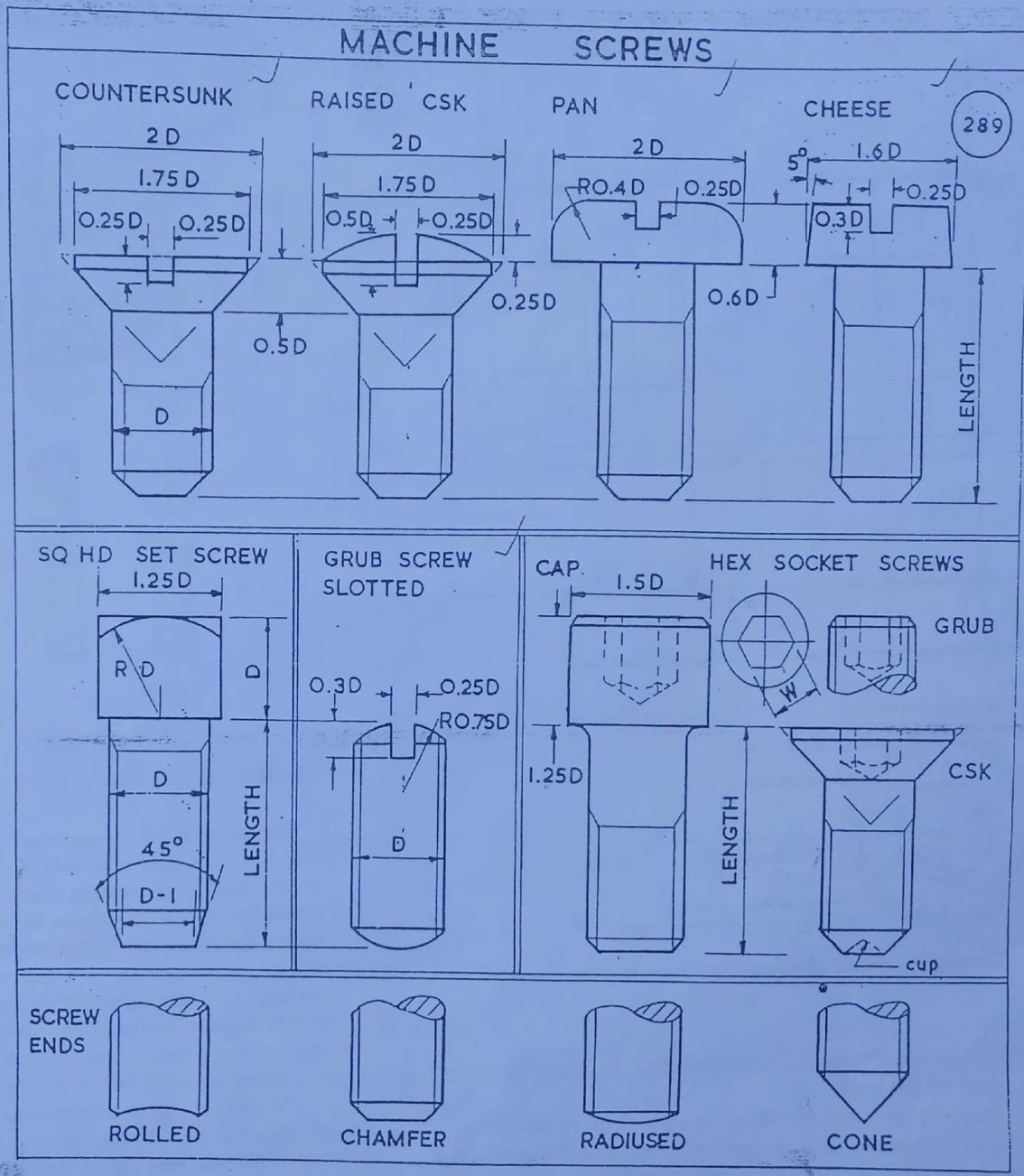
Hexagon Socket screws have that shape recess in the head, weakening the head less than the slot, and are tightened by the use of a hexagon socket key. This is a piece of hexagonal sectioned rod with rightangled bend to give torque.

Cap socket screws are the shape shown, and are used for securing covers and flanges which is counterbored to take the caphead giving a flush finish.

Countersunk head screws also have hexagonal sockets for use with a key.

The ends of machine screws may be rolled, chamfered, radiused, coned, cup, w point, dog as suited to the special purpose.

Tables in Appendix I give the size A/F of the hexagon socket relative to the head size of various socket screws.



290. Nut Locking Devices

A. Locknut A nut may be secured on a stud against vibration by the use of another nut as shown.

B. Slotted nut The nut may be secured by using a taper pin or a split cotter pin which passes through a hole in the stud and lies in a slot cut in the nut.

C. Castle Nut Similar to the slotted nut, the turned reduction allows the folded ends of the split pin to lie without projection.

Three ISO nuts are shown, the thin locknut, the slotted nut, and the castle nut. The proportions are shown in terms of the diameter of the shank of the bolt.

Ring Nut A set screw is tightened into the turned annulus after the nut has been tightened. A taper pin may also be driven through the end of the bolt as an additional safeguard.

Ring Nut Where a ring nut is used away from the edge of a plate or casting, an additional collar has to be used and located by a dowel pin as shown.

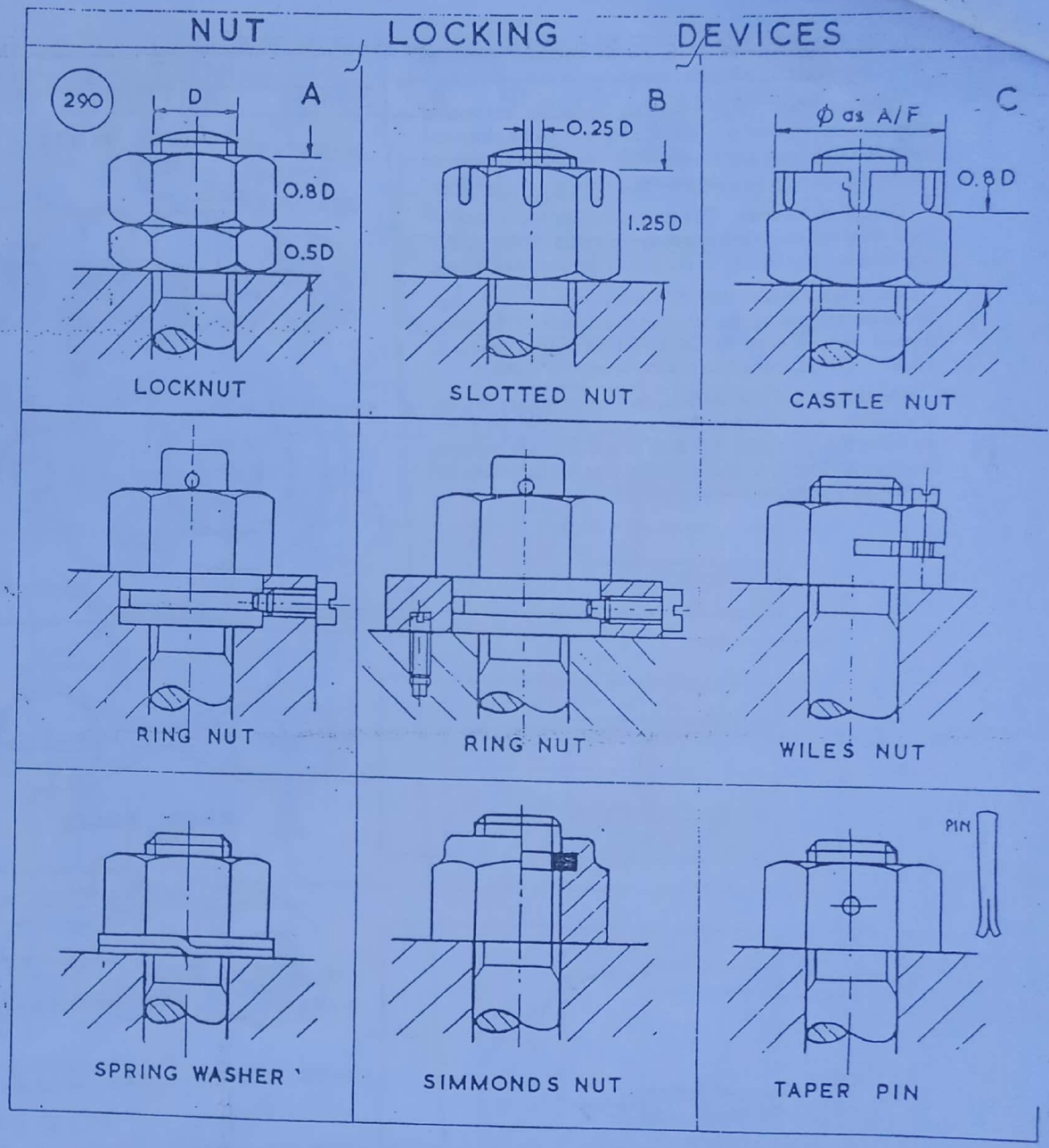
Wile's Nut This invention adopts a slit nut which can be compressed by a set screw to give additional friction.

Spring Washers Split spring washers, with or without serrations on the outer faces, may be employed to prevent a nut from loosening.

Simmond's Nut This type of nut has a fibre or nylon ring set in an annulus cut inside the nut. As the nut is tightened the ring is forced into the thread of the stud or bolt and the compression and friction give the required locking action. Frequently used on automobile construction, but should be replaced on dismantling.

Taper Pin After tightening the nut, a taper pin may be driven through a hole drilled and taper reamed to fit the pin, the ends of which are opened after insertion to prevent accidental withdrawal.

BS Handbook 16. 150 Rec R 288.



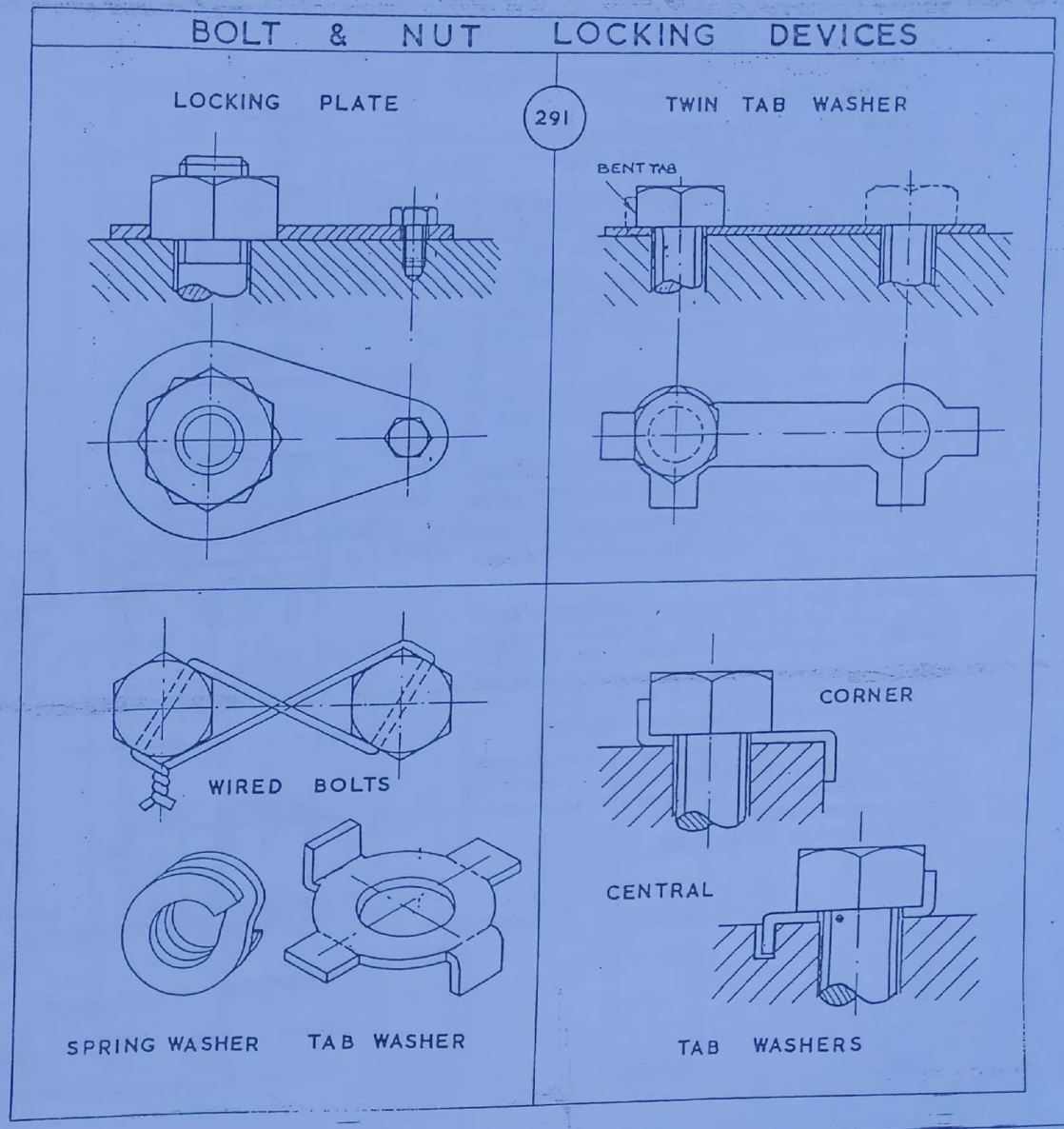
291. Locking Devices Nuts and bolts may be prevented from loosening by adopting various anchoring devices.

Locking Plate This plate has a double hexagonal aperture cut in one end which allows it to be dropped over the tightened nut or bolt head. The plate is secured to the component by a set screw.

Twin Tab Washers The stamped sheet metal strip is tightened under the bolt heads and the tabs of the washer are then bent up closely to the side of the hexagonal face.

Single tab washers may be used at corners and edge locations by turning the tab over the corner of the component. When the tab washer is used in a central position, a hole is drilled in the component to receive the tab.

Wired Bolts In this method, the bolt heads are drilled to receive a wire which is passed through the holes after the bolts are tightened, the ends of the wire are twisted together to fasten off. It is essential that the direction of the wiring prevents loosening of the bolts.



287. ISO Bolts Nuts and Washers The conventional method of drawing the metric screw fastenings are shown with proportions in terms of D = shank diameter. The head may be drawn using a constructional circle 2 D in diameter, enclosing the hexagon, or alternatively, the chamfer circle may be drawn first 1.75 D in diameter, and enclosing it with the hexagon.

The conventional method of rendering external screw-threads on a stud is shown. Proportions are varied to suit the design of the component which is to be fixed.

Internal screwthreads require the hatching to extend over the threaded portion.

Screwthreads assembly shows the bolt clear and the internal thread hatched.

Thread inserts are shown in clear lines.

The designation of ISO bolts require: material, head shape, thread diameter, pitch, length, type of fit.

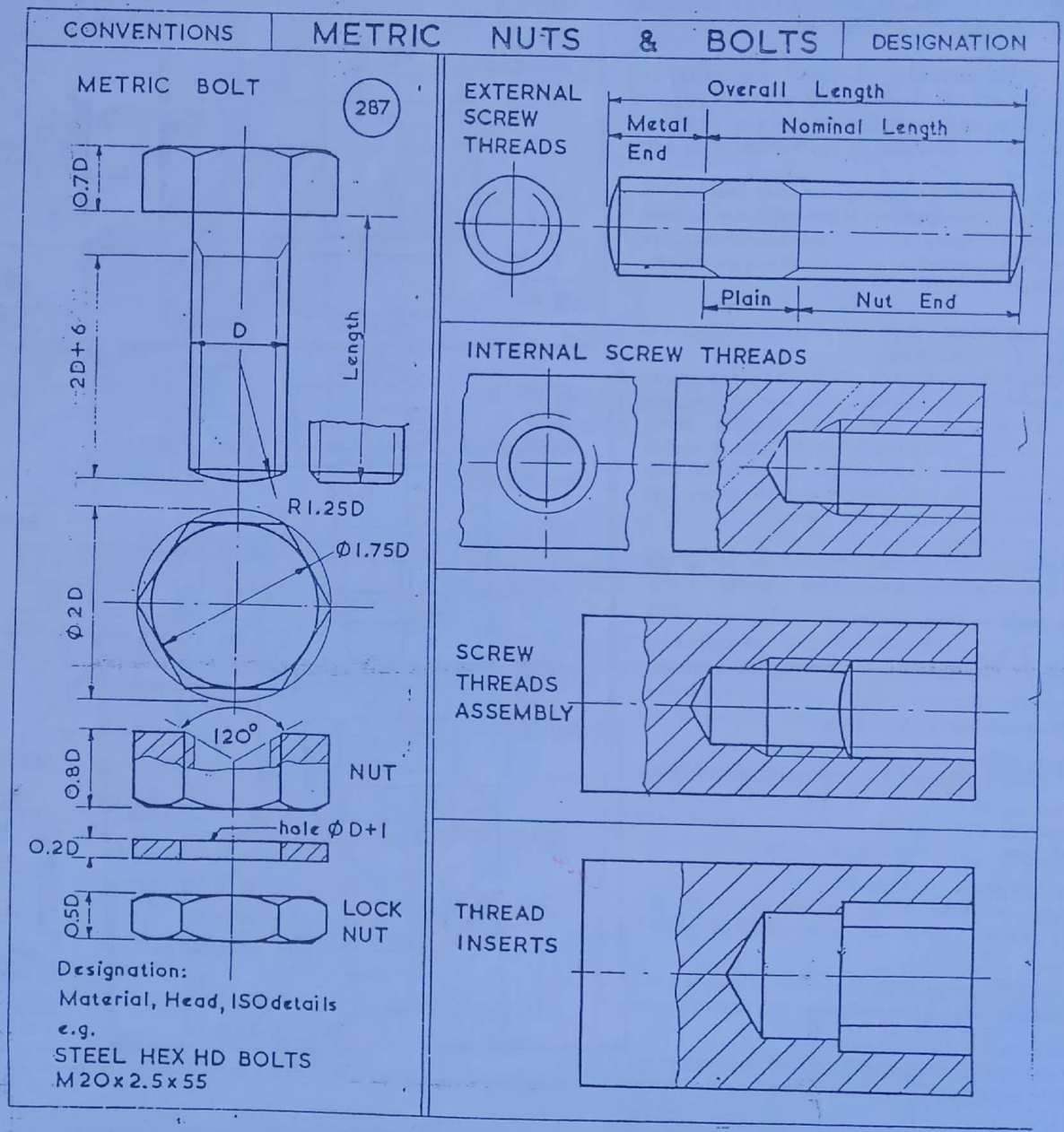
Example: Steel, Hex Hd Bolts,
M 10 × 1.5 × 50 – 6 g
Steel, Hex Nuts,
M 10 × 1.5 – 6 H

Types of fit for bolts are:
close fit, 4 h; medium fit 6 g; free fit, 8 g.

Types of fit for nuts are:
close fit, 5 H; medium 6 H; free 7 H.

See No. 293, page 156 for table of sizes and other relative information. Also tables in Appendix 1.

BS 3L8 1972 part 1.
BS 1936 ISO Metric screwthreads.
BS Handbook No. 18.



Nut and Bolt Assembly The view shows two castings held together by a nut and bolt with a washer inserted under the nut. Note how the casting is sectioned, whilst the bolt washer and nut are clear.

Stud and Nut Assembly In certain cases, studs are screwed tightly into the body casting and left in position where they act as positioning devices enabling the second component to be returned to its former place with accuracy.

Note the method if showing the stud end and the internal thread, with clearance at the bottom of the hole.

Bolts may, in some cases be used instead of studs, again, the internal thread is longer to give clearance enabling the bolt to tighten.

Screwthread Forms Sectional views of a number of screwthread forms are shown.

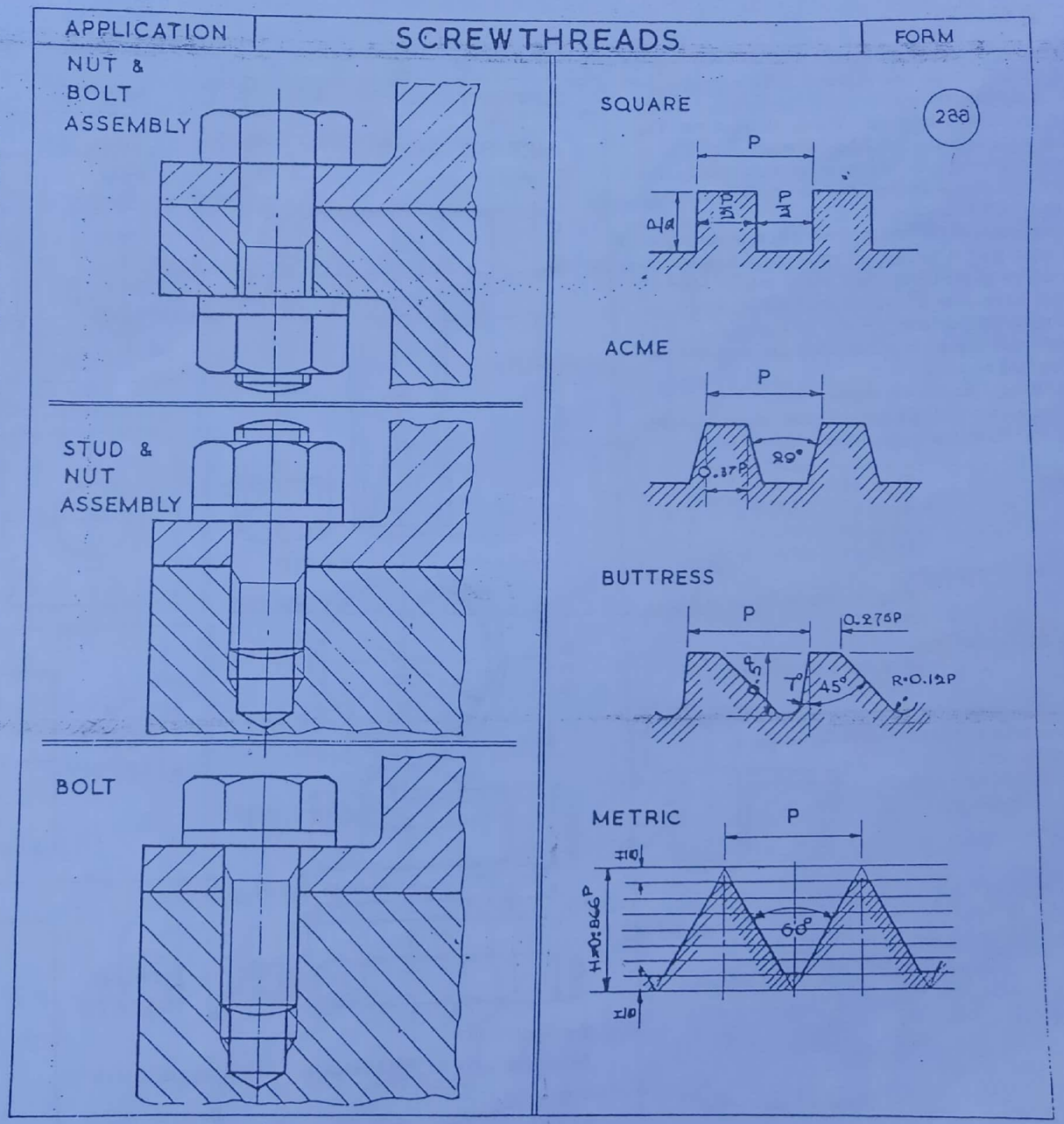
The thread follows the path of a helical groove cut or pressure rolled on the cylinder of the bolt or stud, and may be right-handed or left-handed, single or multi-start (see helices). The pitch is the distance measured from crest to crest of two adjacent thread forms. The major diameter is the full diameter over the crests. The minor diameter is the core or root diameter.

Metric Thread A 60° angle thread similar to the Sellers thread, sizes in millimetres. See No. 293.

Special purpose threads, Square. Used for threads taking pressure in both clockwise and anti-clockwise direction. Used extensively in machine parts for operating slides.

Acme threads used for lead screws.

Buttress threads. Use where pressure is exerted in one direction.



294. **Keys and Keyways** Keys are used to fix shafts and wheels and collars together, either rigidly or with limited axial movement.

Rectangular Key A rectangular recess is cut in both wheel and shaft to the proportions shown, and the key fitted.

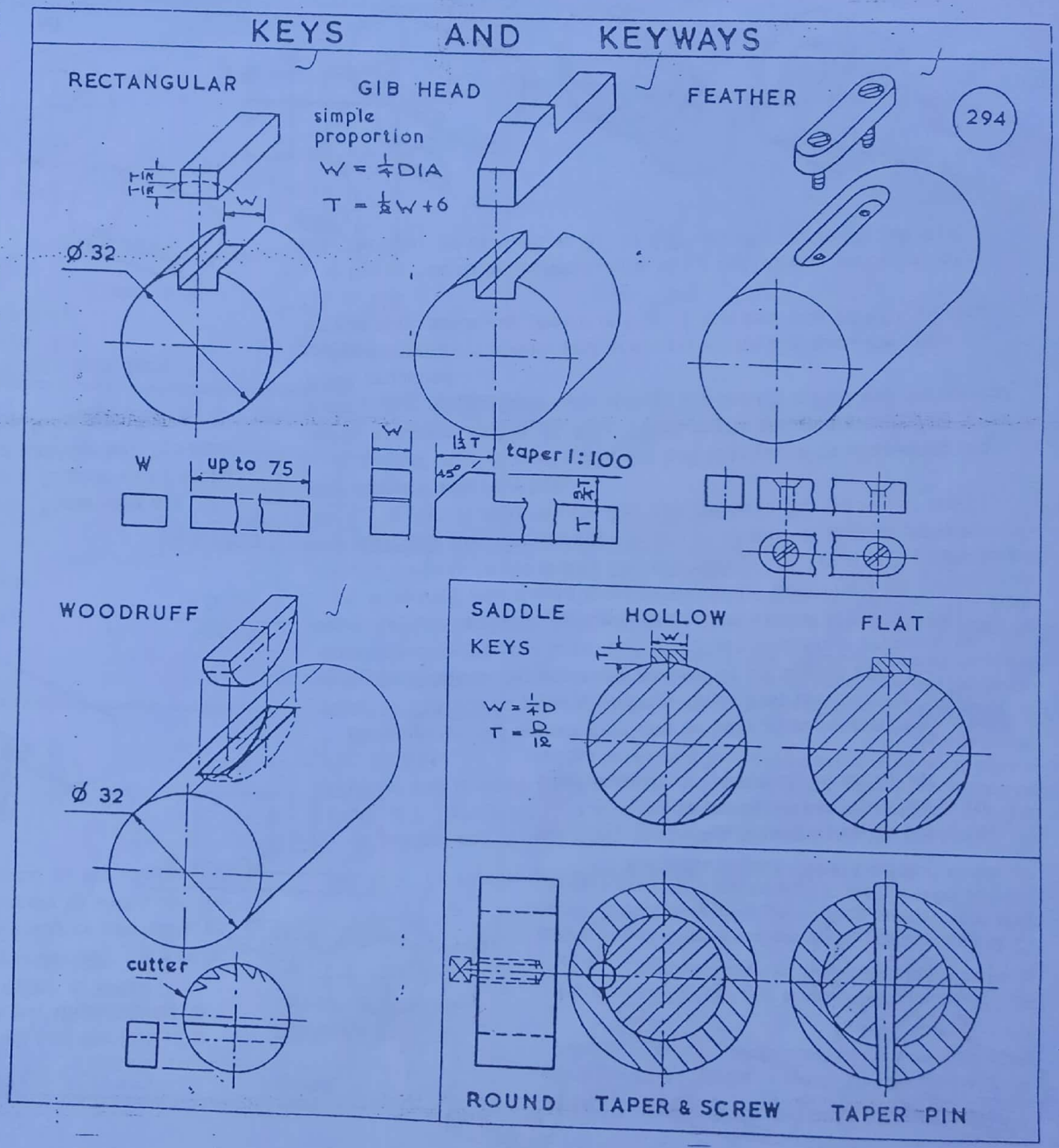
Gib Head Key This tapered key provides a rigid fixing when driven into position. The gib head enables the key to be withdrawn for dismantling.

Feather Key The parallel-sided key is setscrewed into an end milled slot in the shaft. This key allows axial movement of the wheel on the shaft while still transmitting rotary movement. It also facilitates assembly of parts under difficult conditions.

Woodruff Key A segmental shaped key which fits into a corresponding recess cut by a standard size cutter. This key is used on tapers and other positions where self aligning is required.

Saddle Keys Used for temporary fixing or light loads.

Round Keys These may either be screwed or tapered. The diagram shows a screwed pin, the head of which is sawn off after insertion to give a flush finish.



A *key* is a component inserted between the shaft and the hub of a pulley, wheel, etc., to prevent relative rotation but allow sliding movement along the shaft, if required.

The recess machined in a shaft or hub to accommodate the key is called a *keyway*. Keyways can be milled horizontally or vertically, as shown in Fig. 11.1. Keys are made of steel, in order to withstand the considerable shear and compressive stresses caused by the torque they transmit.

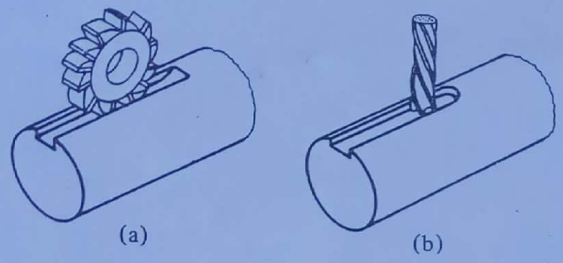


Fig. 11.1 Keyways milled (a) horizontally, (b) vertically

There are two basic types of key:

(a) *Saddle keys*, which are sunk into the hub only. These keys are suitable only for light duty, since they rely on a friction drive alone.

(b) *Sunk keys*, which are sunk into the shaft and into the hub for half their thickness in each. These keys are suitable for heavy duty, since they rely on positive drive.

Hollow saddle keys (Fig. 11.2(a)) are used for very light duty.
Flat saddle keys (Fig. 11.2(b)) are used for light duty.
Round keys (Fig. 11.2(c)) are used for medium duty.

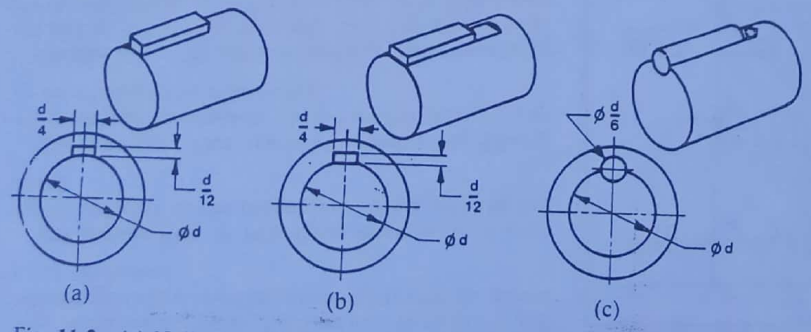


Fig. 11.2 (a) Hollow saddle key, (b) flat saddle key, (c) round key

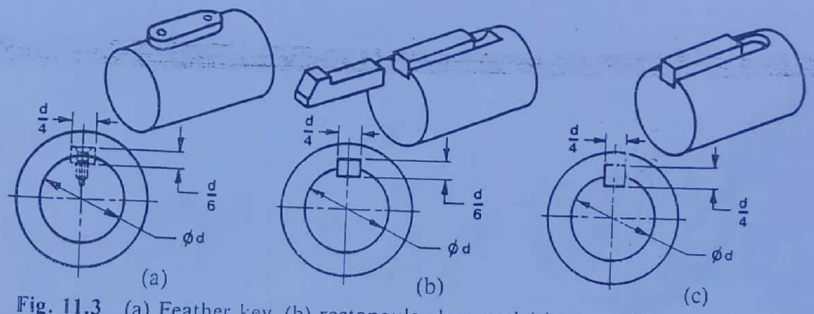


Fig. 11.3 (a) Feather key, (b) rectangular key, and (c) square key

A *feather key* is used when the hub is required to slide along the shaft. It is tightly fitted or secured by means of screws in the shaft keyway, and is made to slide in the hub keyway, as shown in Fig. 11.3(a).

Rectangular and square keys can be parallel or tapered with a basic taper of 1 in 100 to prevent sliding. These keys are used for heavy-duty applications. Students are advised to use square keys for assembly-drawing solutions. *Gib heads* are sometimes provided on taper keys to facilitate their withdrawal, as shown in Fig. 11.3(b).

A *Woodruff key* is an almost semi-circular disc which fits into a circular keyway in the shaft. The top part of the key stands proud of the shaft and fits into the keyway in the parallel or tapered hub, as shown in Fig. 11.4(a). As the key can rotate in the keyway, it can fit any tapered hole in a hub.

A *splined shaft* is used when the hub is required to slide along the shaft, as shown in Fig. 11.4(b). These shafts are used mostly for sliding-gear applications. The splines are usually milled and the splined holes broached.

Square-head set screws and *grub screws* are also used for low-torque applications as shown in Fig. 11.4(c) and also 10.4(h), (i), and (j), p. 106.

If the torque to be transmitted is too great for one grubscrew or key, two may be used set at 90° to 120° around the shaft, but never at 180°.

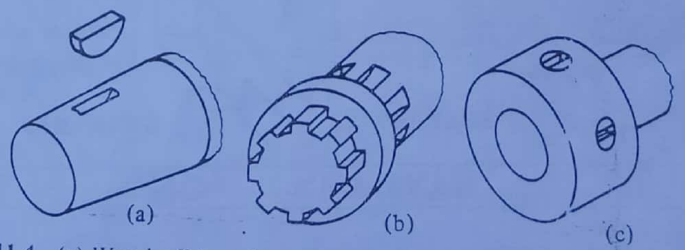


Fig. 11.4 (a) Woodruff key, (b) splined shaft, and (c) grub screws

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Fig. 12.

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375. Conventions Counterbores and Countersinks.

A. The hole may be shown as a fully dimensioned diagram, or with a simplified diagram with printed instructions.

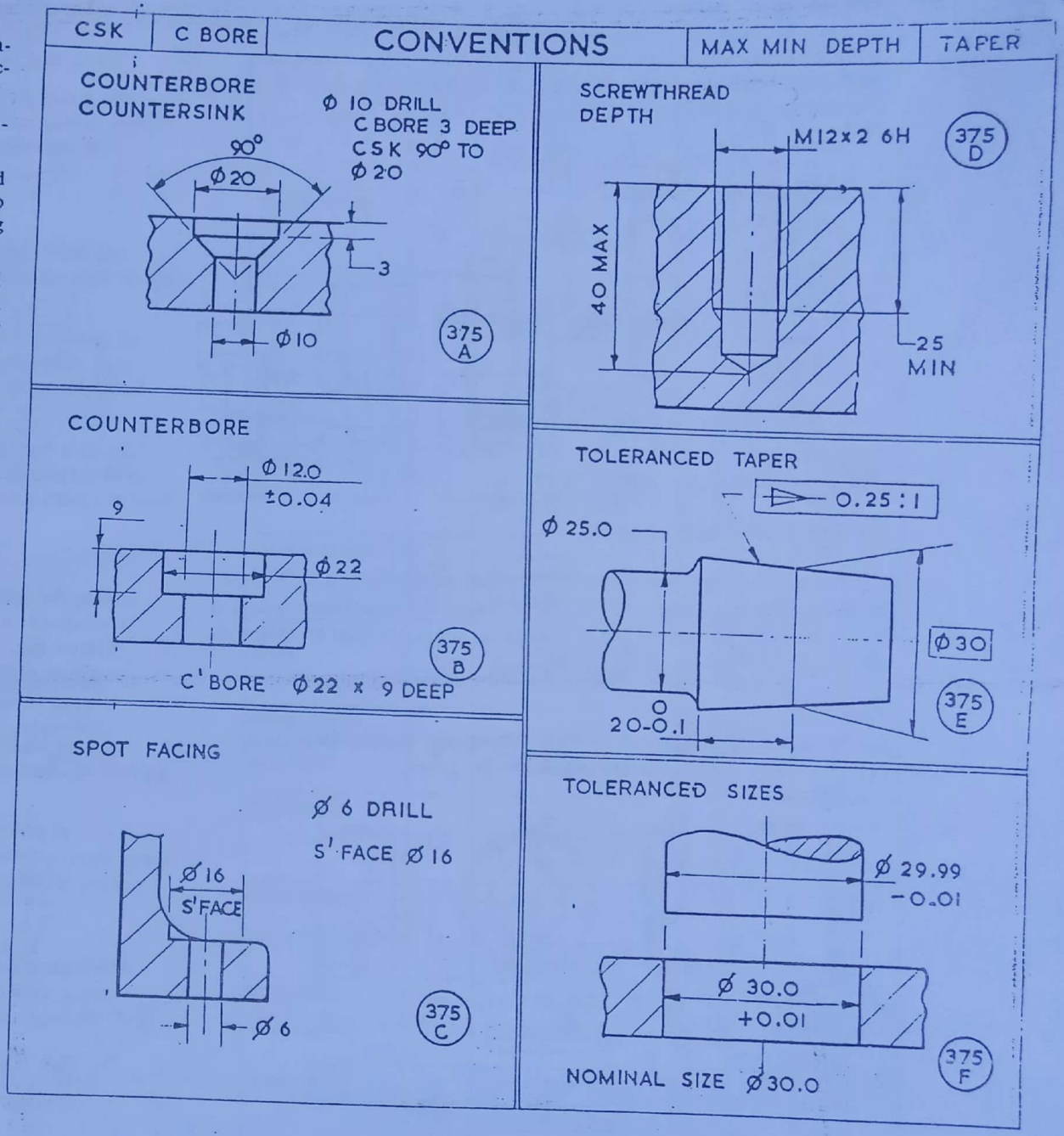
B. The hole may be shown as a fully dimensioned diagram or simplified with printed instructions.

C. In castings, the rough surface at the face of a drilled hole may require spot-facing with a suitable cutter to provide a flat surface at right angles to the bore enabling the nut or bolt head to seat without distortion.

D. Screwthread Conventional Form. A quick simplified method of drawing an internal thread showing maximum and minimum depths. Notice how the hatching crosses the thread lines only in the unoccupied portion of the internal thread.

E. Four methods of indicating a taper are shown in the standard, one only being shown. In this case, the rate of taper on diameter is shown, with a tolerance.

F. Shaft and Hole. The hole is usually taken as the standard part, executed by drilling and reamering. A plus tolerance on the hole is usually allowed. The shaft is usually machined or ground to a minus tolerance to give the required running fit.



Studs are threaded on both ends, with an unthreaded shank in the middle, and are used for parts that must be removed frequently, like cylinder heads, covers, lids, etc.

Studs are screwed tightly into tapped holes in the permanent part, while the removable part has clearance holes in the corresponding positions. Nuts are used on the projecting ends of the studs to secure the two parts together, as shown in Fig. 10.5(c).

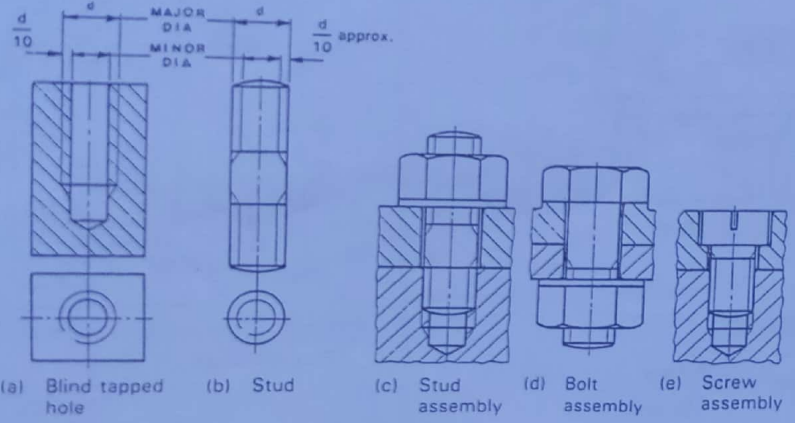


Fig. 10.5 Studs, bolts and screws

Normally only one washer is used for an assembly of a bolt, stud, or screw. The washer should be placed under the component which is turned in order to tighten the assembly, as shown in Figs 10.5(c) and (d).

Pins

Clevis pin (Fig. 10.6(a)) A clevis or dowel pin is a headless cylindrical pin used for precise-location purposes.

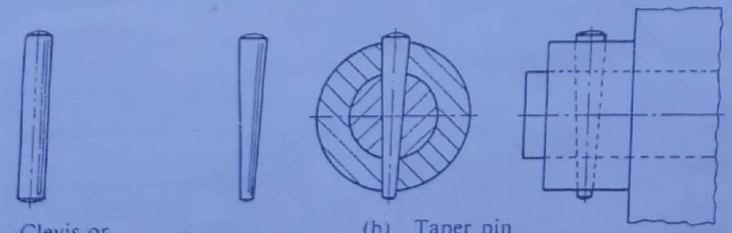


Fig. 10.6 Pins

Taper pin (Fig. 10.6(b)) This type of pin is conical with a slight taper. It is usually used to attach cotters, wheels, etc. to shafts. It is forced tightly into a reamed hole having the same taper, which is standardised.

Split cotter pin The split pin is usually inserted through holes and slots and its ends are opened up as in Fig. 10.7(a).

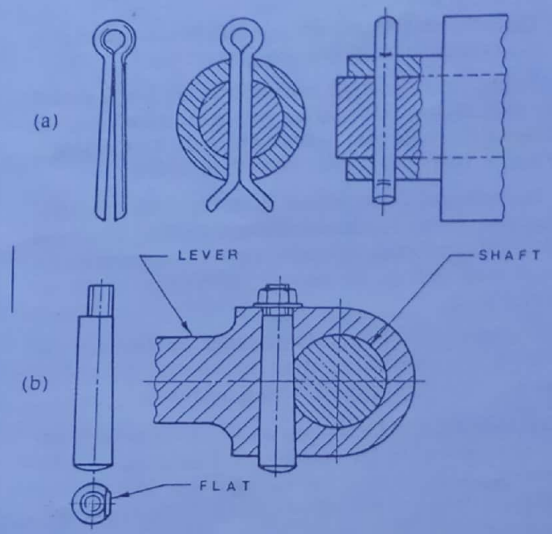


Fig. 10.7 (a) Split cotter pin (b) Cotter pin

Cotter pin The cotter pin is a round rod threaded at one end, or it may be plain with a tapered flat machined along its length. This type is used to secure levers, cranks, etc. to spindles, Fig. 10.7(b). A typical application is attaching a bicycle-pedal crank to the chainwheel spindle.

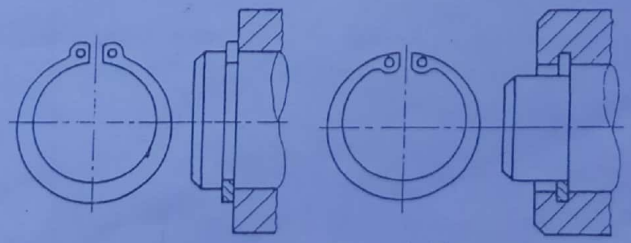


Fig. 10.8 Circlips

WELDING SYMBOLS

Welding

Welding is a process of uniting two pieces of metal by fusing them together to form a permanent joint. This may be done with or without additional (filler) metal and with or without the application of pressure.

Fusion welding In this process where the areas to be joined are heated until they become plastic (i.e. able to flow) and are then welded together with or without the addition of filler metal.

Gas welding is a fusion process in which the heat is provided by burning a gas mixed with oxygen to create a hot flame which is applied to the joint by means of a torch. The most commonly used gases are acetylene, propane, and hydrogen.

Electric-arc welding is a fusion process in which a local area of intense heat is created by passing an electric current through a filler rod, which acts as an electrode, held at a short distance from the joint so that the electric circuit is completed by arcing.

Pressure welding In this process the areas to be joined are heated until they become plastic and are then welded together by applying pressure or sometimes hammering.

In *forge welding*, the pieces to be joined are heated and then hammered together.

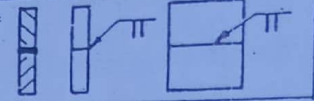
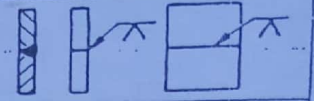
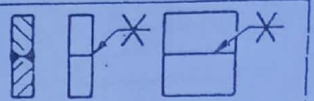
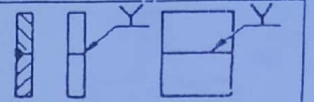
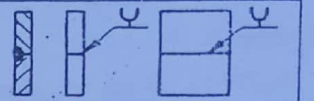
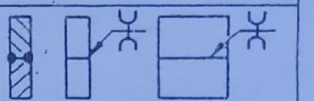
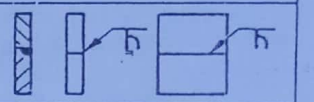
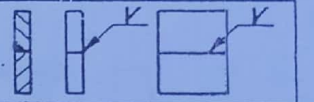
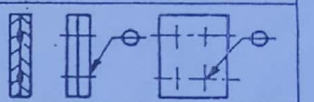
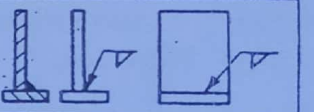
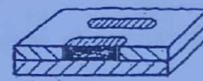
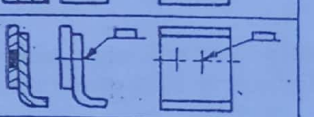
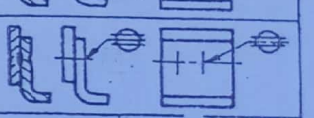
In *resistance welding*, the pieces to be joined are butted together under pressure and a heavy current is passed through them, producing sufficient heat for welding under continual pressure.

Spot welding is a process of pressure resistance welding in which thin parts are overlapped and welds are made at successive single spots by electrodes contacting both sides of the metal sheets under pressure.

Welding symbols

On engineering drawings, welding requirements are made clear and unambiguous by using welding symbols specified in British Standard BS 499. These symbols give instructions as to the type of welds, their position, and sometimes their size.

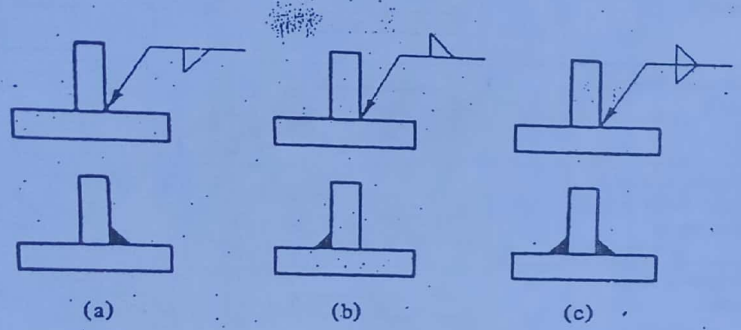
The type of weld to be made is indicated by the type of weld symbol. Some of the welds commonly used and their symbols are shown in Fig. 10.12.

Type of weld	Symbol	Illustration	Symbolic representation
Square butt weld	‖		
Single V-butt weld	V		
Double-V butt weld	X		
Single-V but weld with broad root race	Y		
Single-U butt weld	Y		
Double-U butt weld	Y		
Single-J butt weld	Y		
Single-bevel weld with broad root race	Y		
Spot weld	O		
Fillet weld	△		
Plug weld (Circular or elongated hole, completely filled)	⊓		
Seam weld	⊖		

109 Fig. 10.12 Welds and symbols

The method used to indicate a weld on a drawing is shown in Fig. 10.13.

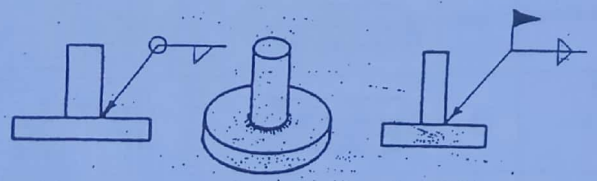
(a) if the weld symbol is below the horizontal reference line, the weld is to be made on the arrow side of the joint;
(b) if the weld symbol is above the reference line, the weld is to be made on the side of the joint away from the arrow, known as the 'other' side;
(c) if the weld symbol is shown above and below the reference line, welds are to be made on both sides of the joint.



(a) (b) (c)

Fig. 10.13 Weld indication on drawings

A weld all round is indicated by a circle drawn at the elbow of the arrow, Fig. 10.14(a), and a weld to be made on site is indicated by a filled-in triangle as in Fig. 10.14(b).



(a) Weld all round (b) Weld on site

Fig. 10.14 Further welds

If a weld requires special preparation, the arrowhead should always point to the edge of the plate.

10.3 Locking devices

In machinery which is subject to constant working vibration, nuts and bolts tend to work loose – often with disastrous results.

Many methods of locking nuts and bolts have been used, and these fall into two basic groups:

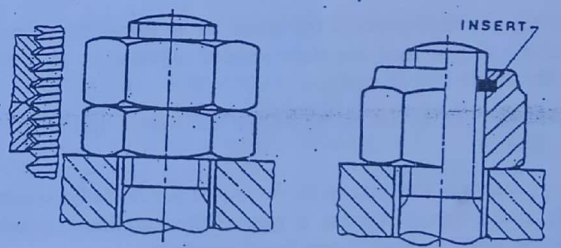
(a) friction locking, which relies on increased friction between the nut and the bolt;
(b) positive locking, which relies on the use of a pin through the nut, various locking plates, washers, or wire locks.

Friction locking devices

Friction locking is usually required on machines which are subject to light vibration. (Friction is the resistance to motion of one surface relative to another surface in contact).

Lock nut Two nuts screwed firmly one on top of the other strain against each other and wedge the nut threads on to the opposite flanks of the bolt threads, This has a locking effect, Fig. 10.15(a).

The thinner lock nut is sometimes fitted beneath the main nut, which carries all the tensile load, and sometimes on top, thus eliminating the need for a thin spanner to adjust it.



(a) Lock nut (b) Self-locking nut

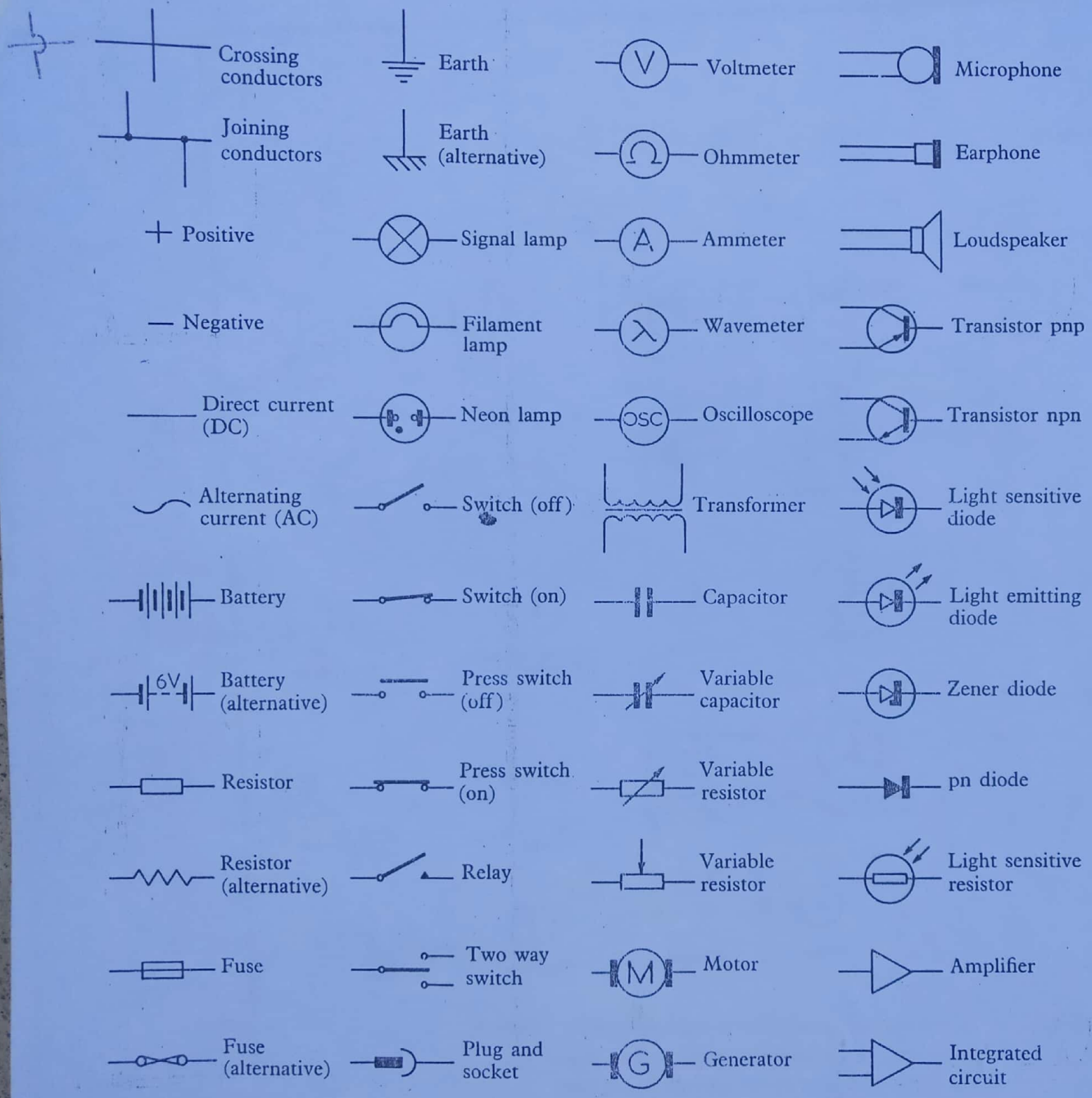
Fig. 10.15 Locking nuts

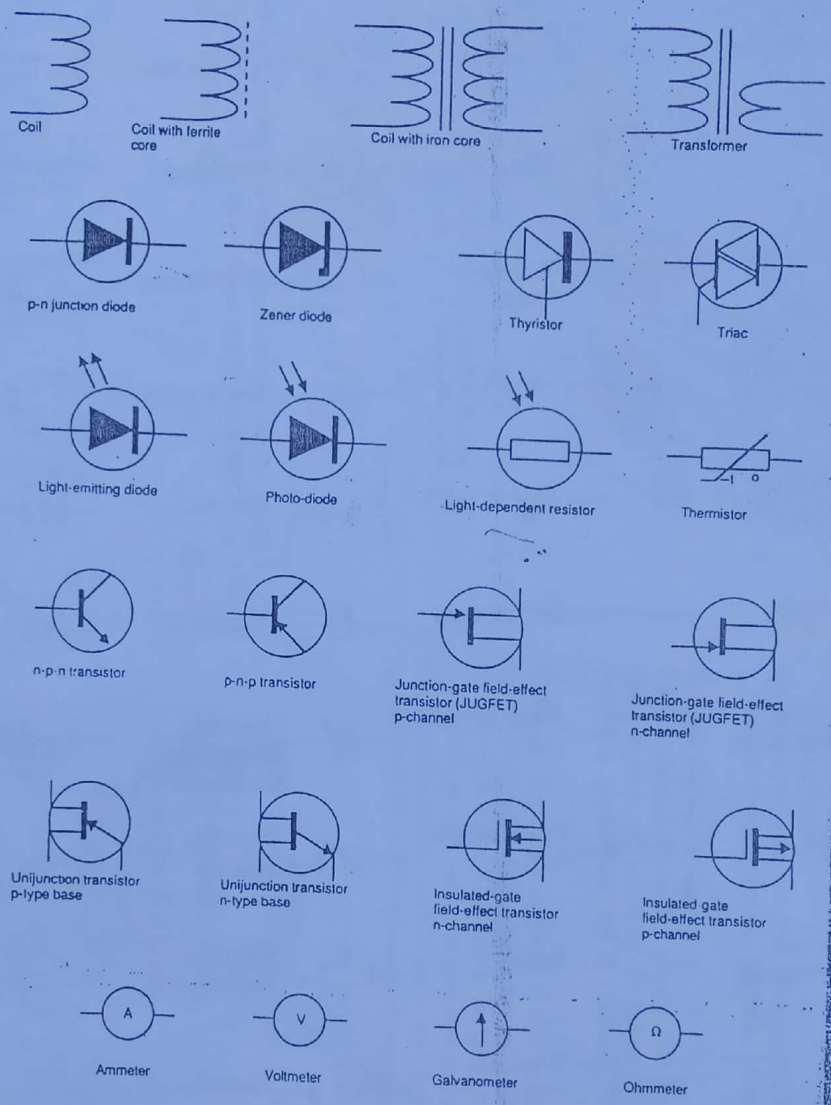
Self-locking nuts These contain a fibre or plastics ring insert, Fig. 10.15(b), which is compressed against the bolt thread when the nut is tightened, thus producing frictional gripping action.

Plain washer A plain washer is not a locking device but provides a flat base for a nut and stops the nut digging in. It is useful on rough surfaces and slots, see p. 105.

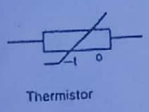
Appendix B

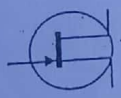
A selection of symbols taken from BS3939: *Graphical symbols for electrical power, telecommunications and electronics diagrams* is given below. These are the symbols most commonly found in electrical and electronics circuits.

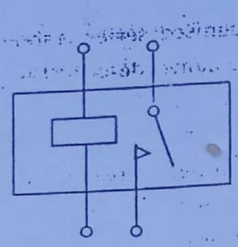


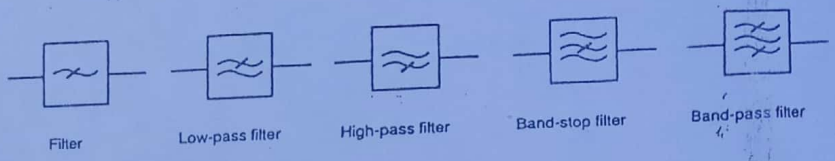


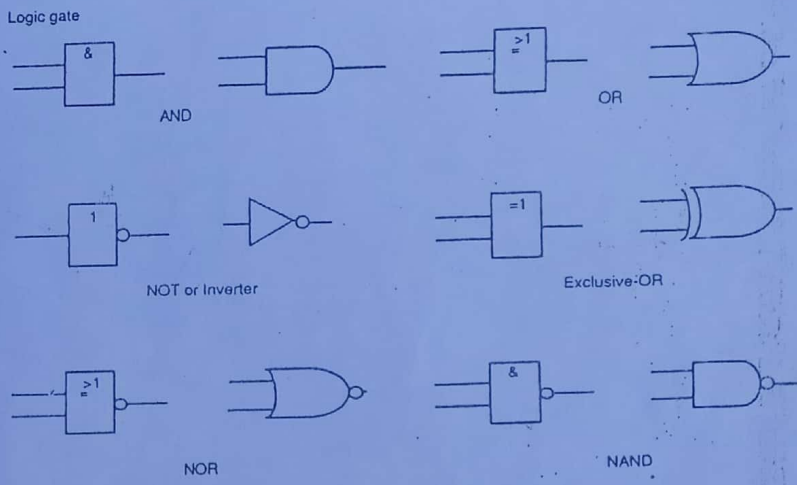
2.6 Circuit di











2.6 Circuit diagrams

Circuits A circuit consists of a number of components connected together in such a ay as to carry out a specific task. A circuit must have a source of electrical pow and therefore every circuit must have some form of power unit connected t t. Most electronic circuits make use of very low power and can be operated fro small d.c. supplies.