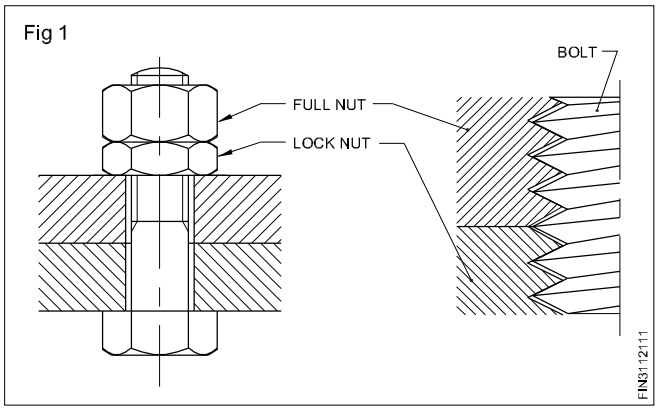
Locking devices - Types of lock nut

Objectives : At the end of this lesson you shall be able to
- **state the different types of locking devices**
- **state the uses of locking devices.**

Nuts used along with bolts in assembly may loosen due to vibration. Different types of nut-locking devices are used depending on the severity of the condition in which the fastener is used. The following are the most commonly used types.

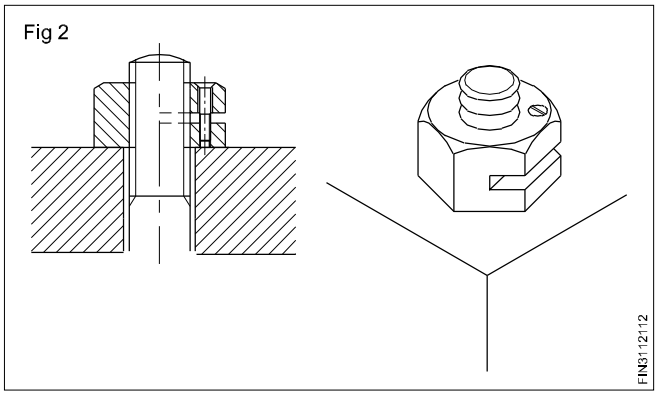
Lock-nut

A thin nut with both faces machined is placed below a nut in the assembly. (Fig 1) Both nuts are tightened over the bolt one after the other. Then using two spanners pressure is exerted on both nuts by turning in opposite directions. Both nuts are held together by friction.



Sawn nut (Wiles nut)

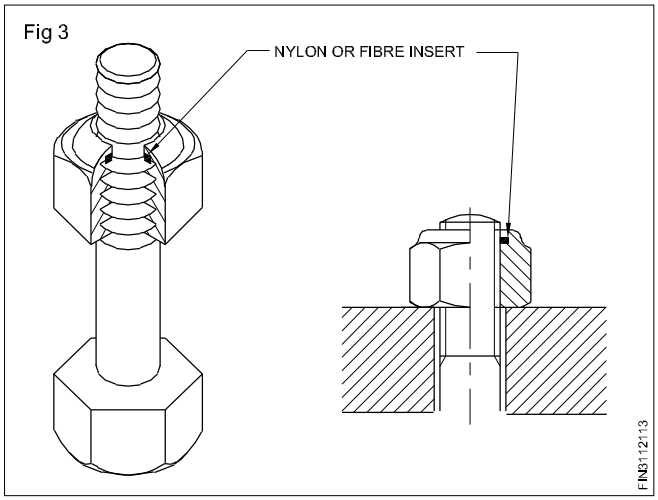
In this type of locking, a slot is cut half way across the nut. A screw is fitted with a clearance hole on the top part and matching thread on the lower part of the nut. (Fig 2) Tightening of the nut provides positive locking for the nut.



Self-locking nut (Simmonds nut)

This is a special nut with a nylon or fibre ring insert placed in the upper part of the nut. The internal diameter of the ring is smaller than the core diameter of the bolt thread.

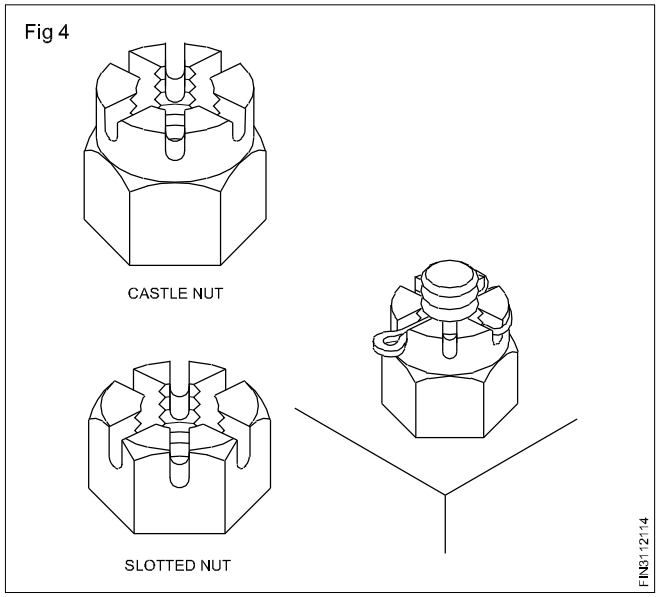
The nut while tightening cuts its own thread on the nylon insert. This provides a positive grip and prevents the nut from loosening due to vibration. (Fig 3)



Slotted and castle nuts

These nuts have special provision in the form of slots for fixing split pins for locking the nuts.

Slotted nuts are hexagonal shaped throughout. (Fig 4) in the case of castle nuts, the top part of the nut is cylinderical in shape.



Slotted and castle nut with split pin

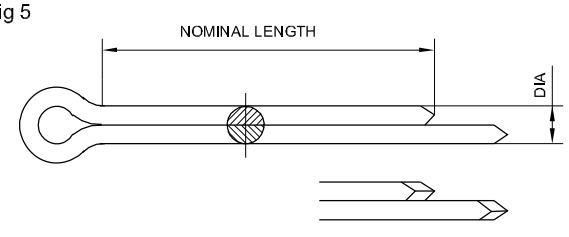
The position of the nut can be locked using a split pin.

Split pins are designated by the nominal size, nominal length, the number of the Indian Standard and the materials (for materials other than steel only).

The nominal size is the diameter of the hole for receiving the split pins.

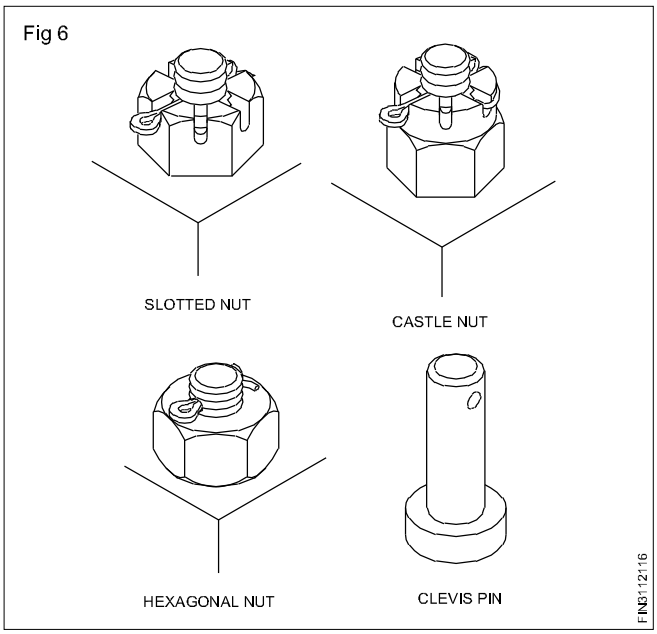
The nominal length is the distance from the underside of the eye to the end of the short leg. (Fig 5)

Fig 5



Split pins are used for locking slotted nuts, castle nuts, hexagonal nuts, clevis pins etc. and are used in different ways. (Fig 6)

Fig 6



Grooved nut (Penning nut)

This is a hexagonal nut with the lower part made cylindrical on the cylindrical surface. There is a recessed groove in which a set screw is used to lock the nut. (Fig 7)

Locking plate

For preventing the nut from loosening locking plates are fixed on the outside of the hexagon nut. (Fig 8)

Fig 7

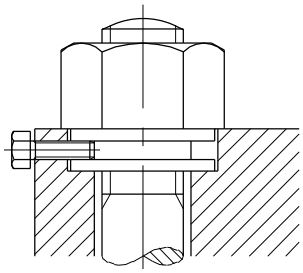
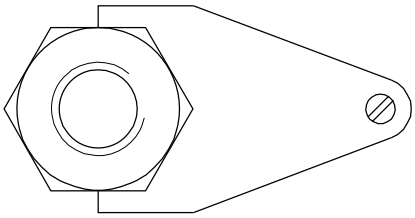


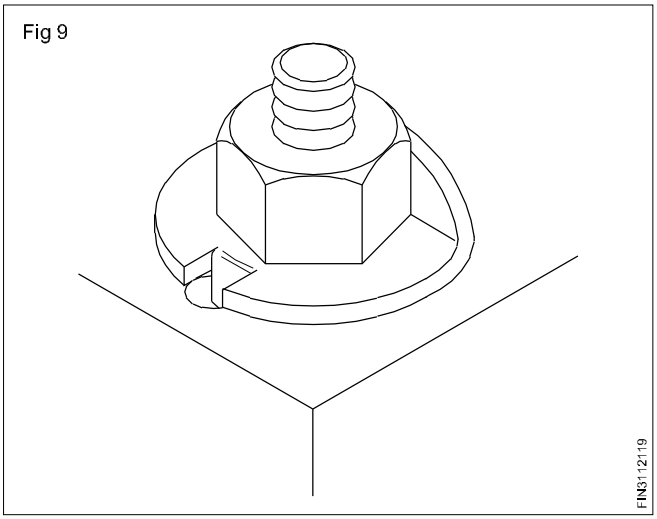
Fig 8



Lock-washers with lug

In this arrangement of locking a hole is drilled for accommodating the lug. (Fig 9)

Fig 9

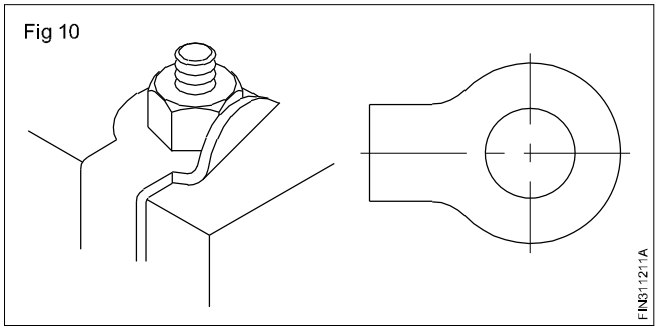


The movement of the nut is prevented by folding the washer against the nut.

Tab washers (Fig 10)

Tab washers can be used for locking the nuts which are located near an edge or corner.

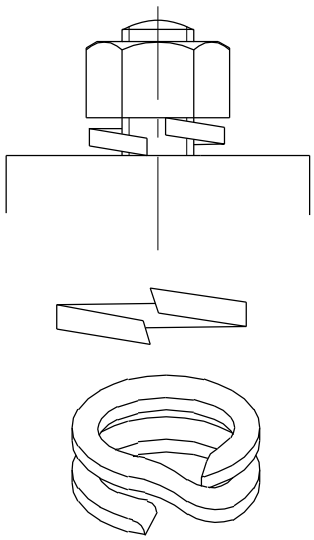
Fig 10



Spring washers (Fig 11)

Spring washers are available with a single or a double coil. These are placed under a nut in the assembly as washers. The stiff resistance offered by the washer against the surface of the nuts serves to prevent loosening.

Fig 11



FIN311211B

Various types of keys

Objectives : At the end of this lesson you shall be able to
- **list the types of keys**
- **state the specification of keys**
- **state the standard taper of key**
- **state the uses of key pullers.**

Key

Key is a metallic piece of wedge inserted between a shaft and hub, parallel to the axis of shaft. It is proportionate to the shaft dia.

Purpose

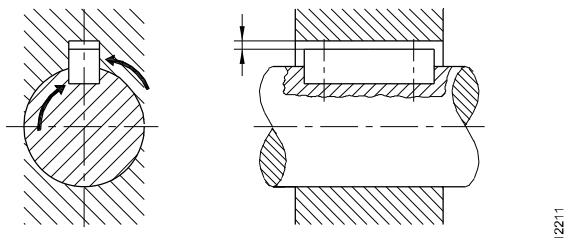
A key is an insert which is housed in the keyway to fit together a hub or a pulley to transmit torque. A keyway is provided on the shaft and also on the hub or on a pulley to connect together the conjugate parts by inserting the key in between. The key can be withdrawn at will to disengage the mating components.

Common types

Parallel key or feather key (Fig 1)

This is the most commonly used key, used for transmitting unidirectional torque. A hub or a pulley is engaged to the shaft by a key which prevents relative motion. The functioning of the feather key assembly is shown in Fig 1.

Fig 1



FUNCTIONING OF A FEATHER-KEYED JOINT

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In many cases the key is screwed to the shaft keyway. (Fig 2)

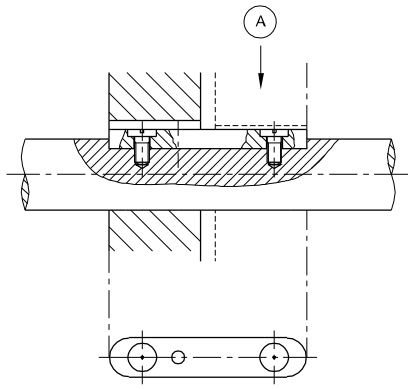
Where axial movement of the hub is required, a clearance fit is provided between the hub and the shaft and the hub and the key. Three types of fits are shown for feather key in Fig 3.

Approximate proportion of parallel or taper keys.

If D is the dia. of the shaft, width of the key W = 1/4D+ 2 mm.

Nominal thickness T = 2/3 w.

Fig 2



HUB IS MOVABLE

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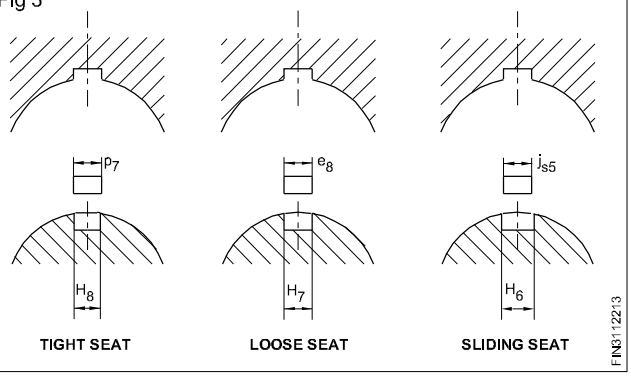
Fig 3



TIGHT SEAT LOOSE SEAT SLIDING SEAT

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Example

Diameter of shaft = 40 mm

$$\text{Width} = \frac{1}{4} \times 40+2 = 12 \text{ mm}$$

$$\text{Thickness} = \frac{2}{3} \times 12 = 8 \text{ mm}$$

Thickness at the large end is the nominal thickness of the taper key.

Taper is 1 in 100 on the top face only.

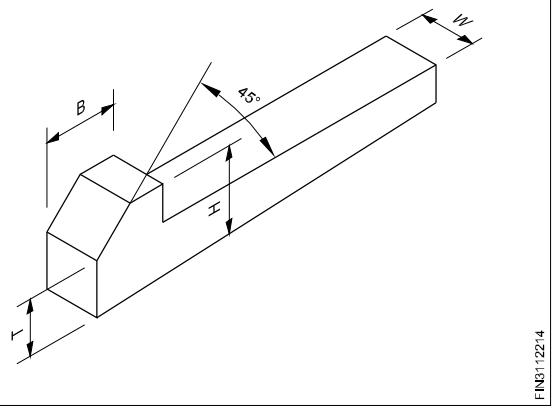
Taper and jib-headed key (Fig 4 & 5)

The key is having a jib-head with a taper (1 in 100) on the top face. It is driven on to the keyway by hammering

on the jib to have a tight fit. The taper rectangular key without a jib-head is also in use. A jib-headed key can be widthdrawn easily and used for transmitting more torque. It is not good for high speed applications.

Approximate propirtion of jib-headed key (Fig 4)

Fig 4



$H = 1.75T$

$B = 1.5\ T$

$W = \frac{1}{4}D+2$

Nominal thickness $T = \frac{2}{3}W$

Angle of chamfer = 45°

Example

Diameter shaft = 46 mm

$$\text{Width(w)} = \frac{1}{4} \times 46+2 = 11.5+2$$

= 13.5 rounded off to 14 mm.

$$\text{Thickness(T)} = \frac{2}{3} \times 13.5 = 9 \text{ mm}$$

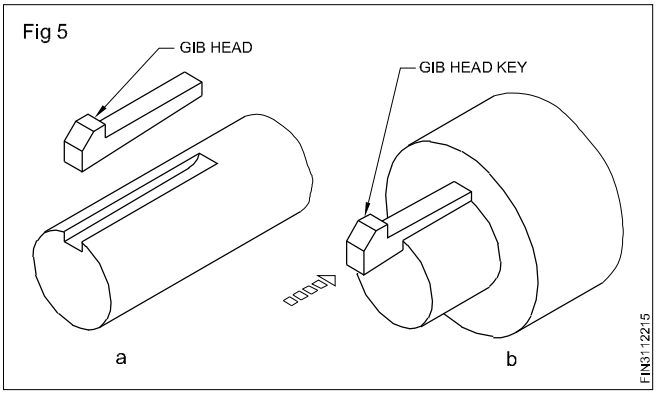
H = 1.75 x 9 = 15.75

say 16 mm

B = 1.5x9 = 13.5 mm.

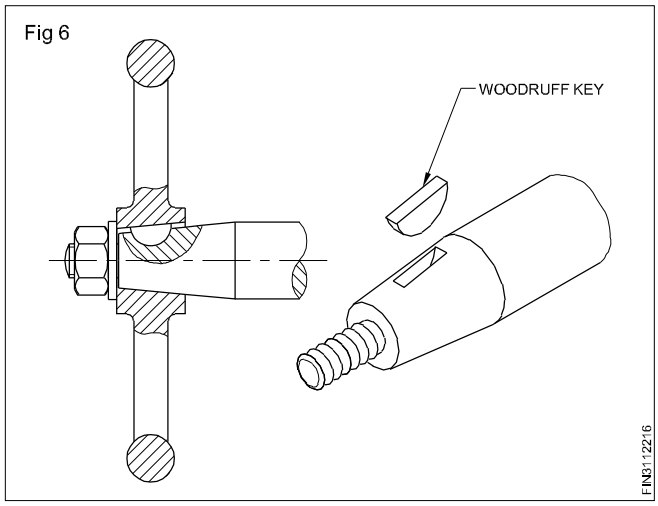
Woodruff key (Fig 5)

Fig 5



It is a semicircular key used for transmitting light torque. It fits on to the shaft on which matching recesses are cut. The top portion of the key projects out and fits in the keyway cut on the hub. (Fig 6)

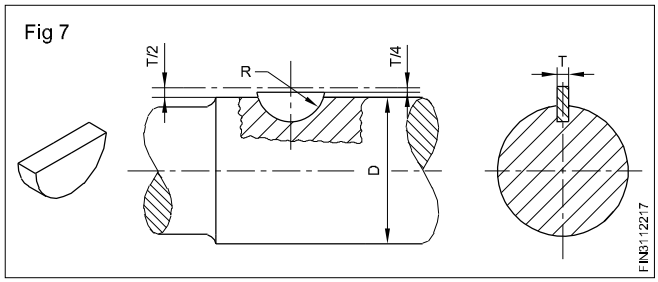
Fig 6



This key is particularly useful on tapered fittings or shafts. Its key way is milled to the prifile of the key on the shaft which tends to weaken the shaft. This type of key positions itself in the keyway to accommodate the hub to have an easy assembly.

Approximate proportion of woodruff key (Fig 7)

Fig 7



Radius of the key (R) $= \frac{D}{3}$

Thickness(T) $= \frac{D}{6}$

Example

For shaft ø 30.

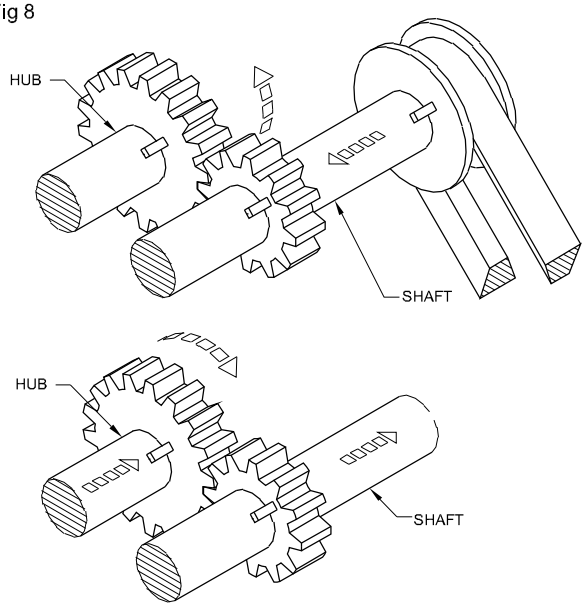
R = 30/3 = 10 mm

T = 30/6 = 5 mm

Keys and splines: Keys and splines are used for transmitting torque from a rotating shaft to a hub/wheel or from a hub/wheel to the shaft. (Fig 8)

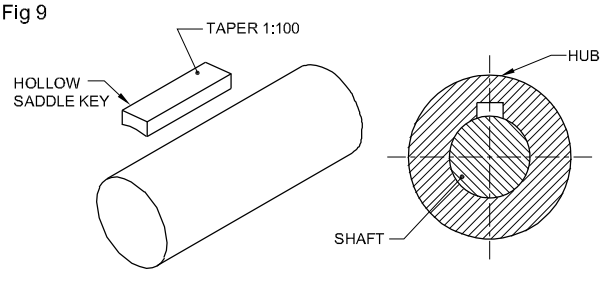
Keys of different types and splines are used depending on the requirements of transmission.

Fig 8



Hollow saddle key: One face of this key has a curvature to match with that of the shaft surface. It has a taper of 1 in 100 and is driven in through the keyway. (Fig 9)

Fig 9

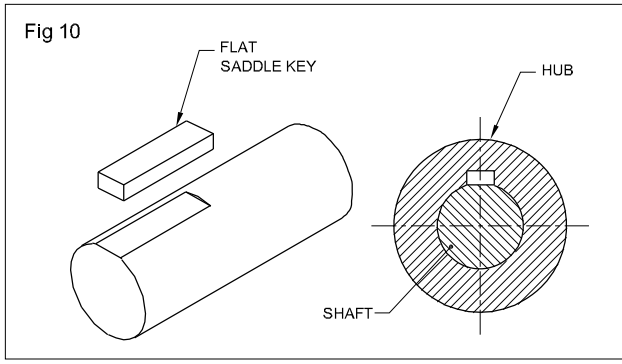


The hub is held on the shaft due to friction. This key is useful only for light duty transmission.

Flat saddle key: This key has a rectangular cross-section.

For fitting this key in the assembly a flat surface is machined on the shaft. (Fig 10) The key is placed between the flat surface of the shaft and the keyway on the hub. This is considered to be stronger than the hollow saddle key. This is not suitable for heavy duty transmission.

Fig 10



Approximate proportion

If D is the diameter of the shaft,

width of the key (W) = $\frac{1}{4}$D+2 mm

nominal thickness (T) = $\frac{1}{3}$W.

Example

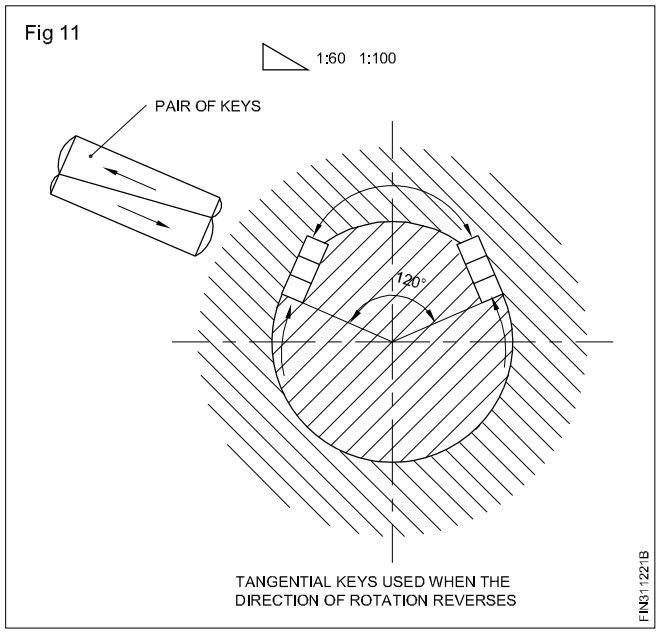
diameter shaft = 24 mm

W = $\frac{1}{4}$ x 24+2 = 8 mm

T = $\frac{1}{3}$ x 8 = 2.7 or 3 mm.

Tangential key (Fig 11)

Fig 11

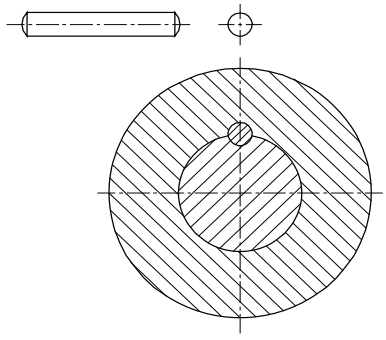


These keys are used when very high torque of impact type is to be transmitted in both directions of rotation. Common applications are found in flywheels, rolling mills etc. A tangential key consists of two taper rectangular wedges, positioned one over the other in opposite directions. Two sets of keys are fixed at 120° angle as shown in Fig 11 and should be such that the broad side is directed along a tangent to the shaft circle while the narrow side sits along the radius of the shaft.

Round key (Fig 12)

It is of cylindrical cross-section and is used in assemblies to secure the mating components where the torque is light. The key is fitted parallel to the shaft into the drilled hole made partly on to the shaft and partly on to the mating part.

Fig 12



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Approximate proportion of round key

If dia. of the shaft = D

Dia. of the key (d) = $\frac{1}{6}$ D

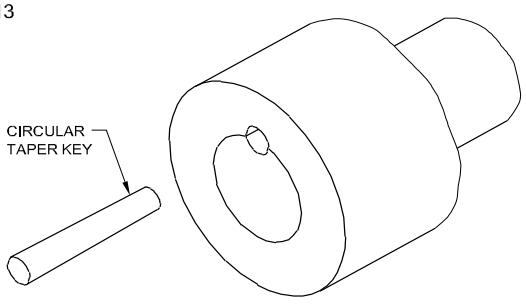
Example

Dia. of shaft = 30 mm

Dia of key = $\frac{1}{6}$ x 30 = 5 mm

Circular taper key: In this case both the shaft and the hub have semicircular keyways cut on them. (Fig 13) The taper key is driven in while assembling. This key is suitable only for light transmission.

Fig 13



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Sunk key: This key has a rectangular cross-section and it fits into the keyway cut on both the shaft and the hub. Sunk keys are either parallel or tapered. (Figs 14 and 15)

Fig 14

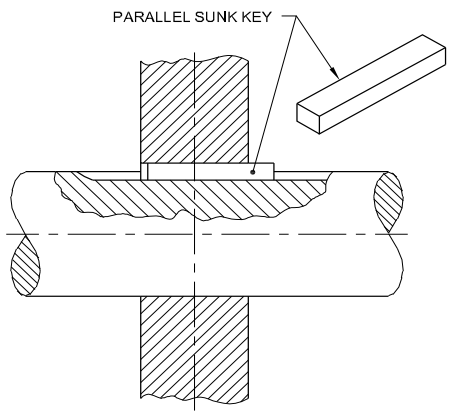

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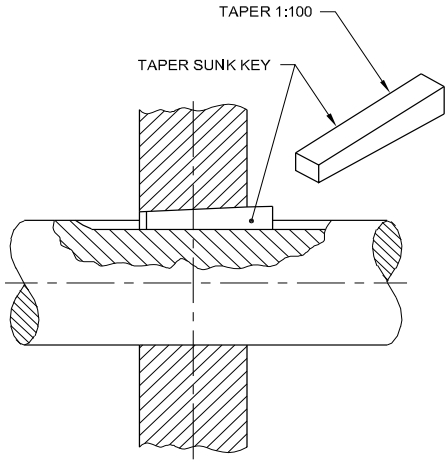
Fig 15



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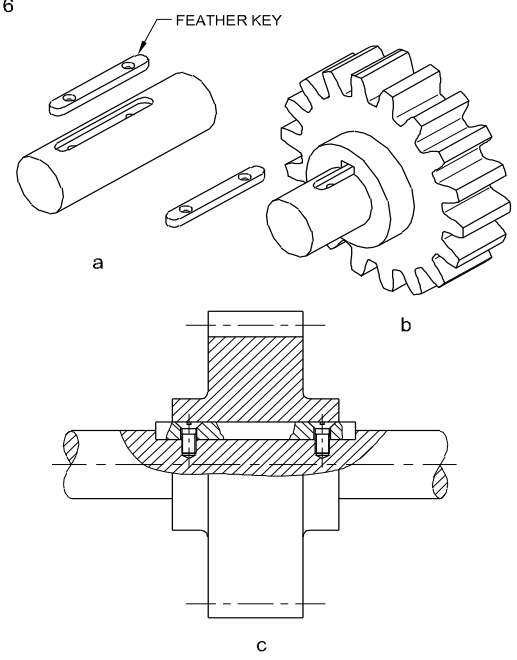
Feather key: This is parallel key with rounded ends. This is useful when the hub/pulley has to slide axially on the shaft to some distance. (Figs 16a, b and c) This key may be either tightly fitted in the keyway or screwed in.

Fig 16



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Splines: Splines are ridges (or) teeth on a drive shaft that mesh with grooves in a mating piece and transfer torque to it, maintaining the angular correspondence between them.

An alternative to spline is a key way and key

Splined shaft and serrated shaft: Splined shafts along with splined hubs are used particularly in the motor industry. The splined hub can also slide along the shaft, wherever necessary (Figs 17a and b) used while fixing change gears in a lathe and heavy duty drilling machine.

In certain assemblies, serrated shafts are also used for transmission. (Fig 18)

Peg feather key: It is a parallel rectangular key having a round peg at the centre or one edge of the key face. (Fig 19)

Fig 17

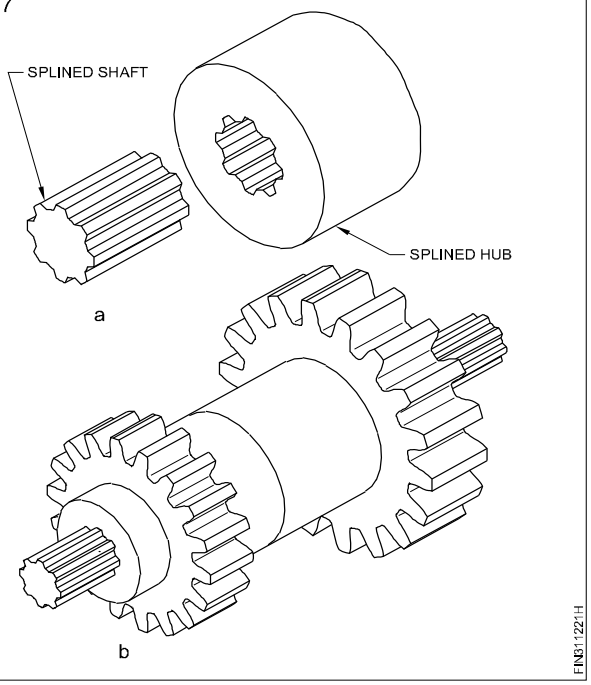


Fig 18

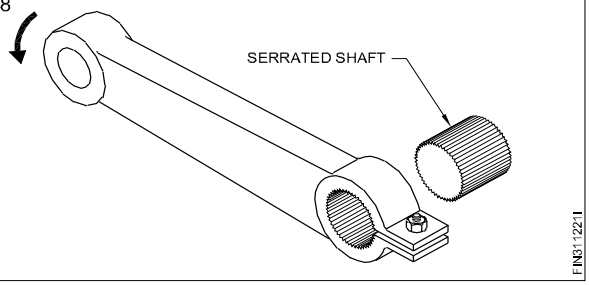
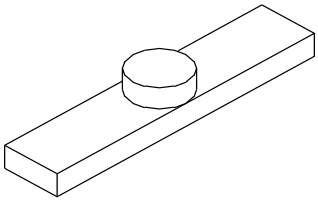


Fig 19



The peg will fits into the hole of the shaft or stationary member of a unit assembly to prevent the sliding of the key.

A peg feather key is used at the bottom of the tail stock barrel to prevent the barrel from rotation. It is also used in a drilling machine spindle while moves along with quill when the spindle in rotation.

Some of the key dimensions as per IS is given in table 1, 2, 3 & 4.

Key puller

Key puller is used for the safe removal of keys from the shaft of any type of machine, motor, blower, compressor, etc.

It is generally used for the keys from 5mm to 35mm width.

Advantages

- Safe and fast removal
- Perpendicular removal
- No damage to shafts & keys
- Saves time & labour costs & costs

Easy-to-use

1 Turn wheel (A) to move the jaws (1) up or down so that they are aligned with housing (2)

2 Turn wheel (B) to fit the size of the key allowing ± 1 mm space.

3 Turn wheel (B) hand tight to secure the key with the jaws.

4. Then turn wheel (A) to extract the key perpendicularly.

5. Turn wheel (A) to move the jaws down, turn wheel (B) to open the jaws and free

Fig 13

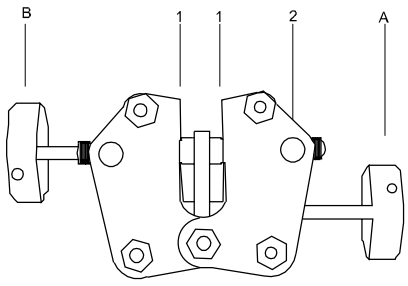


Table 1

Dimensions for keys

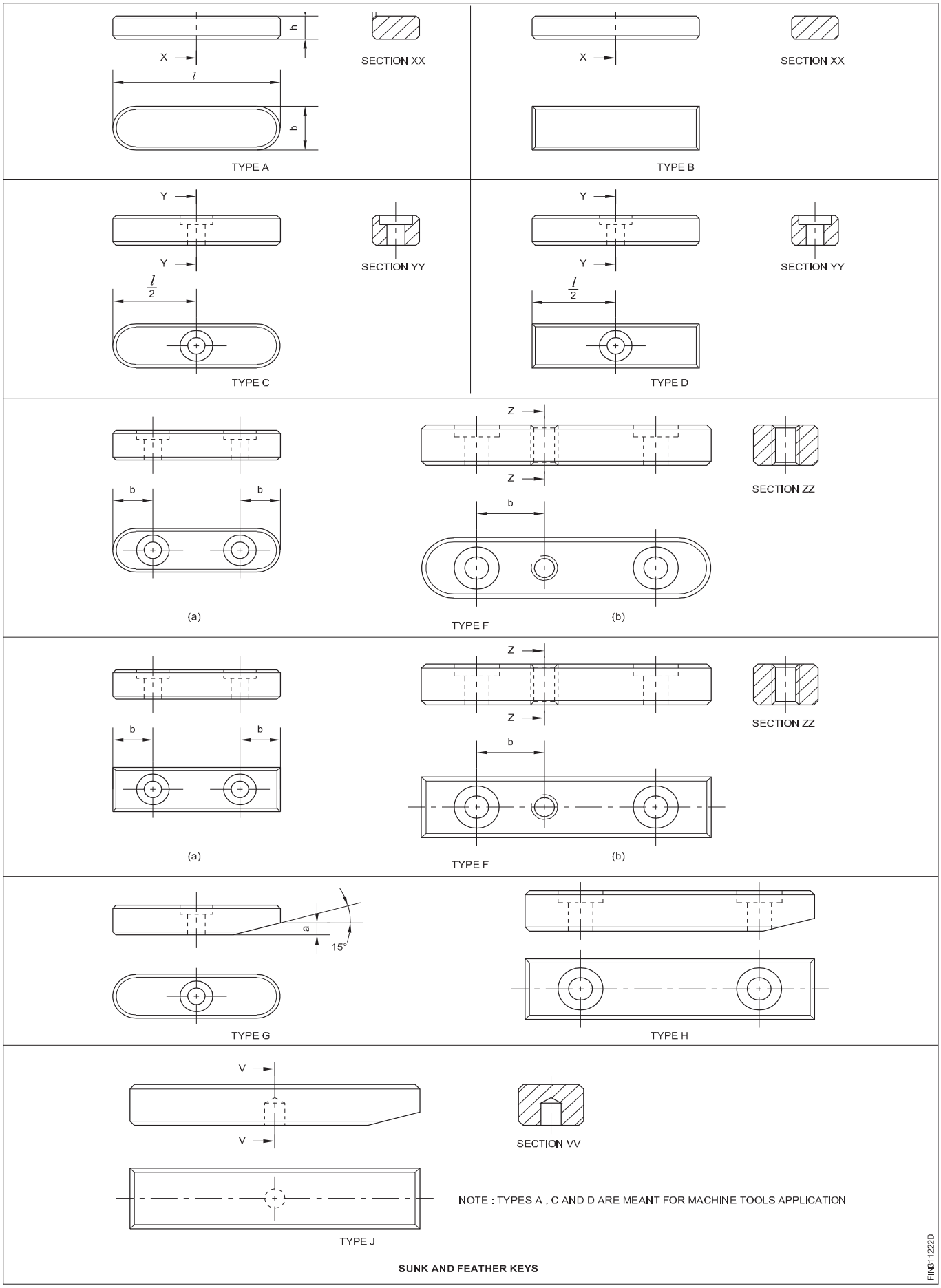
(IS 2048 - 1983)

All dimensions in millimetres

b	Tol on b h9	h	Tol on h*	s		Range of Key Length l		Range of Key Length (for Machine tools only)	
				Min	Max	Min	Max	Min	Max
4	0 – 0.030	4	0 – 0.030	0.16	0.25	8	45	10	45
5		5		0.25	0.40	10	56	12	56
6		6		0.25	0.40	14	70	16	70
8		7		0.25	0.40	18	90	20	90
10	0 – 0.036	8	0 – 0.090	0.40	0.60	22	110	25	110
12		8		0.40	0.60	28	140	32	140
14	0 – 0.043	9		0.40	0.60	36	160	40	160
16		10		0.40	0.60	45	180	45	180

Note - Keys with b = 4 to 40 are meant for machine tools application also.

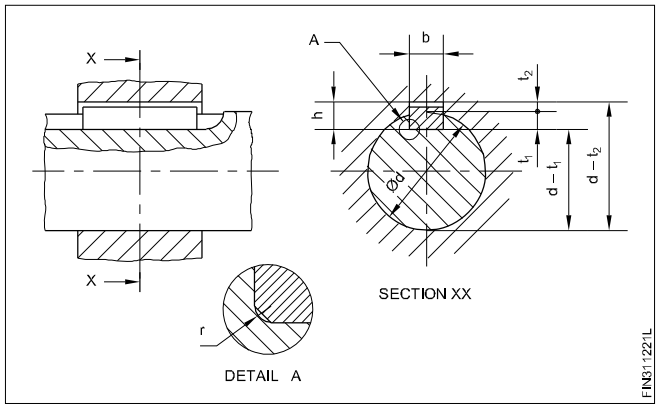
* Tol on h: Square section h9; Rectangular Section h11.



SUNK AND FEATHER KEYS

Table 2

Dimensions for keyways

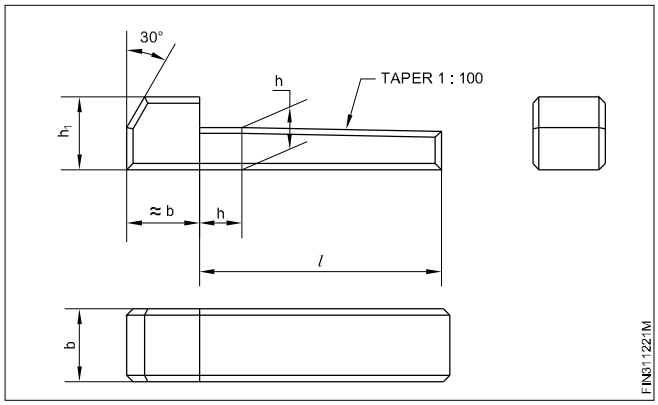


Range of shaft dia d		Key	Keyway								Range of shaft dia d		Keyway for Machine Tools Application			
		b x h	b	Tol on b				t1	Tol	t2 on t1	Tol on t2						
				Running fit		Light drive fit		Force fit									
Above	Upto			Shaft H9	Hub D10	Shaft N9	Hub Js9	Shaft & Hub P9				Above	Upto	t1	Tol on t2	t2	Tol on t2
22	30	8 x 7	8	+ 0.036	+ 0.098	0	+ 0.018.0	- 0.015	4.0		3.3		22	30	5.4 -		1.7 -	
30	38	10 x 8	10	0	+ 0.040	- 0.036	- 0.018.0	- 0.051	5.0		3.3		30	33	6		2.1	
38	44	12 x 8	12	+ 0.043	+ 0.120	0	_ 0.021.5	- 0.018	5.0		3.3		38	44	6	+ 0.2	2.1	
44	50	14 x 9	14	0	+ 0.050	- 0.43	- 0.021.5	- 0.061	5.5	0	3.8	0	44	50	6.5	0	2.6	
50	58	16 x 10	16						6.0	+ 0.2	4.3	+ 0.2	50	58	7.5		2.6	

Table 3

Indian Standard specification for GIB Head keys and keyways

All dimensions in millimetres

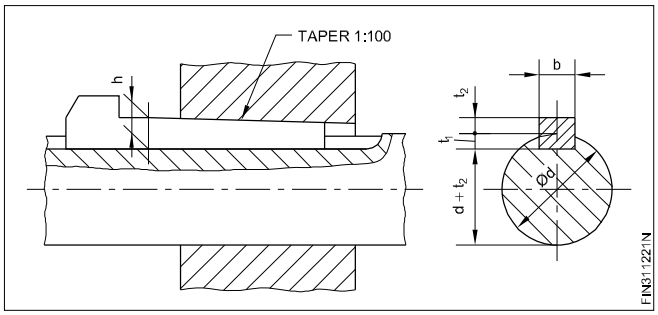


b	Tol on b h9	h	Tol on h*	s		Range of Key length, l		h1
				Min	Max	Min	Max	
4		4		0.16	0.25	14	45	7
5	0	5	0	0.25	0.40	14	56	8
6	– 0.030	6	– 0.030	0.25	0.40	16	70	10
8		7		0.25	0.40	20	90	11
10	0 – 0.036	8		0.40	0.60	25	110	12
12		8	0 – 0.090	0.40	0.60	32	140	12
14		9		0.40	0.60	40	160	14
16	0 – 0.043	10		0.40	0.60	45	180	16

Table 4

Details of keyway and key

All dimensions in millimetres



Range of Shaft Dia d		Key	Keyway							
		b x h	b	Tol on b D10	t1	Tol on t1	t2	Tol on t2	r	
Above	Upto								Min	Max
22	30	8 x 7	8		4.0		2.4		0.16	0.25
30	38	10 x 8	10	+ 0.098 + 0.040	5.0		2.4		0.25	0.40
38	44	12 x 8	12		5.0		2.4		0.25	0.40
44	50	14 x 9	14		5.5		2.9		0.25	0.40
50	58	16 x 10	16	+ 0.120 + 0.050	6.0	0 + 0.2	3.4	0 + 0.2	0.25	0.40