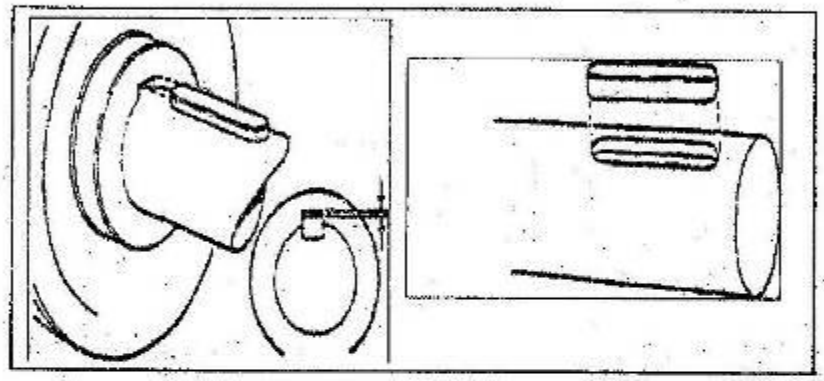
READING MATERIAL

ON

KEY & COUPLING FITTING



STEEL AUTHORITY OF INDIA LIMITED
ROURKELA STEEL PLANT
HUMAN RESOURCE DEVELOPMENT CENTRE

LECTURE NOTES ON KEY FITTING

PART 1- DEFINITIONS AND MAIN TYPES OF KEY

DEFINITIONS

Hub - A hub is any item such as a wheel, gear, pulley, lever or coupling which fits onto a shaft and is driven by the shaft.

Key way - A keyway is a recess in a shaft or hub to accommodate a key,

Key - A key is a shaped metal piece, which fits into the aligned shaft and hub key ways to:

(1) Secure the hub to the shaft.
(2) Prevent rotation of the hub around the shaft.

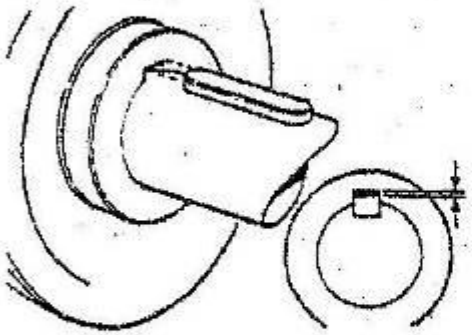
MAIN TYPES OF KEY

(A) Parallel Key

A parallel key is normally of rectangular or square cross section, uniform in both width and thickness throughout its length and with either square or rounded ends. It is sunk for half its depth into a closed keyway on a shaft and for the other half of its depth into an open keyway on a hub.

It is generally used where the hub is required to slide along the shaft. When this is the case, the standard of fitting to be achieved is a tap fit into the shaft and a push fit into the hub with a 0.1 mm clearance between the top of the key and the hub.

It is occasionally used to resist both end and rotary movement. When this is the case, the fitting standard must be a tap fit into both the shaft and hub.



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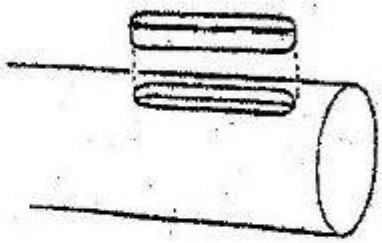


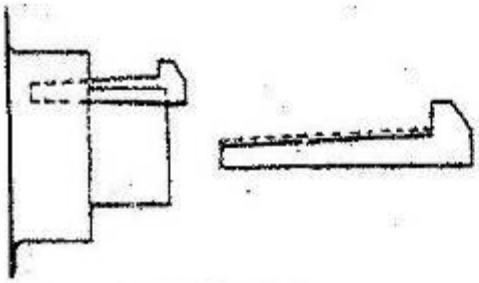
KF 2

(B) Taper

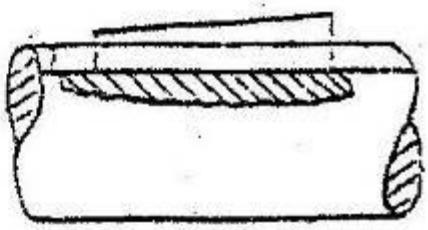
A taper key is normally of rectangular or square section, uniform in width but tapered 1 in 100 in depth. It can have square or rounded ends. It is sunk for half its depth

into either a closed or open keyway on a shaft and for the other half of its depth into an open keyway on a hub.
It is generally used to both drive and hold the hub in the correct position on the shaft and must therefore be a tight fit in both the shaft and hub keyway.

Where the shaft keyway is closed, the hub is driven into position over the key. Where the shaft keyway is open, the key is driven into position after the hub has been correctly positioned on the shaft.



Open Keyway
KF 3



Closed Keyway
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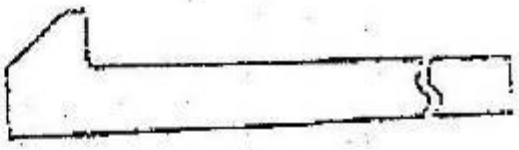
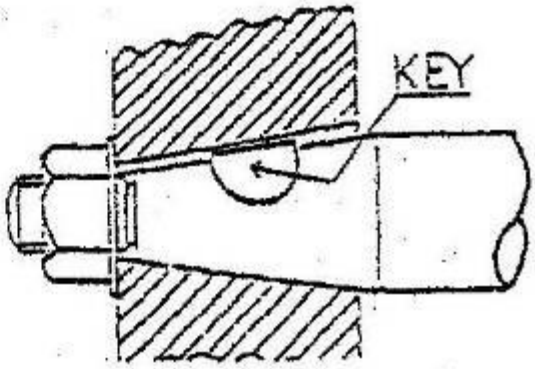
Some taper keys are made with GIB heads to enable them to be more easily removed by levering between the face of the hub and the face of the GIB head.



(C) Woodruff Key

A woodruff key is part of a circular disc having a flat top. It is sunk into a closed keyway in a shaft and open keyway in a hub. It is designed to project above the shaft by an amount equal to half its thickness.

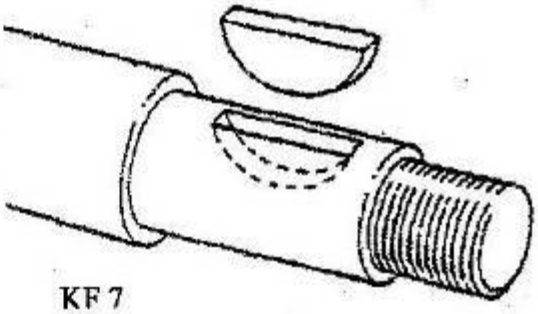
The shaft keyway is milled using a cutter having the same diameter as the circular disc from which the key is made. The hub keyway can be either parallel to the shaft or tapered.



KF 6

Where it is tapered, the key will rotate within the shaft keyway allowing the flat top of the key to line up with the taper in the hub keyway.

It is generally used for tapered shafts and hubs and is a push fit. Once fitted, the hub is normally secured to the shaft by means of a locknut or other fixing device.



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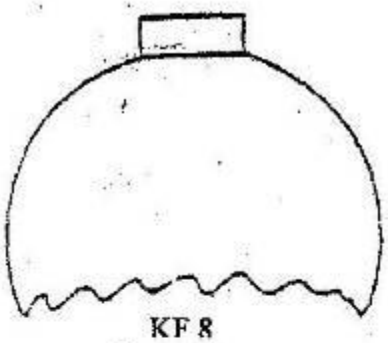
OTHER TYPES OF KEY

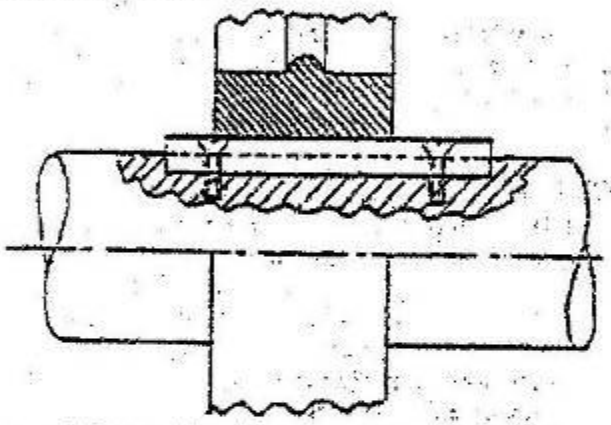
Flat saddle - A taper key fitting into a keyway in the hub and a flat on the shaft. It is only suitable for light duty and is not widely used.



KF 8

Feather key-

A parallel key permanently fixed by countersunk screws to either the shaft or hub, the free half being a sliding fit in the keyway of the moving piece allowing axial movement. It is used extensively for machine tool drives and gears.



Round key-

A simple device that eliminates the need for machined keyways. The shaft and hub are fitted together and a hole of 1/6 of the shaft diameter is drilled through the hub and shaft. A round steel pin is then driven into the hole to act as a locking device.

PART:2-KEY EXTRACTION

(A) General

Keys need to be extracted when components are changed or repaired and when new keys are tried whilst being fitted.

During extraction it is very important that NO DAMAGE is done to the keyways, shaft and hub. Keys should always be treated with care, although in some cases the process of extraction will make them unfit to use again.

The method of extraction will depend on:

- The type of key used.
- The availability of new keys.
- The access to the working area.
- The safety of personnel working in the area.

SAFETY NOTE

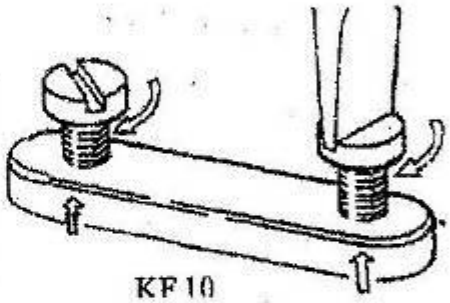
Before carrying out work on any key, the drive must be isolated and locked off electrically and mechanically and a Permit to Work must be obtained from a responsible person.

Considerable force is sometimes necessary to remove a tight fitting key. When it does move, it can travel over quite a distance and inflict damage relative to the force applied to move it. Care must always be taken to ensure the safety note only of the personnel engaged on the removal but also any other personnel working in the vicinity.

B) Methods of extraction

Jacking screws -

Used for parallel keys. The key is drilled and tapped before final fitting, the size and number of screw points depending on the length of the key. To remove the key, Suitable screws or bolts are carefully tightened down (one or two turns of each in sequence). The key will then lift from the keyway in a controlled manner.



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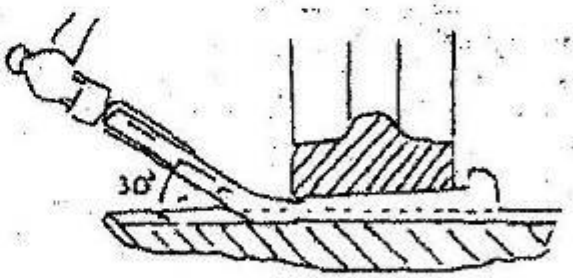
Key drifts -

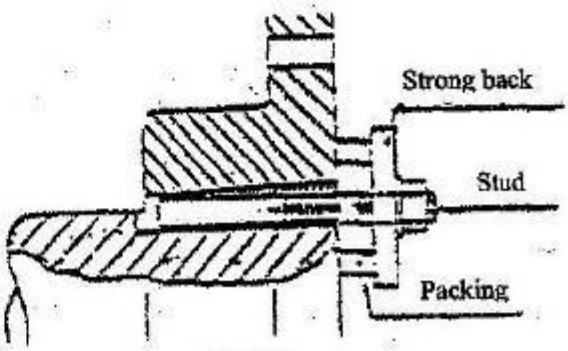
Used when the small chamfered end (tail) of a taper key is accessible. If necessary, small pieces of steel called dominoes can be inserted between the drift and key in order to extend the effective reach of the drift.



KF 11

Drilling -

Used when the end (tail) of a taper key is NOT accessible. Using the largest possible tapping drill size, a hole is drilled through the length of the key. The hole is then

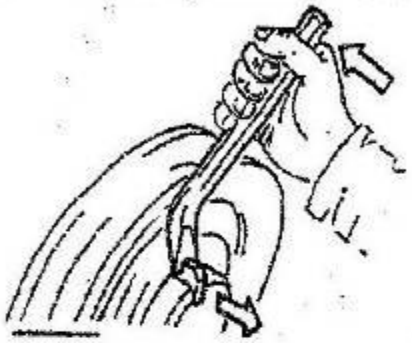


KF 12

tapped with a suitable fine thread. A stud can then be screwed into the tapped hole and either used to press against the keyway end in order to force the key out or used with a strong back between the stud head and hub to force the key out.

Pinch bar -

Used for taper keys with a GIB head. To prevent damage to the hub, protection pieces must be placed between the hub and the pinch bar.



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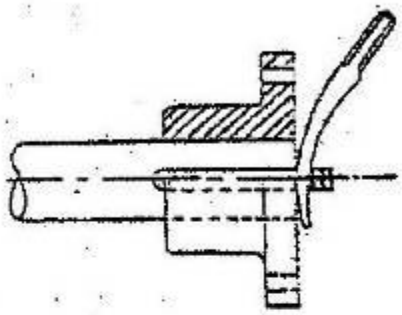
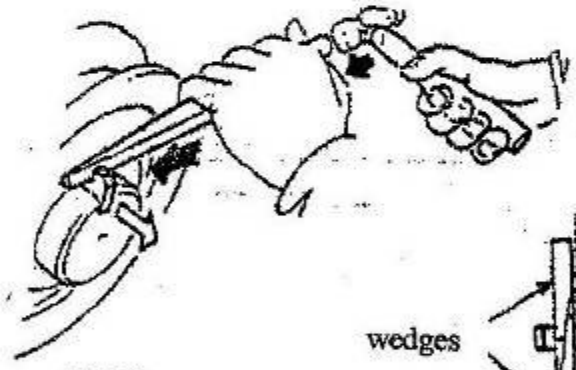


KF 14

Wedges -

Also used for taper keys with a GIB head. The two wedges provide an in-line force, which reduces the chance of the key bending. As with a pinch bar, suitable protection pieces must be used to prevent damage to the hub.



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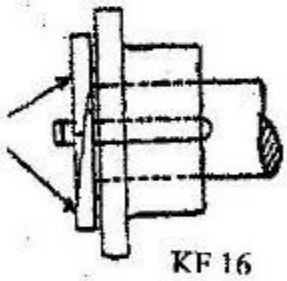
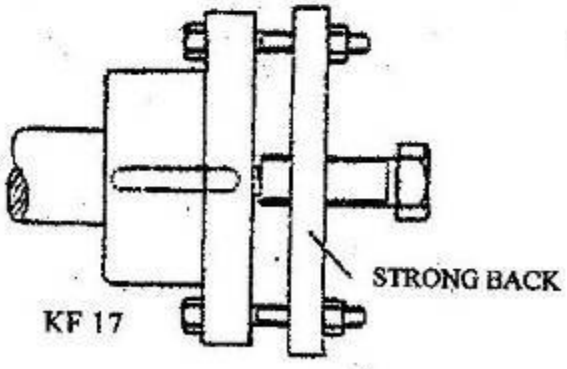


KF 16

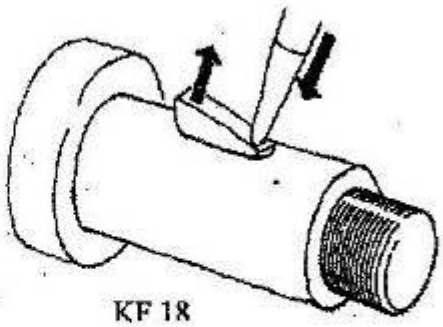
Strong back -

Used when the complete hub is to be removed from a shaft fitted with a parallel or woodruff key. Care must be taken to ensure that the jacking screw does not damage the end of the shaft.



KF 17

In the case of Woodruff Key, once the hub is removed the key is simply tapped out of the keyway using a small soft metal drift



KF 18

PART:3-KEY SIZE

Selection of the correct size and type of key is critically important.

Normally it is a simple matter of comparison with the key already in place or of approximate measurement of the keyways to enable the appropriate key to be drawn from the stores. In this case the keyway can be measured by using an engineers steel rule.

Occasionally a parallel or taper key may have to be made. In this case the keyway can be measured accurately by using:

- A vernier caliper to measure the length of the keyway.
- Suitably sized slip gauges to measure the width of the keyway.
- A suitably sized micrometer and parallel rollers to measure the depth of the keyway.

When making a key, the following rules must be applied to ensure that the key will be adequate for the purpose.

(a) The Key MUST be made out of key steel.

(b) For parallel keys:

- The key width MUST be a quarter of the shaft diameter.
- The keyway depth MUST be a sixth of the shaft diameter.
- The minimum key length MUST be one and a half times the shaft diameter.
- The depth of the keyway in both shaft and hub MUST be half the width of the key(Ref RSN 33.75).

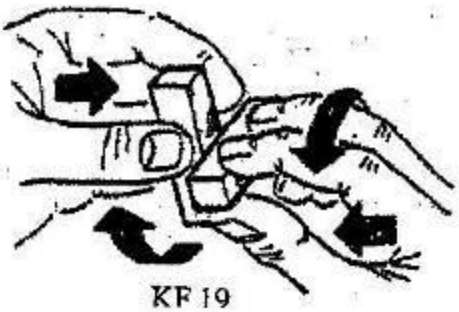
(c) For taper keys the rules in (b) apply. In addition, the taper MUST be 1 in 100 (Ref RSN 33.71)

(d) For woodruff key refer RSN. 33.77.

(A) Preparation before checking the Size of a Keyway

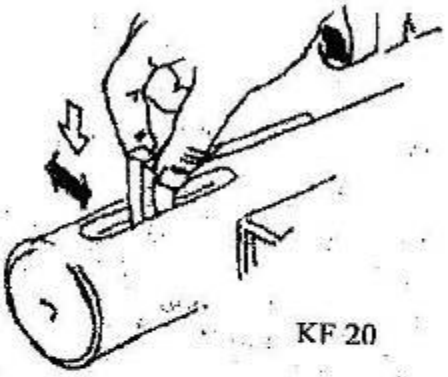
- Examine the selected keyway removing any dirt and burrs.
- Measure the keyway using an engineers rule to obtain approximate length, width and depth. Note down the measurements.
- Select a suitably sized vernier caliper, micrometer and rollers together with a set of slip gauges.

(B) Procedure to Check the Width of a Keyway:



KF 19

- Select two or more slip gauges that when joined will be close to the approximate size
- Clean the slip gauges using a soft cloth
- Join the slip gauges with a slight rotary motion. The gauges should stick firmly to each other. This process is called wringing.
- Try the wringed gauges in the keyway. To ensure the correct measurement the gauges should be a push fit for the complete depth of the keyway.
- Use different gauges until the correct push fit is obtained.
- When the correct push fit is obtained note down the size of the individual gauges that are wringed together.

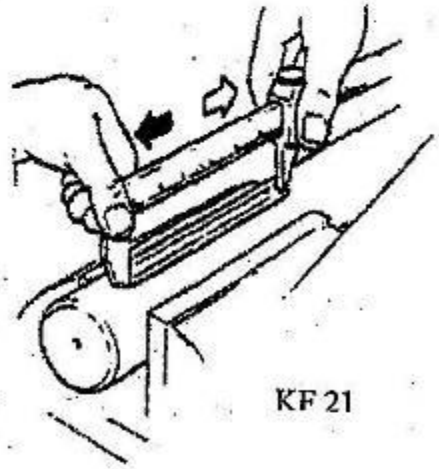


KF 20

- The final accurate width is determined by adding the individual gauge sizes together.
- Note down this width.

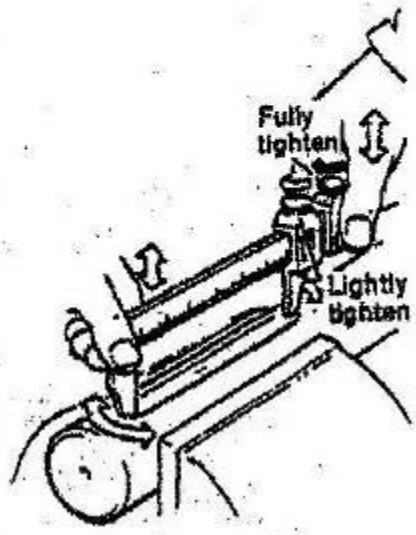
(C) Procedure to Check the Length of a Keyway

- Select a suitable sized vernier caliper.
- Note down the combined dimension of the caliper points and call it "X". (This dimension must be added to the reading on the vernier scale to account for the space taken up by the caliper points).



KF 21

- Hold the fixed jaw of the vernier with one hand and the sliding jaw in the other hand.
- Place the caliper point of the fixed jaw to one end of the keyway and move the sliding jaw along until it touches the opposite point at the other end of the keyway.
- Tighten the locking screw (directly above the fine adjustment screw). Also tighten the locking screw on the sliding jaw just enough to allow freedom of movement for fine adjustment to take place.
- Turn the fine adjustment screw at the same time moving the vernier up and down until a smooth sliding fit is obtained.
- Apply a slight rotary movement to the vernier to make sure that the jaws are fully extended and reading across the apex points at the end of the keyway.



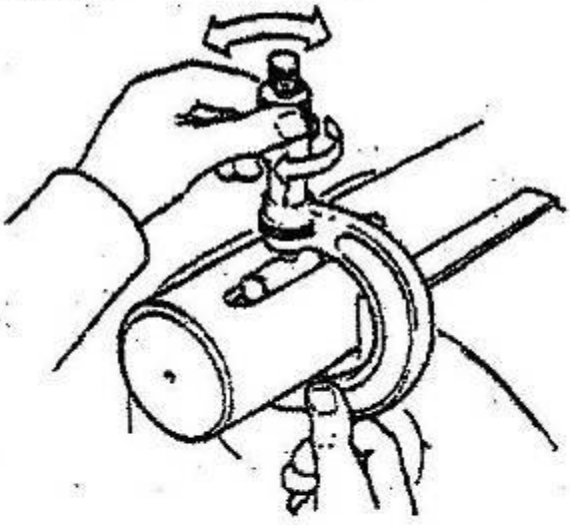
KF 22

- Lock the sliding jaw and remove the vernier from the keyway.
- Take the reading and call it "Y".
- To calculate the keyway length, add the combined dimension of the caliper points "X" to the vernier reading "Y". The resultant is the accurate length of the keyway.

Note down this accurate length.

(D) Procedure to Check the Depth of a Keyway

- Select a suitable sized micrometer and roller gauges.
- Adjust the micrometer to measure the shaft diameter. Note down the measurement and call it "A".
- Select a roller having a diameter of less than the keyway width and a length less than the keyway length. Note down the roller diameter and call it "B".
- Place the roller lengthways into the keyway.


KF 23

- Adjust the micrometer, to measure the distance over the shaft and roller. Note down the measurement and call it "C".

- To calculate the keyway depth:
  i. Subtract "B" from "C" and call the answer "D".
  ii. Subtract answer "D" from "A". The answer is the accurate keyway depth. Note down this depth.

(E) Cross Checking

- To carry out a simple cross check compare the accurate width, length and depth with the approximate figures measured with the engineers rule. If there is a large difference check all measurements again.

PART:4–KEY FITTING

SAFETY NOTE

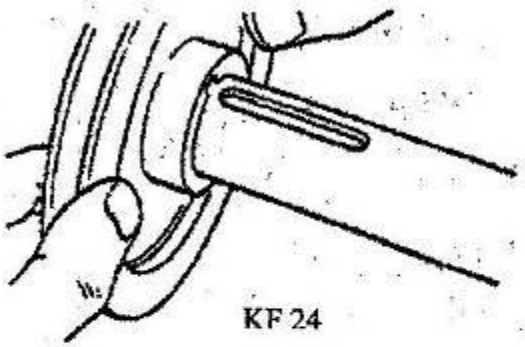
Before carrying out work on any key, the drive must be isolated and locked off electrically and mechanically and a Permit to Work must be obtained from a responsible person.

Considerable force is sometimes necessary to remove a tight fitting key. When it does move, it can travel over quite a distance and inflict damage relative to the force applied to move it. Care must always be taken to ensure the safety not only of the personnel engaged on the removal but also any other personnel working in the vicinity.

(A) Parallel Key:

The procedure for fitting a Parallel key is :

a. Select a parallel key of the required size and length.
b. Inspect and clean the shaft, hub, and keyways and at the same time, remove any burrs.
c. Try the hub on the shaft and check that the keyways are the same size and can be aligned correctly.
d. Try the key against the shaft keyway. If the key is much too wide, remove the excess by filing. If the key is only slightly too wide, continue to the next step.



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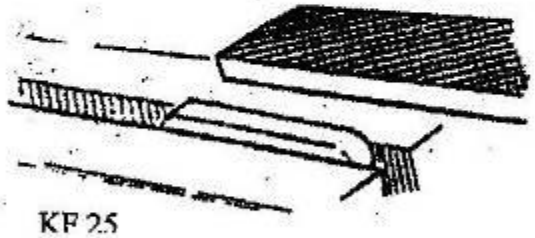
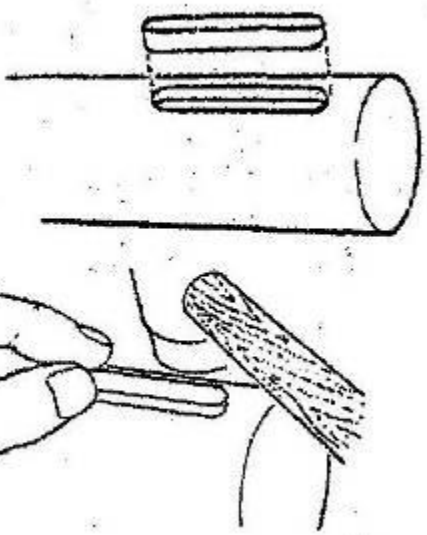


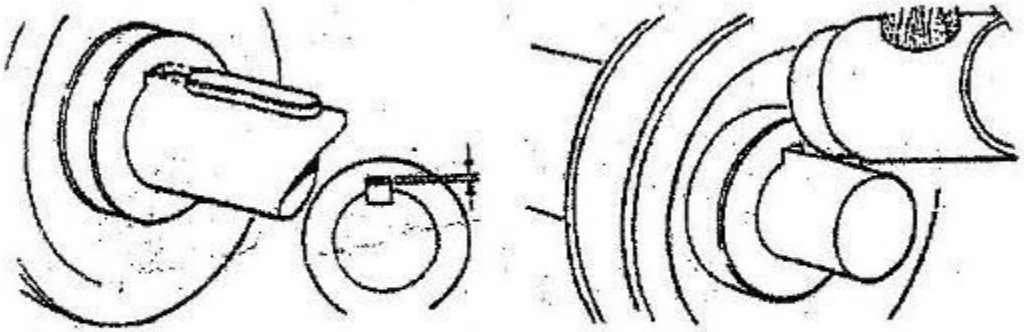
KF 25

e. Apply lubricating oil mixed with marking compound to the key.
f. Using a soft mallet, tap the key in the keyway.
g. Remove the key and note any high spots.
h. Remove the high spots with a file or scraper.
i. Repeat steps e, f, g and h until the key is touching all over and can be driven home by a sharp blow of the mallet.
j. Position the hub and check the clearance between the top of the key and the hub keyway. If necessary file the top of the key down to give the required clearance.



KF 26

k. Try the hub over the key. It should be a light drive fit. Remove high spots with a scraper.
l. Fit the hub to its final position using a mallet to drive it home.

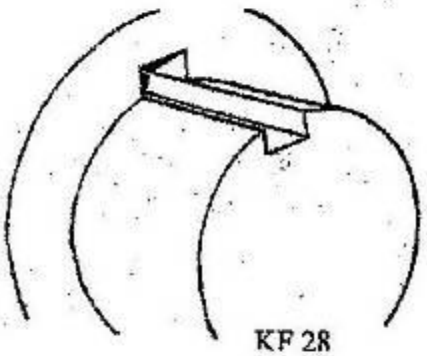


KF 27

(B) Taper keys

To fit a taper key:-

(a) Select a taper key of the required size and length.
(b) Inspect and clean the shaft, hub, and keyways and at the same time remove any burrs.
(c) Try the hub on the shaft and check that the keyways are the same size and can be aligned correctly.
(d) Try the key against shaft keyway.
(e) If the key is much too wide, remove the excess by filing. If the key is only slightly too wide, continue to the next step.



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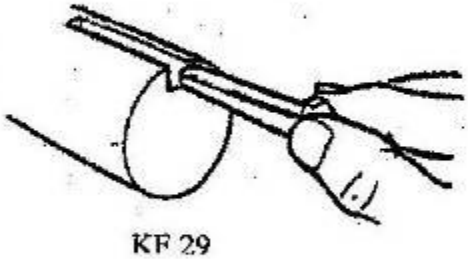
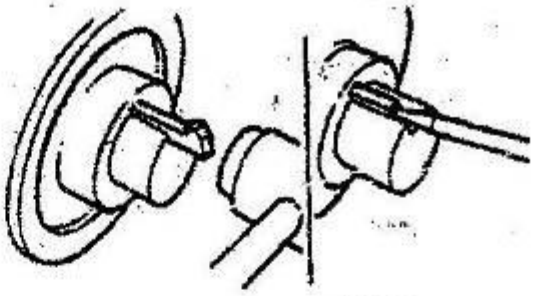


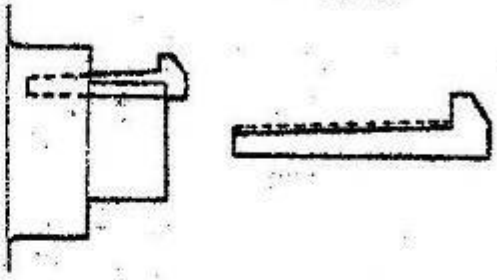
KF 29

(f) Apply lubricating oil mixed with marking compound to the key.
(g) Using a soft mallet, tap the key into the keyway.
(h) Remove the key and note any high spots.
(i) Remove the high spots with a file or scraper.
(j) Repeat steps e, f, g and h until the key is touching all over and can be driven home by sharp blow of the mallet.
(k) Place the hub in the correct position on the shaft, insert the key and gently tap it home until it locks the hub in position.



KF 30

(l) If the key does not enter as far as required, file down the back of the key evenly so that the taper is not altered.
(m) Repeat steps (i) and (k) until the key will almost enter far enough and then drive it home firmly.
(n) Finally, check that the hub is still correctly positioned on the shaft.

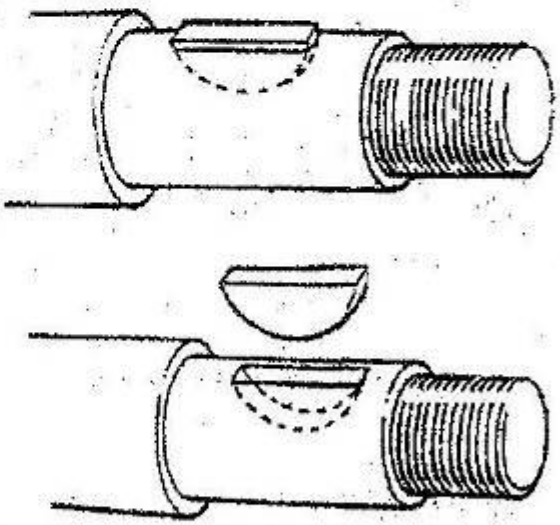


(C) Woodruff Keys

To fit a woodruff key;
(a) Select a key of the required size.
(b) Inspect and clean the shaft, hub and keyways and at the same time remove any burrs.

(c) Fit the key into the shaft keyway ensuring that the top of the key is parallel to the edge of the keyway.

(d) Fit the hub over the key and tighten the locknut or other fixing device.
(e) Check that the hub is correctly positioned on the shaft.

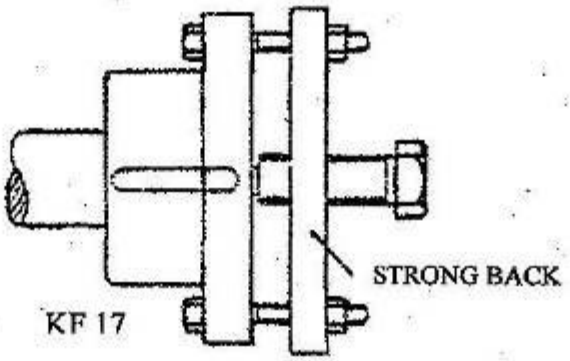
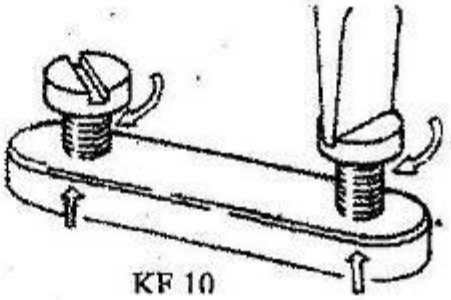


KF 31

EXERCISE-1

EXTRACTION USING JACKING SCREWS

NOTE - Jacking screws are normally used to remove parallel keys from closed keyways after the hub has been withdrawn.

Step 1	➢ Check that the key is parallel and that the shaft end is free of burrs.
Step 2	➢ Withdraw the hub using a strong back as outlined in section (a) or other appropriate method.
	 KF 17
Step 3	➢ If the parallel key already has jacking screw holes obtain the appropriate screws and screw them down until resistance to the turning movement is felt.
Step 4	➢ Tighten each screw a half turn alternately so that the key is withdrawn evenly in a con trolled manner.
	 KF 10
Step 5	➢ If the key does not already have jacking screw holes then they can be carefully drilled and tapped taking care to ensure that drilling too deeply does not damage the shaft.

TOLERANCE VALUES IN MICRONS

(Extracted from RSN 50.03.01.06)

Range of nominal dimensions in mm.	Bore	Shaft					Bore	Shaft			
	H8	f7	e8	f8	h8	h9	H11	d10	d11	e11	h11
Over 3	+18	-10	-20	-10	0	0	+75	-30	-270	-70	0
Upto 6	0	-22	-38	-28	-18	-30	0	-78	-345	-145	-75
Over 6	+22	-13	-25	-13	0	0	+90	-40	-280	-80	0
Upto 10	0	-28	-47	-35	-22	-36	0	-98	-370	-170	-90
Over 10	+27	-16	-32	-16	0	0	+110	-5Q	-290	-95	0
Upto 18	0	-34	-59	-43	-27	-43	0	-120	-400	-205	-110
Over 18	+33	-20	-40	-20	0	0	+130	-65	-300	-110	0
Upto 30	0	-41	-73	-53	-33	-52	0	-149	430	-240	-130
Over 30	+39	-25	-50	-25	0	0	+160	-80	-310	420	0
Upto 40	0	-50	-89	-64	-39	-62	0	-180	-470	-280	-160
Over 40	+39	-25	-50	-25	0	0	+160	-80	-320	-130	0
Upto 50	0	-50	-89	-64	-39	-62	0	-180	-480	-290	-160
Over 50	+46	-30	-60	-30	0	0	+190	-100	-340	-140	0
Upto 65	0	-60	-106	-76	-46	-74	0	-220	-530	-330	-190
Over 65	+46	-30	-60	-30	0	0	+190	-100	-360	-150	0
Upto 80	0	-60	-106	-76	-46	-74	0	-220	-550	-340	-190
Over 80	+54	-36	-72	-36	0	0	+220	-120	-380	-170	0
Upto 100	0	-71	-126	-90	-54	-87	0	-260	-600	-390	-220
Over 100	+54	-36	-72	-36	0	0	+220	-120	-410	-180	0
Upto 120	0	-71	126	-90	-54	-87	0	-260	-630	-400	-220
Over 120	+63	-43	-85	-43	0	0	+250	-145	-460	-200	0
Upto 140	0	-83	-148	-106	-63	-100	0	-305	-710	-450	-250
Over 140	+63	-43	-85	-43	0	0	+250	-145	-520	-210	0
Upto 160	0	-83	-148	-106	-63	-100	0	-305	-770	-460	-250
Over 160	+63	-43	-85	-43	0	0	+250	-145	-580	-230	0
Upto 180	0	-83	-148	-106	-63	-100	0	-305	-830	-480	-250
Over 180	+72	-50	-100	-50	0	0	+290	-170	-660	-240	0
Upto 200	0	-96	-172	-122	-72	-115	0	-355	-950	-530	290
Over 200	+72	-50	-100	-50	0	0	+290	-170	-740	-260	0
Upto 225	0	-96	-172	-122	-72	-115	0	-355	-1030	-550	-290

TOLERANCE VALUES IN MICRONS (Extracted from RSN 50.03.01.06)									
Range of nominal dimension in mm	BORE	SHAFT							
	H7	g6	h6	j6	k6	m6	n6	p6	r6
1 To 3	+10	-2	0	+4	+6	+8	+10	+12	+16
	0	-8	-6	-2	0	+2	+4	+6	+10
Over 3	+12	-4	0	+6	+9	+12	+16	+20	+23
Upto 6	0	-12	-8	-2	+1	+4	+8	+12	+15
Over 6	+15	-5	0	+7	+10	+15	+19	+24	+28
Upto 10	0	-14	-9	-2	+1	+6	+10	+15	+19
Over 10	+15	-6	0	+8	+12	+18	+23	+29	+34
Upto 18	0	-18	-11	-3	+1	+7	+12	+18	+23
Over 18	+21	-7	0	+9	+15	+21	+28	+35	+41
Upto 30	0	-20	-13	-4	+2	+8	+15	+22	+28
Over 30	+25	-9	0	+11	+18	+25	+33	+42	+50
Upto 40	0	-25	-16	-5	+2	+9	+17	+25	+34
Over 40	+25	-9	0	+11	+18	+25	+33	+42	+50
Upto 50	0	-25	-16	-5	+2	+9	+17	+25	+34
Over 50	+30	-10	0	+12	+21	+30	+39	+51	+60
Upto 65	0	-29	-19	-7	+2	+11	+20	+32	+41
Over 65	+30	-10	0	+12	+21	+30	+39	+51	+62
Upto 80	0	-29	-19	-7	+2	+11	+20	+32	+43
Over 80	+35	-12	0	+13	+25	+35	+45	+59	+73
Upto 100	0	-34	-22	-9	+3	+13	+23	+37	+51
Over 100	+35	-12	0	+13	+25	+35	+45	+68	+76
Upto 120	0	-34	-22	-9	+3	+13	+23	+43	+54
Over 120	+40	-14	0	+14	+28	+40	+52	+68	+88
Upto 140	0	-39	-25	-11	+3	+15	+27	+43	+63
Over 140	+40	-14	0	+14	+28	+40	+52	+68	+90
Upto 160	0	-39	-25	-11	+3	+15	+27	+43	+65
Over 160	+40	-14	0	+14	+28	+40	+52	+68	+93
Upto 180	0	-39	-25	-11	+3	+15	+27	+43	+68
Over 180	+45	-15	0	+16	+33	+45	+60	+79	+106
Upto 200	0	-44	-29	-13	+4	+17	+31	+50	+77
Over 200	+45	-15	0	+16	+33	+45	+60	+79	+109
Upto 225	0	-44	-29	-13	+4	+17	+31	+50	+80

FITS FUNDAMENTALS AND EXAMPLES		RSN 50.03 01.04 Sheet 4 of 5	
Fit types	Examples	Tolerance zones	
		Bore	Shaft
Shrink fit	Wheel sets, types, couplings under certain conditions.	H8	x8/u8
Press fit	Gear Wheels, couplings, braking discs on last braking discs on last running shaft (connected by feather key), bearing bushes (on part) and bushes in housings and wheel hubs. Valve seats.	H7	r6
Light press fit	Ball on handles, levers to spindles, bearing bushes in housing, wheels and shafts assembly for easy dismantling (with leather key).	H7	n6
Force fit	Gear wheels Belt pulleys | 51- 500 mm bore dia couplings Coupling bolts over 50mm dia, non-ferrous worm wheels, tyre on wheel, fitting pins with round head.	H7	m6
Push fit	Gear wheels Belt pulleys | 10 - 50 mm bore dia. Couplings Coupling bolts upto 50 mm dia, Fitting screws (shaft dia).	H7	k6
Easy push fit	Easily assembled discs pulleys, wheels etc. (fastening by taper key, revolutions not too high, because of eccentric seat, e.g. n. max. 200 r.p.m.) fastening flanges for motors. Set collars.	H7 H8	j6 j8
Sliding fit	Easily removed central parts, for instance of bearing covers fastenings of gear wheels, couplings and braking discs on smooth shafts (in this case connections by taper key therefore low rotational speed), fits for sliding flat parts instance connecting links and slide blocks.	H7	h6
Running fit	Multi-spline shafts, (basic dia) Sleeve bearings with high revolutions, also possible: Sleeve bearings with medium revolutions, ring-lubricating bearings, grease - lubricating bearings of wheel boxes gear- wheel sliding on shaft, coupling flanges sliding on shaft, bolt on linkage (machine or hand-operated, here perhaps H8 0.2 mm) fits for sliding flat parts e.g. sliding-blocks, connecting pins (tapered) Sleeve bearings with low revolutions, plastic material bearings.	H7 H7 H7 H8 H8	g6 f7 e8 e8 d9
Special cases	Oil Seals (Simmering) with metal housing (fit in housing contact surface on shaft) rivets with smooth ends, multi-spline shafts (dia of spline).	H8	h11

FEATHER KEYS & KEY WAYS

(Extracted from RSN 33.75)

For more information refer the original RSN chart

TYPE-A ROUND ENDED 1) 2) TYPE-B SQUARE ENDED 1) 2)

Feather Key		Width (b)	2	3	4	5	6	8	10	12	14	16
		Height (h)	2	3	4	5	6	7	8	8	9	10
For shaft diameter (d1)		Over	6	8	10	12	17	22	30	38	44	50
		To	8	10	12	17	22	30	38	44	50	58
Shaf t key way	width	Tight fit (P 9) / Sliding fit (N 9)	2	3	4	5	6	8	10	12	14	16
	depth	With back clearance Perm. Ver.	1.2	1.8	2.5	3	3.5	4	5	5	5.5	6
			+0.1					+0.2				
Hub key way	width	Tight fit (P 9) / Sliding fit (N 9)	2	3	4	5	6	8	10	12	14	16
	depth	With back clearance perm. Ver.	1	1.4	1.8	2.3	2.8	3.3	3.3	3.3	3.8	4.3
			+0.1					+0.2				
		With over size Perm. Ver.	0.5	0.9	1.2	1.7	2.2	2.4	2.4	2.4	2.9	3.4
			+0.1					+0.2				

Page 18 of 38

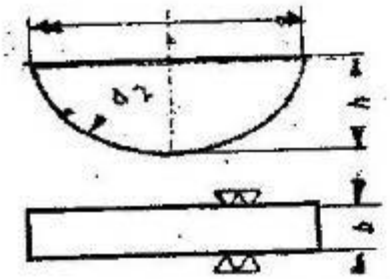
Feather Key		Width (b)	18	20	22	25	28	32	36	40	45	50
		Height (h)	11	12	14	14	16	18	20	22	25	28
shaft diameter (d1)		Over	58	65	75	85	95	110	130	150	170	200
		To	65	75	85	95	110	130	150	170	200	230
Shaft key way	width	Tight fit (P 9)	18	20	22	25	28	32	36	40	45	50
		Sliding fit (N 9)										
	depth	With back clearance Perm. Ver.	7	7.5	9	9	10	11	12	13	15	17
			+0.2						+0.3			
Hub key way	width	Tight fit (P 9)	18	20	22	25	28	32	36	40	45	50
		Sliding fit (N 9)										
	depth	With back clearance perm. Ver.	4.4	4.9	5.4	5.4	6.4	7.4	8.4	9.4	10.4	11.4
			+0.2						+0.3			
		With over size	3.4	3.9	4.4	4.4	5.4	6.4	7.1	8.1	9.1	10.1
		Perm. Ver.	+0.2						+0.3			

WOODRUFF KEYS & KEY WAYS

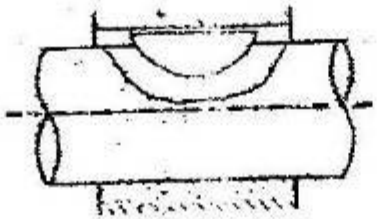
(Extracted from RSN 33.77)

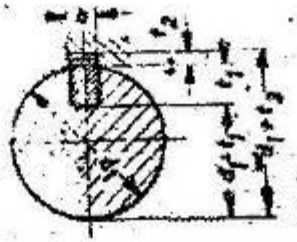
For more information refer the original RSN chart

Woodruff keys	RSN 33.77



Designation of a woodruff key of width b = 4 mm and height h = 5 mm
Woodruff key 4 X 5 RSN 33.77



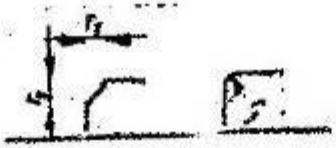


R at bottom of keyway in shaft and hub

Breaking of corners

(all – round)

Chamfering / readjusting of manufacturer's choice



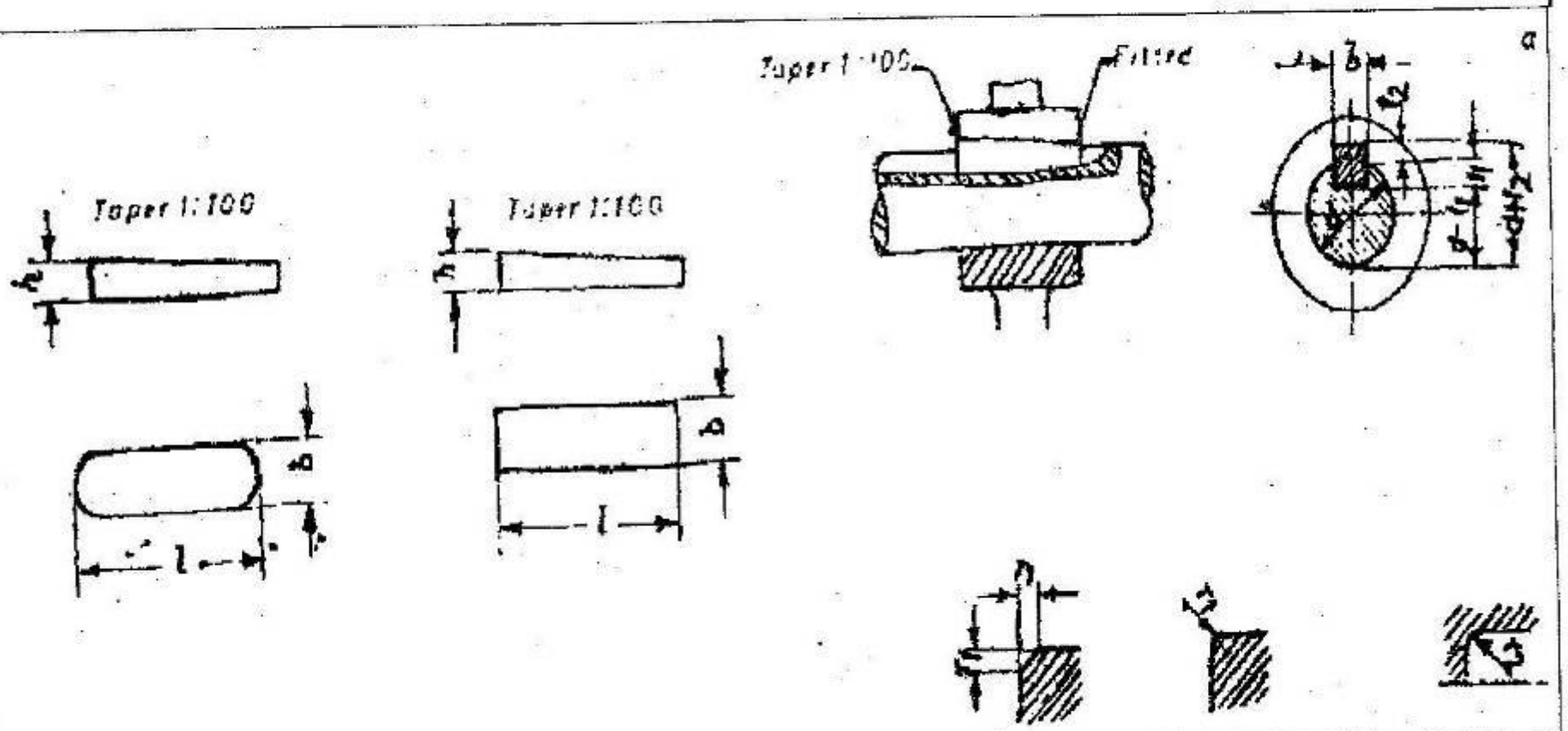
WOODRUFF KEY

Woodruff key			width	4			5			6				8			10		
			height	5	6.5	7.5	6.5	7.5	9	7.5	9	10	11	9	11	13	11	13	16
Allocation	I	For shaft dia	Above	10		-	12		-	17			-	22		-	30		-
			Up to	12		-	17		-	22			-	30		-	38		-
	II		Above	17			22			30				38			-		
			Up to	22			30			38				-					
Diameter of key			D2	13	16	19	16	19	22	19	22	25	28	22	28	32	28	32	45
			Per.var.	-0.1			-0.1			-0.1		-0.2		-0.1	-0.2		-0.2		
Length (L)				12.65	15.72	18.57	15.72	18.57	21.63	18.57	21.63	24.49	27.35	21.63	27.35	31.43	27.35	31.43	43.08
Shaft	Width	P9 & N9		4			5			6				8			10		
	depth	Series-A		3.5	5	6	4.5	5.5	7	5.1	6.6	7.6	8.6	6.2	8.2	10.2	7.8	9.8	12.8
		Series-B		4.1	5.6	6.6	5.4	6.2	7.9	6	7.5	8.5	9.5	7.5	9.5	11.5	9.1	11.1	14.1
		Perm.var. A&B		+0.1			+0.1		+02	+0.1		+0.2		+0.2			+0.2		
Hub	Width	P9 & N9		4			5			6				8			10		
	Depth	Series –A		1.7			2.2			2.6				3			3.4		
		Series-B		1.1			1.3			1.7				1.7			2.1		
		Perm.var.A& B		+0.1			+0.1			+0.1				+0.1			+0.1		

TAPER KEYS & KEY WAYS

(Extracted from RSN 33.71)

For more information refer the original RSN chart



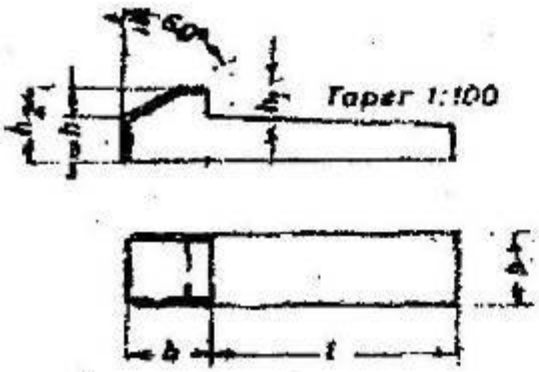
Taper key	Width (b)	2	3	4	5	6	8	10	12	14	16	18	20
	Height h)	2	3	4	5	6	7	8	8	9	10	11	12
Shaft diameter (d1)	Over	6	8	10	12	17	22	30	38	44	50	58	65
	To	8	10	12	17	22	30	38	44	50	58	65	75
key way width (b),tol:D10		2	3	4	5	6	8	10	12	14	16	18	20
Shaft key way depth (t1) Perm. Ver.		1.2	1.8	2.5	3	3.5	4	5	5	5.5	6	7	7.5
		+0.1					+0.2						
Hub key way depth (t2) Perm. Ver.		0.5	0.9	1.2	1.7	2.2	2.4	2.4	2.4	2.9	3.4	3.4	3.9
		+0.1					+0.2						

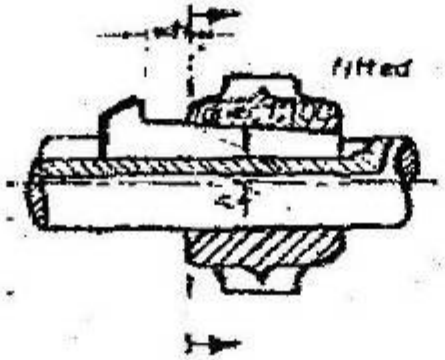
Taper key	Width (b)	22	25	28	32	36	40	45	50	56	63	70
	Height h)	14	14	16	18	20	22	25	28	32	32	36
Shaft diameter (d1)	Over	75	85	95	110	130	150	170	200	230	260	290
	To	85	95	110	130	150	170	200	230	260	290	330
Key way width (b),tol:D10		22	25	28	32	36	40	45	50	56	63	70
Shaft key way depth (t1) Perm. Ver.		9	10	11	12	13	15	17	20	20	22	25
		+0.2			+0.3							
Hub key way depth (t2) Perm. Ver.		4.4	5.4	6.4	7.1	8.1	9.1	10.1	11.1	11.1	13.1	14.1
		+0.2										

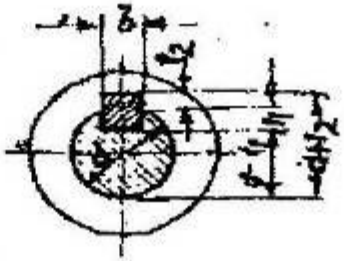
TAPER KEYS WITH GIB HEAD & KEY WAYS

(Extracted from RSN 33.72)

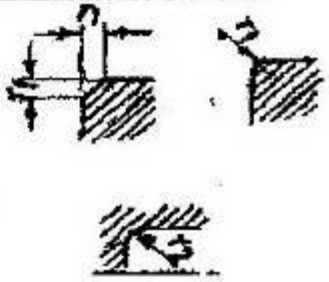
For more information refer the original RSN chart







Champers Radius at manufacture's choice



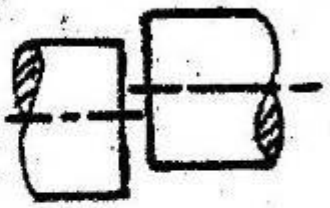
Key width (b) Tol: h 9		4	5	6	8	10	12	14	16	18	20	22	25
Key height (h)		4	5	6	7	8	8	9	10	11	12	14	14
Shaft dia.(d1)	Over	10	12	17	22	30	38	44	50	58	65	75	85
	Up to	12	17	22	30	38	44	50	58	65	75	85	95
Key height (h1)		4.1	5.1	6.1	7.2	8.2	8.2	9.2	10.2	11.2	12.2	14.2	14.2
Perm. Var.		-0.1			-0.2								
Gib height (h2)		7	8	10	11	12	12	14	16	16	20	22	22
Key way width (b) D10		4	5	6	8	10	12	14	16	18	20	22	25
Shaft key way depth (t1)		2.5	3	3.5	4	5	5	5.5	6	7	7.5	9	9
Perm. Var.		+0.1			+0.2								
Hub key way depth (t2)		1.2	1.7	2.2	2.4	2.4	2.4	2.9	3.4	3.4	3.9	4.4	4.4
Perm. Var.		+0.1			+0.2								

SECTION - II
COUPLINGS

PART 1 - TYPES OF SHAFT MISALIGNMENT

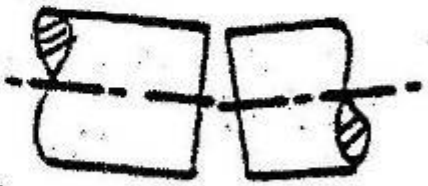
There are three types of shaft misalignment::

Radial - Where the axies of the two shafts to be joined are parallel but offset.



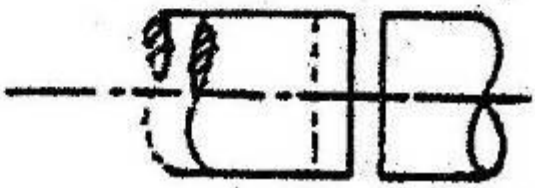
CF 1

Angular- Where the two shafts are at a slight angle to each other.



CF 2

Float - Where there is too much or too little axial movement in one or both shafts.



CF 3

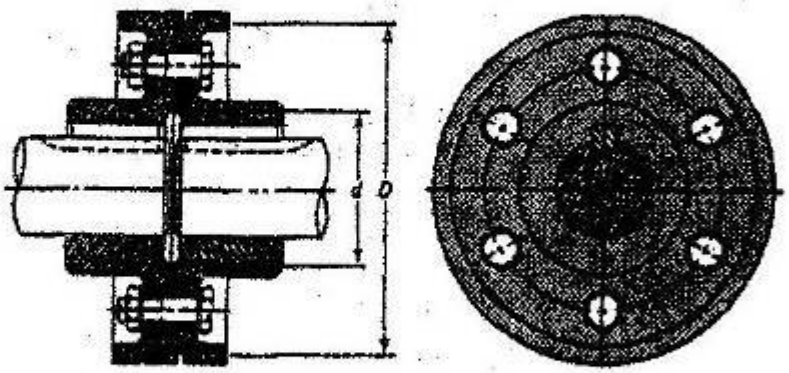
PART 2 - COMMONLY USED TYPES OF COUPLING

(A) Flanged coupling

A flanged coupling is a rigid coupling having (as an additional safety feature) a flange on the outside diameter which prevents the bolt heads from catching on such items as loose clothing should the guard be removed illegally.

The turning movement is transmitted from one shaft to the other by the bolts joining the coupling halves together.

The boltholes are reamed to ensure a close fit so that the driving load is spread equally amongst the bolts.



CF 4

The coupling size is usually determined by measuring the coupling hub, which should be at least 1.75 times the shaft diameter plus 6mm.

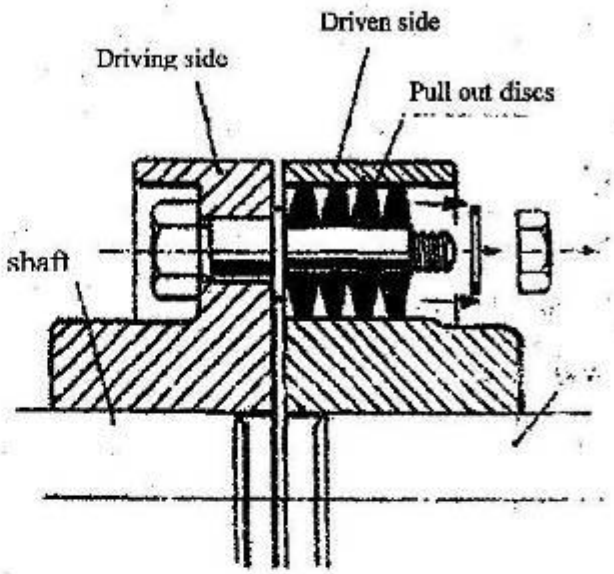
(B) Pin coupling

A pin coupling is a flexible coupling which cope with minor radial and angular misalignment.

The coupling bolts are sheathed with rubber discs, which in turn fit snuggly into the coupling boltholes.

The turning movement is transmitted through the coupling bolts. The rubber sheathing absorbs small fluctuations and shock loading in the drive and takes up any minor misalignment.

The coupling size is determined by measuring the coupling hub, which should be at least 1.75 times the shaft diameter plus 6mm.



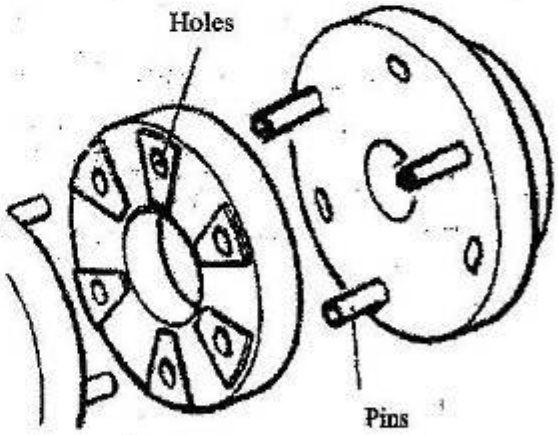
CF 5

(C) Disc coupling

A disc coupling is also a flexible coupling, which copes with minor radial and angular misalignment.

It normally consists of 6 pins (3 on each coupling half) which when bolted in position project from each side into a laminated rubber disc.

The turning movement is transmitted through the pins and the disc absorbs small fluctuations and shock loading in the drive and takes up any minor misalignment.

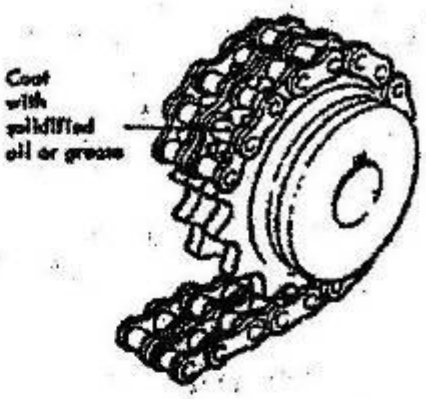


The coupling size is again usually determined by the hub diameter, which should be at least (1.75 x shaft diameter + 6mm.)

(D) Chain coupling

A chain coupling is a flexible coupling, which will accommodate misalignment up to 5 degrees.

It consists of a chain wheel sprocket cut onto each half coupling flange end, which are then joined together by a double roller chain, which just encircles the cut teeth.

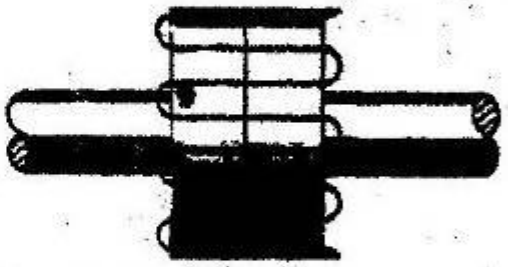


The turning movement is transmitted through the chain, which does not absorb shock loads and also generates some noise. It has an advantage that removing just one pin from the chain can quickly disconnect the coupling.

The chain must be grease lubricated to the manufacturer's specification and must be covered.

(E) Spring couplings (also known as Bibby couplings)

These are flexible couplings in a number of design variations, which will accommodate minor misalignment and have the common element of a continuous steel strip that weaves through serrations in each half of the coupling.



The turning movement is transmitted through the spring, which also gives sufficient flexibility to cater for minor misalignment.

The spring is normally retained in place by a shroud and can be changed or inspected quickly. The coupling is grease lubricated.

SAFETY NOTE

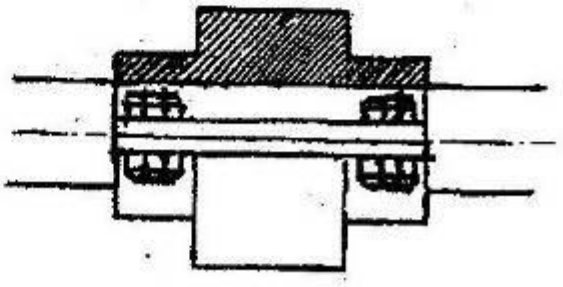
The spring is powerful and care must always be exercised when removing it to ensure that it does not fly off or break.

PART - 3 OTHER TYPES OF COUPLING:

There are a number of other types of coupling and a wide variety of designs of each type. The most common found in a steelworks are:

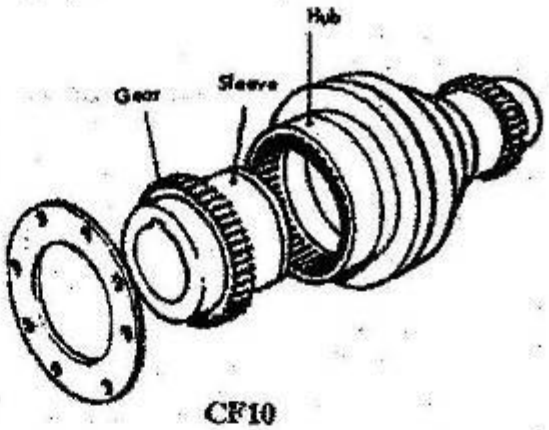
Muff couplings:

A rigid coupling that is simple split in a horizontal rather than vertical plane. The halves are clamped together to grip the ends of both the driver and driven shafts.



Gear couplings:

It is similar in principle to the chain coupling. The turning movement is transmitted through internal and external gears.

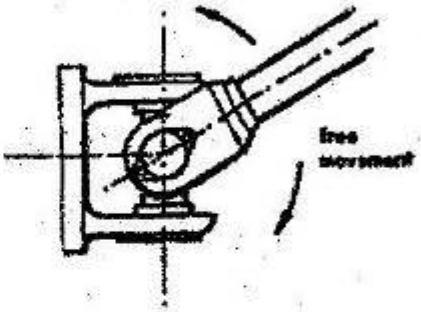


CF10

Universal Joint :

Used for very large angular or offset misalignment between two shafts. The most familiar example is the universal joints on a car transmission shaft.

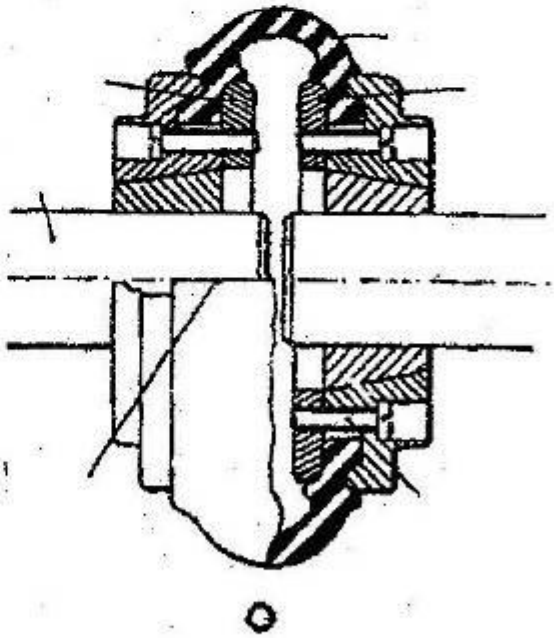
When this type of coupling is fitted with needle roller bearings in a spider, it is sometimes known as a Hooke's joint.



CF11

Tyre couplings:

The half couplings are joined together by a specially made rubber tyre, which transmits the drive and allows a degree of flexibility in alignment.



PART 4 -CAUSES OF WEAR IN COUPLINGS

There are four main causes of wear in couplings. They are:

i. Misalignment
ii. Vibration
iii. Thermal expansion
iv. Lack of lubrication

(A) Misalignment

Any one of the three types of shaft misalignment previously referred to (i.e. radial, angular or float) can occur as a result of the following:

- Incorrect coupling installation
- Loosening of the holding down bolts
- Wear in the bearings or bearing housings
- Mechanical damage to the shaft or equipment

(B) Vibration

Almost all equipment vibrates in use and may transmit its vibrations to other equipment through the drive shaft, bedplate or even the foundations.
Severe vibration will cause stress in both shaft and couplings and may loosen mountings which may then lead to further and increasing wear.

Vibration may be caused by:

- Wear in machine components (bearings, gears and chains)
- Out of balance of either the driving or driven machinery
- Misalignment of shafts or couplings
- Lack of rigidity due to:
  - Loose mountings or foundation bolts
  - Loose machine components (housings, guards, couplings etc.).
  - Loose or missing fastenings (bolts, studs and screws)

(C) Thermal expansion

Many machines generate heat when in use. This heat can be transmitted into the drive shafts. The thermal expansion that results may damage both couplings and bearings.

Thermal expansion may be caused by:

- Lack of end float in the driving or driven shaft
- Overheating of the shafts through rubbing or lack of lubrication (friction)
- Overheating of the motor through overload
- High ambient temperatures

(D) Lubrication

Some types of couplings (for example chain and gear couplings) need lubrication to operate effectively.

- Lubrication failure can occur due to:
- Inadequate routine maintenance
- Using unsuitable lubricants
- Hardening of the lubricant due to heat or age
- Over packing with grease
- Badly fittings seals or missing covers allowing dirt or water to contaminate the lubricant.

PART 5 - FAULT SYMPTOMS

The following symptoms may indicate that a fault has occurred or is developing:

- Excessive noise
- Overheating
- Vibration
- Intermittent operation
- Burning smell

SAFETY NOTE

Vibration and the presence of heat may have to be detected while the machine is running. Before inspecting a running machine:

DO - inform the operational staff
DO - keep well clear of all moving parts
DO - check that the floor is free of oil and grease.
DO NOT - wear any loose clothing
DO NOT - remove the machine guards
DO NOT - try to make any adjustment or remove any bolts

PART 6 - INSPECTING AND WITHDRAWING COUPLINGS

SAFETY NOTE

BEFORE CARRYING OUT WORK ON ANY COUPLING THE DRIVE MUST BE ISOLATED AND LOCKED OFF ELECTRICALLY AND MECHANICALLY AND A PERMIT TO WORK MUST BE OBTAINED FROM A RESPONSIBLE PERSON.

PROCEDURE

Consult the plant records to determine the type of coupling that is to be inspected and any previous maintenance history. If possible, examine the manufacturer's coupling specification to establish:

- The required clearance between the ends of the shafts
- The required accuracy of shaft alignment

- The orientation of the driver/driven sections of the coupling
- The method and type of any lubrication.

Remove the guards and inspect the coupling as follows:

(a) Hold one shaft and turn the other backwards and forwards by hand. The amount of movement will give some indication of the amount of wear that has taken place in couplings joined by bolts or pins.

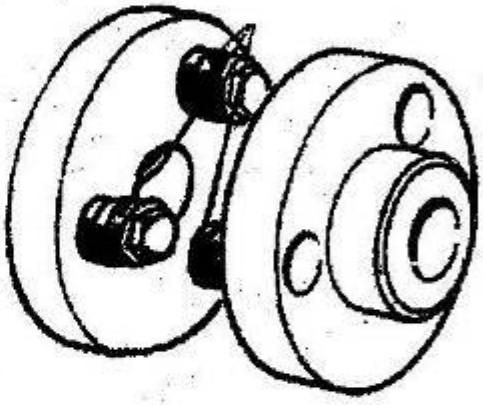
(b) Remove the coupling bolts/holding device and visually inspect: -

For flanged couplings:

- The bolts for signs of wear, metal fatigue, bending and damaged threads.
- The flange for signs of wear.

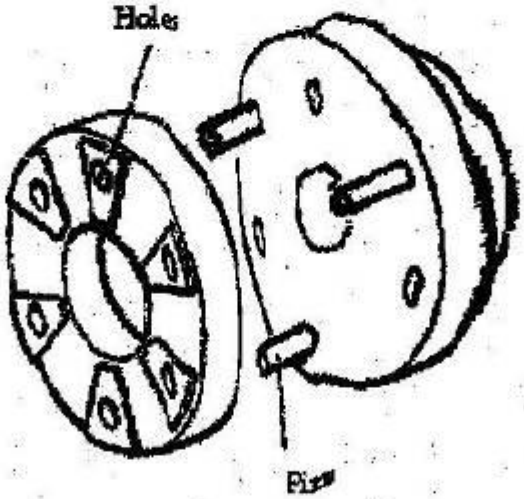
For pin couplings:

- The bolts for signs of wear, metal fatigue, bending and damaged threads.
- The rubber discs for signs of wear, cracking or deformation



For disc coupling:

- The pins for signs of wear, bending and damaged threads.
- The discs for elongation or enlargement of the holes.

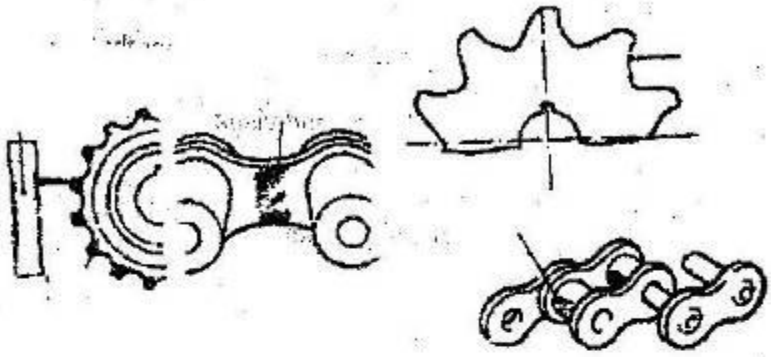


For spring couplings:

- The spring for signs of wear, distortion and metal fatigue
- The coupling serrations for signs of wear.

For chain couplings:

- The chain for signs of wear on the link plates, rollers and chain pins.
- The chain wheels for signs of wear on the sides and profile of the teeth.



(c) Lift both the driver and driven coupling halves to check for bearing wear. If in doubt double check by using a dial gauge.

(d) Check the end float of both driving and driven shafts using a dial gauge.

(e) Loosen or remove the mounting bolts on the driver only (the driver unit is normally an electric motor and can be moved more readily). Check that the supply cable is free and can be moved. Also make sure that any packers are saved. (If due to the inaccessibility of the driven unit, the driven unit is to be moved, make sure that any mechanical connections are disconnected after the appropriate isolations are made).

(f) If a coupling half is to be removed then:

- Withdraw the key using an appropriate key extraction method.
- Withdraw the coupling using a suitable puller.

PART 7 - SELECTING A REPLACEMENT COUPLING

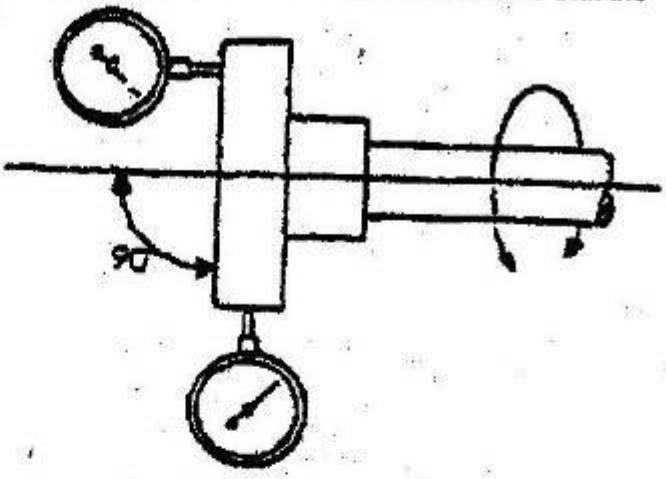
A replacement coupling must be identical in all aspects to the one removed. It should either be from the same manufacturer or be recognised by the manufacturer as a satisfactory substitute. It must be:

- Of the same type
- Having the same internal and external measurements
- Designed to transmit the same power
- Designed to operate over the same speed range
- Able to accept the same amount of misalignment
- Able to accept the same amount of end float

PART 8 - FITTING A COUPLLNG

PROCEDURE

The following procedure assumes that only the driver unit has been removed and that the driven unit is already in place.



(a) Remove any burrs from the ends of the shafts and the keyways.

(b) Place the driver coupling in the correct position on the driver shaft and lightly fit the key.

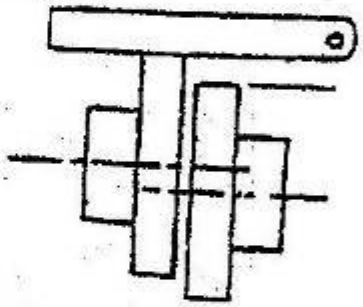
(c) Check the coupling for squareness using two dial indicators arranged as follows:

(d) Adjust as required and then fit the key firmly. Recheck the coupling for squareness.

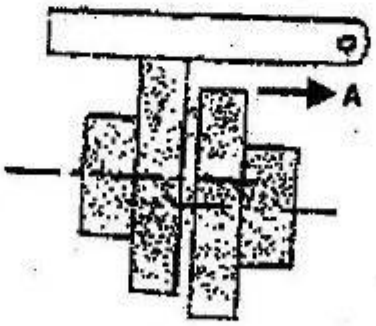
(e) Place the driven coupling in the correct position on the driven shaft and lightly fit the key. Repeat steps (c) and (d).

(f) Position the driver unit to the approximate final position by :

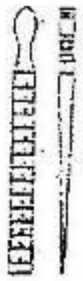
- Packing the mountings until the driver coupling is slightly higher than the driven coupling. Use a spirit level both longitudinally and transversely to ensure that the driver unit is square.
- Checking that the coupling halves are parallel by using a straight edge and feeler gauges.

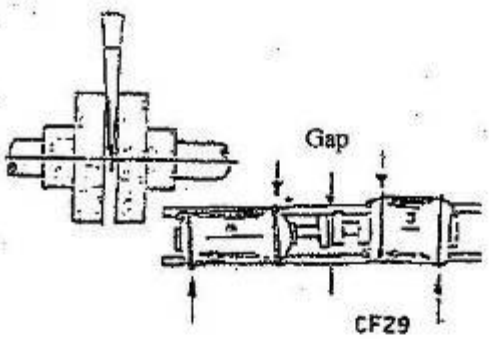


- Checking and adjusting the height of the driver coupling by first measuring the gap "A" and then adding or taking away an equal amount of shim under the driver unit.



- Checking the gap between the two halves of the coupling (i.e. axial movement to allow for float) by using a wedge gauge.





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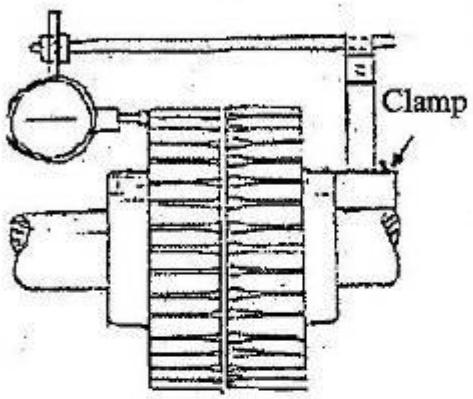
CF19

- Checking the angular alignment by using a dial indicator.
- If necessary more accurate tests of parallelism, end float and height can also be obtained using a dial indicator.



CF20

(g) Tighten down the driver mountings and recheck the alignment.
(h) Fit the coupling bolts, pins, springs or chain (lubricating where necessary)
(i) Fit the shroud, cover and guards as appropriate.

(j) Test run the machine and check for:

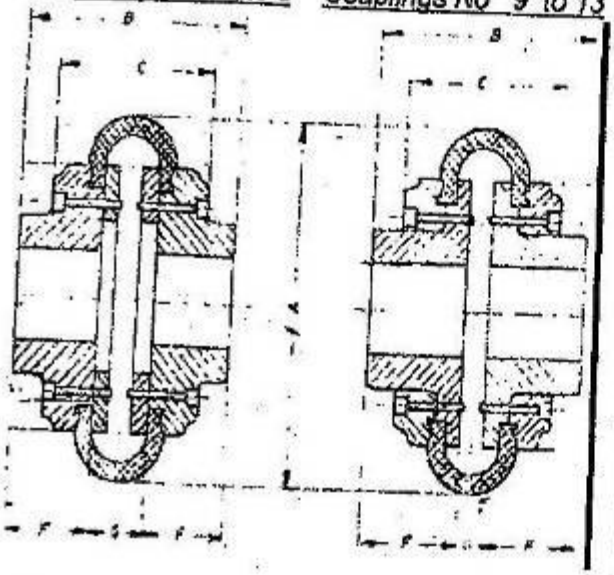
- Excessive vibration
- Excessive noise
- Excessive heat generation
- Electrical overload
- Smooth operation

Tyre Type Flexible Couplings

As per IPSS : 1 – 01 – 004 - 04

Dimension in mm

Couplings -No-2 to 8 Couplings No 9 to 13



In mm

Coup. No	A	B	C min	F	G Gap
2	108	103	52	36	27
3	135	105	56	39	27
4	178	146	83	53	40
5	212	157	83	56	45
8	277	205	132	76	53
9	322	208	108	96	16
10	317	250	125	115	20
11	450	280	155	125	30
12	550	358	224	142	74
13	746	515	228	232	51

Pin and bush type coupling

As per IPSS : 1-01-003-86

All dimension : in mm

Size	D_a	D_3	D_4	L	N	N_1	S
0.06	96	44	50	35	24	18	4:2
0.16	112	62	68	45	24	18	4:2
0.63	160	85	95	60	38	22	4:2
1.4	200	120	128	80	38	22	4:2
2	225	134	144	90	42	28	7:3
4	285	166	176	110	54	35	7:3
8	360	205	210	140	68	44	10:4
11	400	218	230	160	80	52	10:4
16	450	240	260	180	80	52	10:4
22	500	270	290	205	102	62	10

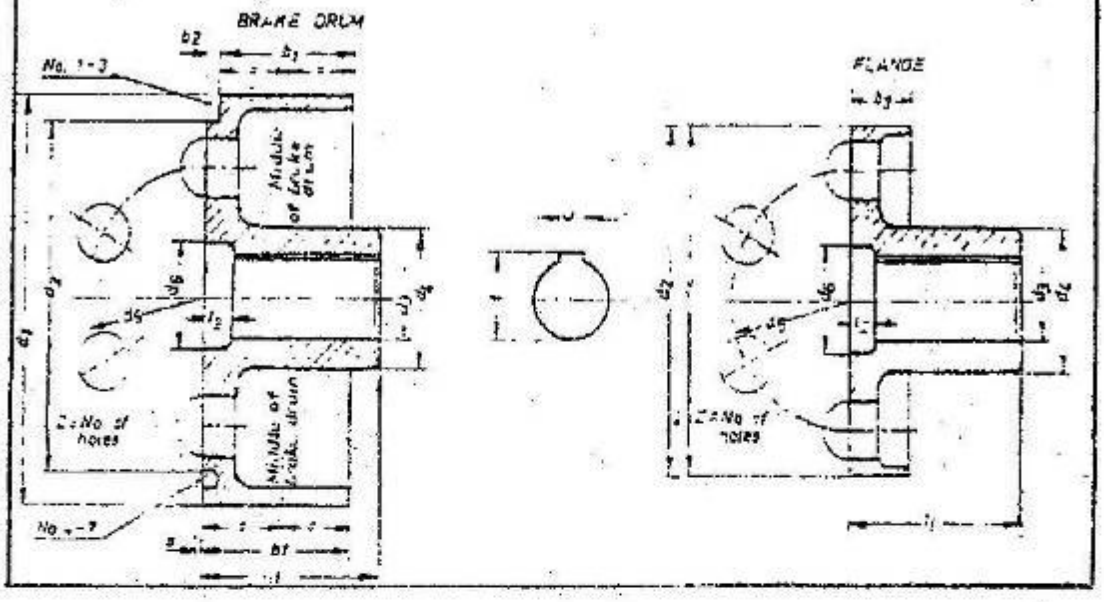
Designation of a pin and bush type coupling
HP/100 RPM ratio = 14
Pin and bush type coupling,
size 1.4-RSN 51.14

ELASTIC PIN COUPLINNG

Brake Drum / Flaange

(GEAR BOX SIDE)

RSN 51.11 01.35



Sl. No.	b_1	b_2	b_3	d_1	d_2	Maximum
1	75	10	49	200	180	4
2	95	10	49	250	220	4
3	118	15	56	315	270	5
4	150	–	65	400	335	5
5	190	–	72	500	425	5
6	235	–	81	630	530	7
7	265	–	95	710	600	8

CURVED TOOTH GEARED COUPLING

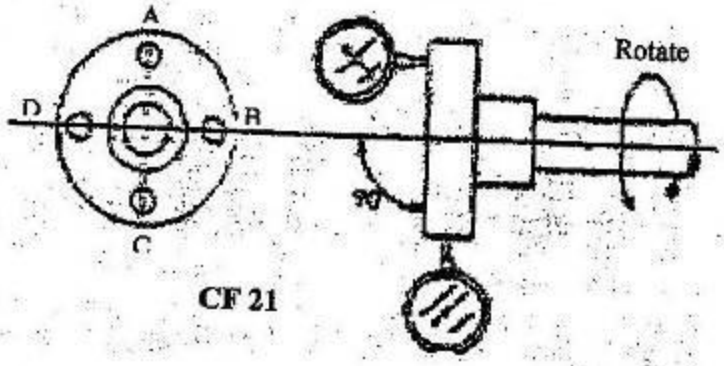
SIZE	D (OD)	C (GAP)	SIZE	D (OD)	C (GAP)
40	160	5	125	355	10
50	183	5	140	410	10
60	215	6	160	460	12
70	230	6	180	505	12
80	255	6	200	570	14
90	290	8	220	610	16
100	300	8	280	785	22
110	330	8	350	960	30

D - O.D is the outer dia. of

PROCEDURE - 1

CHECKING THE SQUARENESS OF THE COUPLING TO THE SHAFT

NOTE:	The coupling halves must be checked individually for squareness.
Step 1	Position the two dial gauges shown making sure that the magnetic bases are clamped to the bedplate or other suitable fixed datum.



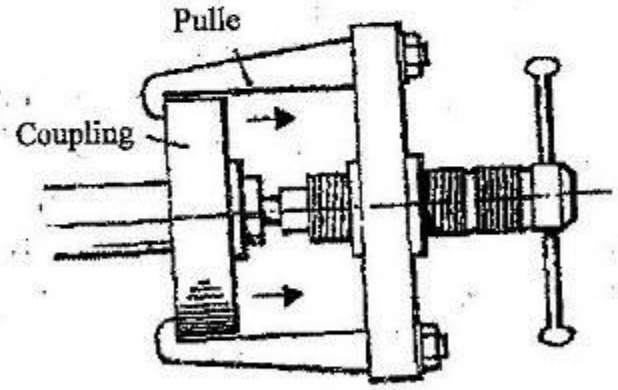
CF 21

Step 2	Set the dial gauges to read zero.
Step 3	Mark the coupling with chalk at four equally spaced positions (at 90 degree intervals) around the shaft calling the points A, B, C and D as in the sketch above.
Step 4	Rotate the shaft by hand through one complete revolution noting any movement of the dial indicators. Record the readings at the four points.
Step 5	If there is no movement, the coupling is correctly mounted. If there is a movement, the problem may be that the; ➢ Coupling is not correctly mounted ➢ Unit is not level on the bedplate ➢ Shaft is moving the horizontal plane due to the normal end float ➢ Shaft is bent ➢ Bearing are worn ➢ Coupling is distorted
Step 6	If the unit is not level or the shaft is moving in the horizontal plane, carry out the necessary adjustments until the readings are satisfactory. Repeat steps (1) to (5) for the other half coupling.

PROCEDURE - 2

FOR WITHDRAWING A COUPLING

Remove the guards and inspect the coupling as follows:

Step 1	Hold one shaft and turn the other backwards and forwards by hand. The amount of wear that has taken place in couplings joined by bolts or pins.
Step 2	Remove the coupling bolts/holding device and visually inspect to establish if they need to be renewed.
Step 3	Lift both the driver and driven coupling halves to check for bearing wear, if in doubt double check by using a dial gauge. If wear is excessive the bearings and housings will need to be repaired or replaced.
Step 4	Measure the end float of both driving and driven shafts using a dial gauge. Clamp the dial gauge to fixed point and move the shaft as far as it will go in one horizontal direction. Set the dial gauge and note down the reading. Move the shaft as far as it will go in the opposite direction and note down the dial gauge reading. The difference in the two readings is the end float. Compare the resultant measurement with the bearing manufacturers float allowance and the coupling gap recommended by the coupling manufacturers. If the readings are greater than the manufacturers recommendations the bearings and housings must be examined and repaired or replaced as necessary.
Step 5	Withdraw the key using an appropriate key extraction method.
Step 6	Withdraw the coupling using one of the following: ➢ Suitable mechanical puller, ensuring that the puller is properly positioned and that the centre point of the shaft is smeared with grease to ease the movement of the jacking screw.  CF ➢ Hydraulic puller, ensuring that the ram is smaller than the internal bore of the coupling. ➢ Bench press. In this case the shaft and coupling will need to be removed from the machine. Lightly mark the shaft where it enters the bearing so that it can be accurately relocated when it is replaced.

SAFETY NOTE:

Before carrying out any checking on site, the driver & driven unit must be isolated & locked off. Electrically & Mechanically & **Permit to work** must be obtained from a responsible persons.

D O' s

1. Start the job after obtaining 'Permit to work' properly.
2. Isolate the machine, both electrically and mechanically if possible.
3. Ensure safety of the personnel engaged on the work.
4. Ensure safety of other people working in the vicinity.
5. Use proper and safe tools.
6. Use correct procedure and steps of work.
7. Keep the work area clean.

DO NOT's

1. Don't jump to work.
2. Don't work on running machine.
3. Never forget your PPE's.
4. Never compromise on safety of workmen.
5. Don't use defective tools.
6. Don't go for short cut.