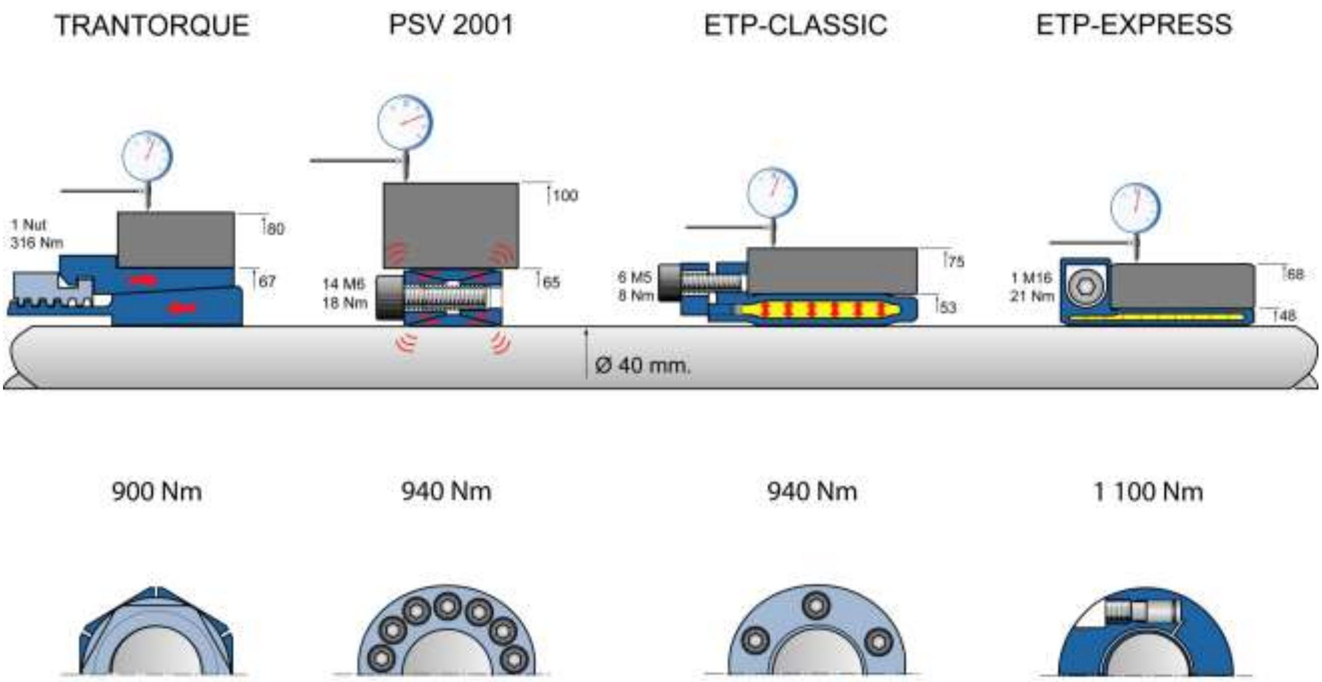
Technical Manual

Hydraulic - Mechanical friction joints



Content

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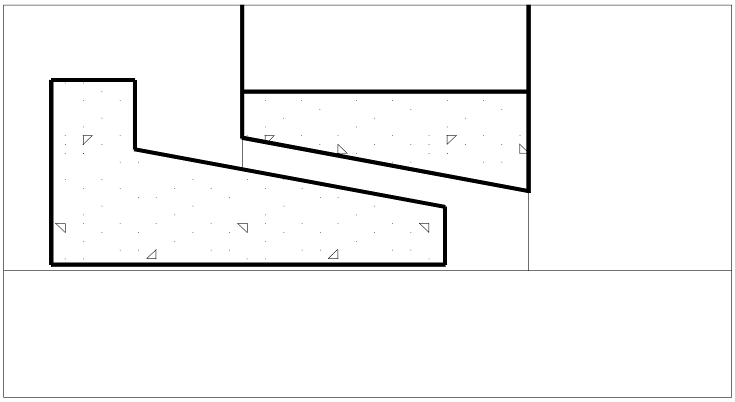
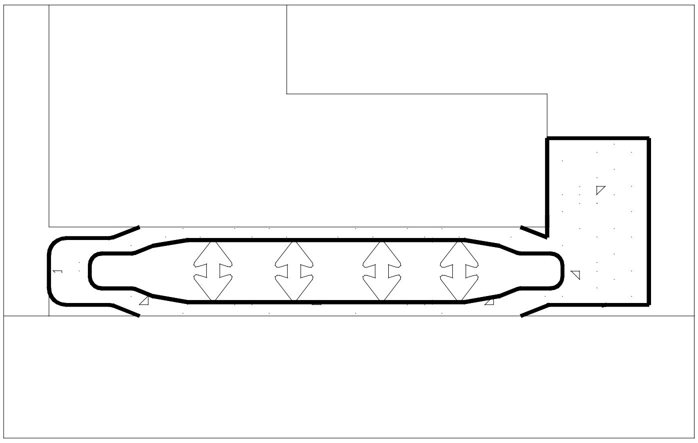
Tapered sleeves



Design: All "mechanical" friction joints consists of basically two sleeves which each has a tapered surface. In rare cases the tapered surface is divided with steps into several surfaces. This is to get a larger friction angle in order to make it easier to dismantle. In most cases the sleeves are partly or completely slotted to make them easier to deform and increase the surface pressure.

Function: The sleeves are pressed against each other along the shaft. To do This, screws or a big nut are used. Because of the surface pressure between the two sleeves they deform into contact with the bore of the hub and the shaft.

The hydraulic principle

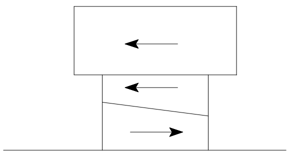


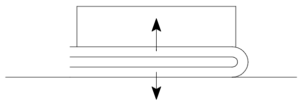
Design: Consists of a double walled sleeve which encloses a pressure Medium, which is practically incompressible. The medium acts as a fluid at high pressure. This means according to "Pascals Principle" that the pressure is the same at every point in the fluid.

Function: Through one or more screws or an external pressure source (pump) the pressure in the medium is increased. The double walled sleeve then deforms elastically and uniformly into contact with the bore of the hub and the shaft.

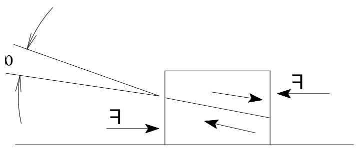
Comparison mechanical/hydraulic principle

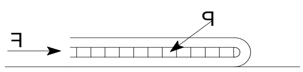
Mounting



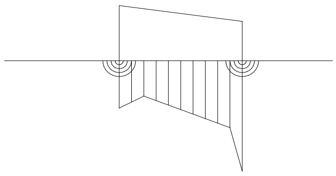


	Mechanical		Hydraulic
-	The rings move axially when mounting, this makes it difficult to position the hub.	+	The sleeve moves only radially,,this makes it easy to position the hub.
-	Small contact surface (length) against shaft and hub requires a higher surface pressure to transmit the same torque.	+	Large contact surface (length) against shaft and hub, means low surface pressure. This together with the small outer diameter gives a thin hub.
+	Can take wider tolerances on shaft/hub especially if the rings are slotted.	-	Can't take so wide tolerances on shaft/hub as the sleeves are not slotted.
+	Can be mounted over shafts with keyways.	-	Not suitable for mounting on shafts with keyways. The keyway has to be filled in.





-	The friction force between the rings has to be overcome, when tightening the screws, this means a high tightening torque and big and many screws are required.	+	No friction forces which reduce the screw force. The force is directly transformed into a surface pressure against shaft and hub. Fast and accurate mounting.



- The surface pressure against shaft and hub increases momentarily, which means high stress concentration factors. This can cause deformation on the surfaces of shaft and hub, with following problems with dismantling and fretting corrosion.

+ The surface pressure increases gradually. No stress concentration. No dismantling problems and no fretting corrosion.

- For most types it is not possible to use hubs of aluminium as they can get deformed.

+ Aluminium hubs can be used for most types.

In operation

- To get resonable concentricity, the screws are to be tightened very even.

+ The hydraulic principle automatically gives a good concentricity.

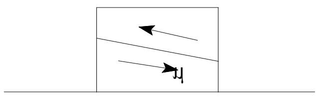
+ The torque capacity is not changed with the temperature.

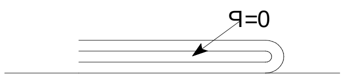
- Not suitable for extreme high/low temperatures.

+ Can take high radial forces.

- Not suitable for extreme high radial forces.

Dismantling





+ When dismantling special dismantling screws or outer force against the hub (the outer ring of the joint) is needed to overcome the friction between the rings. This makes it time consuming to position the joint.

- As soon as the screws are loosened, the pressure in the sleeve disappears, the sleeve goes back to its original measurements (no plastic deformation) and the hub loosens. Easy to adjust.

- If the rings are slotted, there is a risk that fluid gets in between the surfaces and cause corrosion.

+ As there are no slots, the surfaces can't corrode.

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Summary

	Mechanical	Hydraulic
No fretting corrosion		X
No permanent deformation of shaft and hub.		X
OD of hub small		X
Hub material of average quality		X
Easy to dismantle (no extra screws)		X
Good runout, axially and radially		X
Just a few screws, fast to mount		X
Low tightening torque for the screws		X
Good balance – high rpm		X
Can take higher radial loads and bending torque	X	
Not temperature sensitive	X	
Can take rough tolerances	X	
Price competitive		“X”

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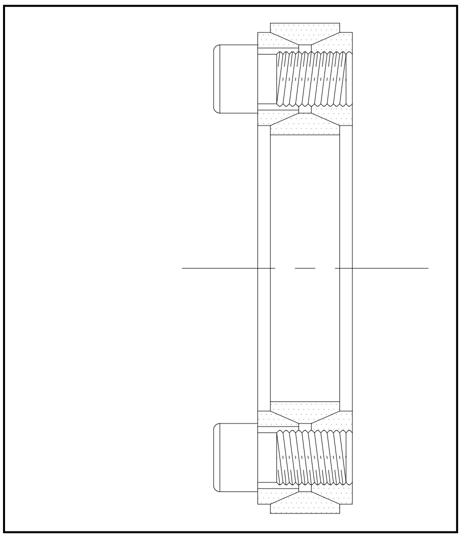
Competitors



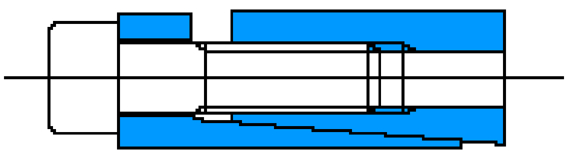
The most common type is the one above. Products with the same design and dimensions are sold by numerous distributors and manufacturers under many different trade marks.There are however quality- as well as - price differences between them although they look alike.

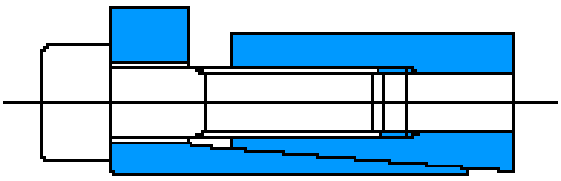
The high surface pressure, the small contact surface (length), the slotted sleeves and the principle by itself causes the following main disadvantages:

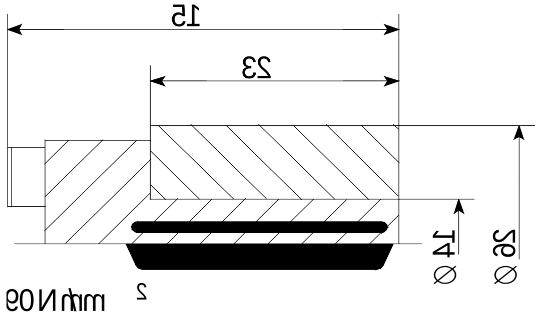
- bad runout both radially and axially
- big outer diameter necessary for the hub
- time consuming and hard to mount, because of the many and big screws, which have to be tightened evenly and according to a certain pattern to minimize the run out.
- dismantling screws necessary
- plastic deformation of hub and shaft surface
- fretting corrosion and corrosion on hub and shaft
- for bigger shaft sizes usually 2 pcs have to be used in order to get an acceptable run out and to transmit the same torque as with an ETP-Product.

The second most common types are shown below in two versions. The only difference between these two is that one has a bigger flange, which prevents the hub from moving along the shaft, when the screws are tightened. This one type then also has some more screws, this to overcome the additional friction force between the bore of the hub and the OD of the sleeve.

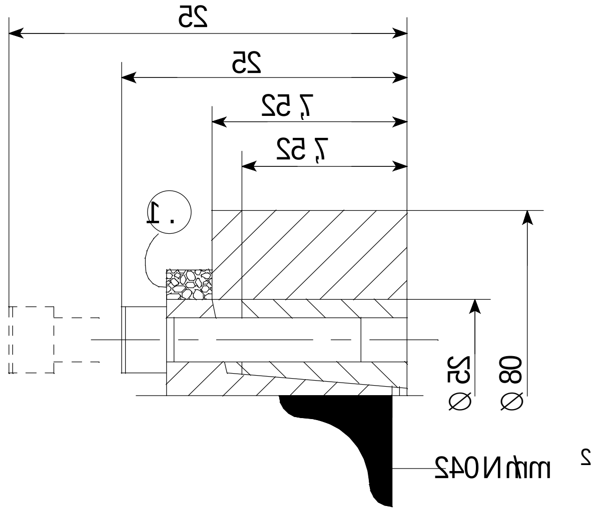
Products with the same dimensions are made by many manufacturers.







ETP-CLASSIC, 30 mm

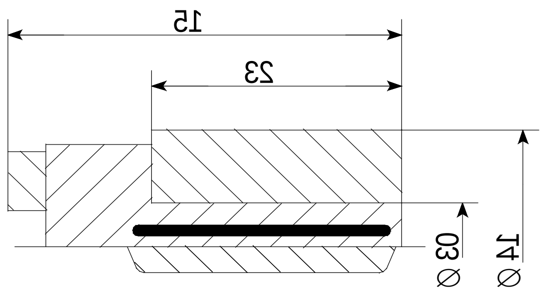


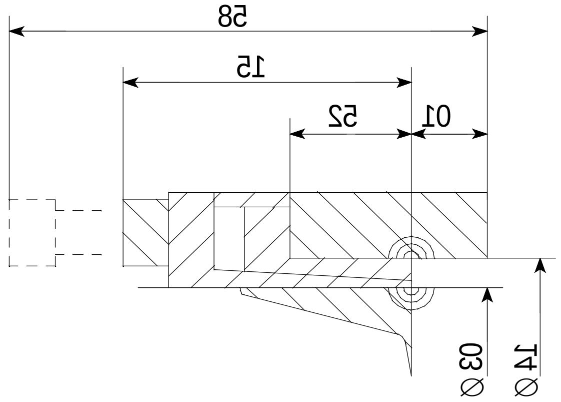
T_{rated} (Nm)	420	530
Surface pressure	90 Mpa	240 Mpa plus stress concentration
Stress concentration	no	yes
Screws	4 M5	5 or 7 M6
T_{tight} (Nm)	8	17
Hub OD	62	80
Clamping length	32	22
Total length	51	52 extra space for the screws
Dismantling screws	no	yes
Shaft tolerance	k6 - h8	h8
Hub bore tolerance	H7	h8
Slotted sleeves	no	yes
TIR (mm)	0,03 mm	approx. 0,1mm

Some manufacturers also have made mechanical products with approx. same dimensions as ETP-CLASSIC.
There are, however, some major disadvantages with these products which are created by the mechanical principle.

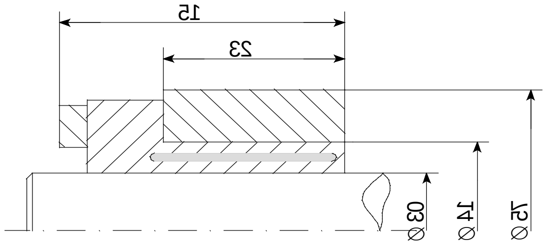
On next page please find a rough comparison.

-	The torque is lower because of the friction force between the tapered sleeves and the ring between the flange and the hub (to prevent axial movement of the hub). If the ring is not used the torque will be about the same as for ETP-CLASSIC.
-	The stress concentration causes fretting corrosion.
-	Harder to mount because of bigger screws.
-	The hub has to protrude 10 mm over the end of the sleeve to withstand the surface pressure without permanent deformation.
-	The "total length" of the mounted unit is longer. To this also extra space has to be added so that the screws can be completely untightened and moved to the dismantling bores and tightened again.
-	Dismantling screws are needed.
-	The slotted sleeves causes unbalance and bad runout.

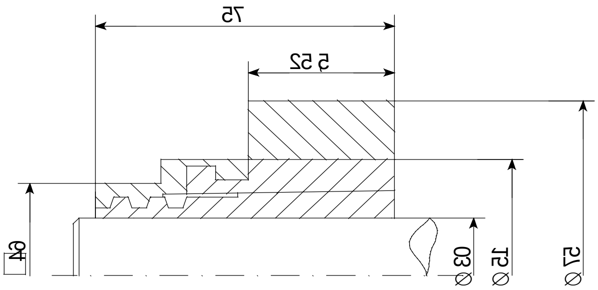




T_{rated} (Nm)	420	340
Surface pressure	even (approx. same)	uneven
Stress concentration from surface pressure	no	yes
Screws	4 M5	4 M6
T_{tight} (Nm)	8	15
Hub OD	same	approx. same but: extra hub length of 10 mm
Clamping length (mm)	32	25
Total length (mm)	51	85 extra space for the screws
Dismantling screws	no	yes
Shaft tolerance	k6 - h8	h8
Hub bore tolerance	H7	h8
Slotted sleeves	no	yes
TIR (mm)	0,03 mm	approx. 0,1 mm

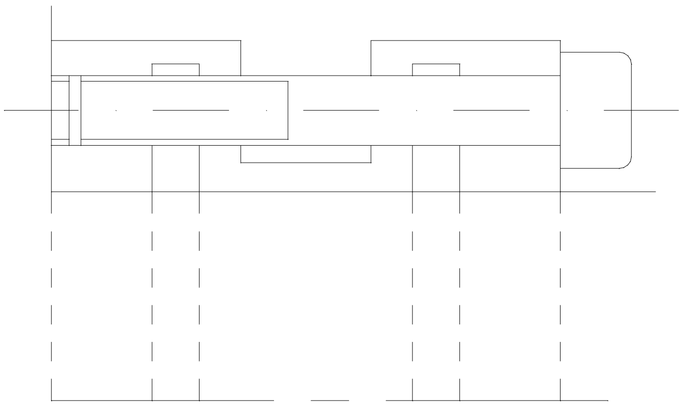


ETP-CLASSIC, 30 mm



Another mechanical type has a large nut around the shaft, used to pull the outer sleeve along and up on the inner sleeve.
This design works for small shafts (less 20 mm) where the big nut is not so difficult to handle. Following are some valuable comments.

-	the run out and balance are not good because of the small contact length and the slotted sleeves
-	extreme high tightening torques, also a special tool, is needed to keep the shaft from turning.
-	same applies for dismantling
-	surface pressure is uneven which gives fretting corrosion
-	OD is big which means that a big hub is necessary
-	a lot of space in the machine is needed for the tooling, necessary for dismantling and mounting
-	risk for self loosening when the machine is vibrating
-	axial movement when tightening



This type differs in design to most other mechanical types as it just consists of one piece of steel. When tightening the screws the whole sleeve is pressed together and also into contact with hub and bore.
It is mostly sold to the machine tool industry where the compact design gives some design advantages.

Following are some valuable comments:

-	only "linear contact" with the hub and shaft which gives a low transmittable torque and risk for fretting corrosion
-	shaft tolerance required is h6 which means ground shafts
-	many and small tightening screws
-	the run out is affected by uneven tightening of the screws
-	dismantling problems because of permanent deformation of the sleeve

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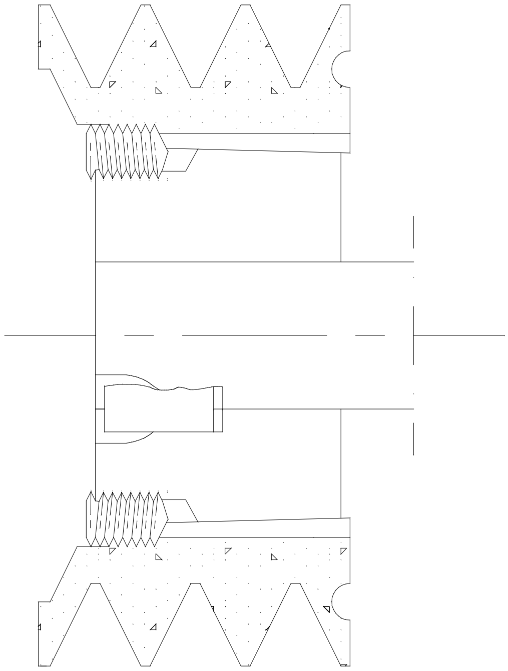
This type were one of the first on the market with tapered sleeves.
Still used by some companies like a “dismantable keyway joint”.



Design: Consists of a slotted cast-iron sleeve with a keyway in the bore and two half threads and two screws on the OD. The OD is tapered. The bore in the hub has the same half threads and taper.

The torque is transmitted through the keyway and the friction surfaces between the tapered surfaces and the screws.

Used by distributors for standardized hubs like pulleys and sprockets. Decreases the inventory of hubs as the sleeve is available with the same OD for different ID's.

- in reality a keyway joint
- fretting corrosion
- special dismantling screws
- the sleeve often breaks when dismantling or at high uneven loads
- axial movement when mounting
- high tightening torque
- big OD
- bad runout