Constant Velocity Joints for Industrial Machines: Application Examples

CAT.No.5604/E

NTN Constant Velocity Joints (CVJ) support countless industries around the world

NTN was the first to commercialize CVJs in Japan as a joint to transfer drive power from vehicle engines to the tires. Since then, **NTN** has continued to lead the industry with its high level of technical expertise, developing and supplying high-performance, lightweight and compact CVJ with a long operating life for automobiles, as well as countless other industries around the world including steel manufacturing, paper manufacturing, food processing, and medical applications.

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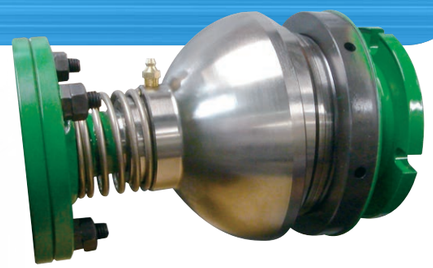
Related catalogs

Constant Velocity Joints for Industrial Machines
Cat. No.5603/E

Tri-Ball Joint Constant Velocity Joints (Small and Medium Size)
Cat. No.5602/E

Refer to the relevant catalogs above for technical data such as allowable torque and permitted rotational speed for standard type CVJ listed in this "Constant Velocity Joints for Industrial Machines : Application Examples."

Metal Seal Joint



Superior heat resistance, water resistance and dust resistance enable a long operating life in severe environments that make the use of rubber boots difficult, which contributes to reliable equipment operation and easier maintenance.

Features

Water resistance, dust resistance

The seal of joint provides a more complete seal for a longer operating life when used in areas subjected to water splashes or high levels of dust.

Heat resistance

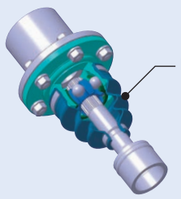
The use of a metal seal enables the joint to be used in high-temperature ranges where the use of rubber boots is difficult.

High strength

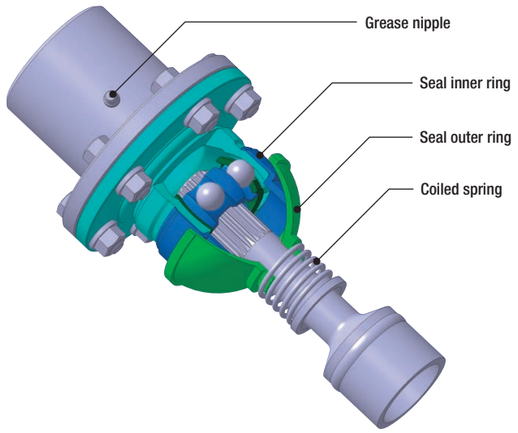
Metal seals are less likely to be damaged by flying debris compared to rubber boots, which makes them suitable for many severe applications.

Structure

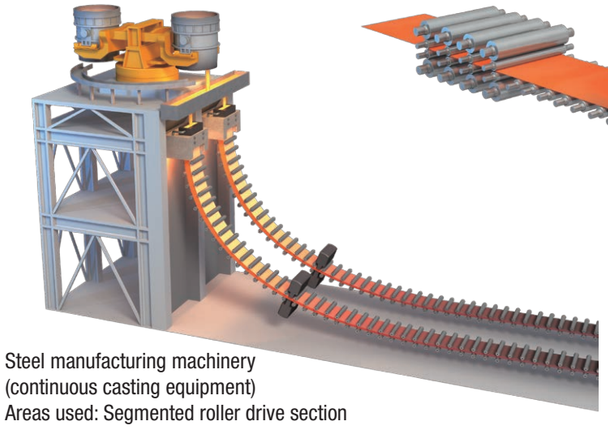
Metal seals have a spherical shape to prevent damage to sealed sections caused by high temperatures, corrosive environments or flying debris.
They are also available with a grease nipple, or O-ring between seals for better sealing.



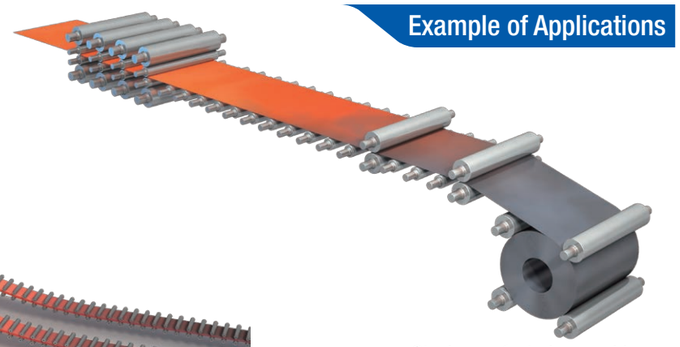
Standard type BJ CVJ (reference)



Example of Applications



Steel manufacturing machinery
(continuous casting equipment)
Areas used: Segmented roller drive section



Steel manufacturing machinery
(hot rolling mill)
Areas used: Hot run-out coiler

Specifications

Allowable rotational speed — Contact **NTN** for considering individual specifications.

Allowable torque — Same allowable torque as standard type joints.

Allowable operating angle — Max. 25°

Available sizes

BJ	75	95	100 *1	125	150	175	200	225	250 *2	300 *2

*1 BJ100 available as cup type only
*2 BJ250 and 300 available as disc type only

High Top Joint (HTJ)

High Top Joints (HTJ) are more compact than the large DOJ type, allowing greater torque transmission, for both space-efficient and high-load capacity applications.

Features

High-load capacity

Instead of the spline fitting structure between the inner race and shaft that is used with large DOJs, the inner race and shaft are integrated, allowing a higher load capacity. (Fig. 6)

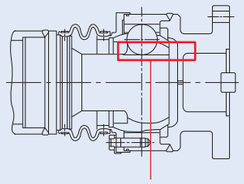
Space saving

A design is 23 to 33% more compact than DOJ with the same load capacity (allowable torque).

High rigidity

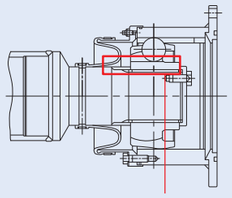
Greater load capacity (allowable torque) and high strength with the integrated inner race and shaft structure, achieving a higher rigidity than DOJ.

HTJ structure



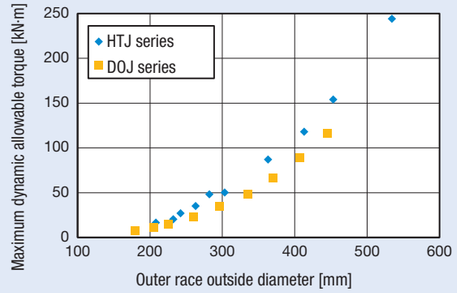
Integrated inner race and shaft structure

DOJ structure



Inner race and shaft spline fitting

Fig. 6 Outer ring outside diameter and maximum dynamic allowable torque

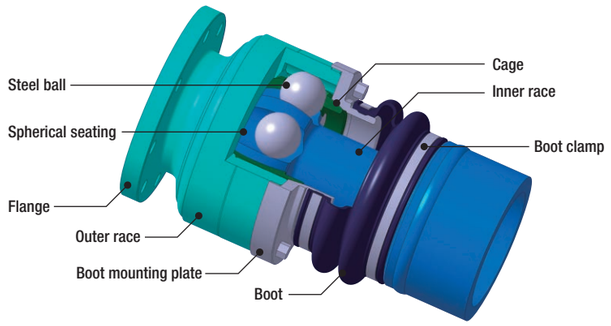


Structure

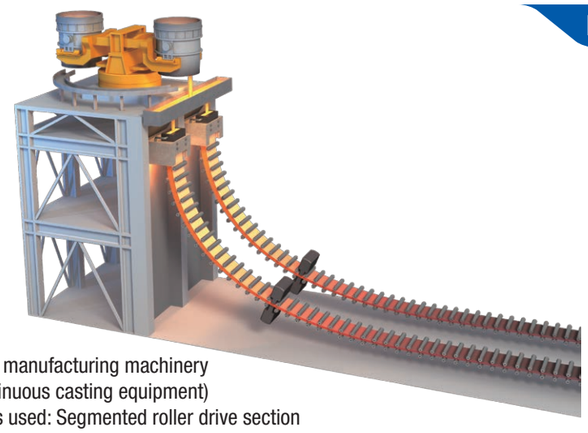
(1) The High Top Joint has an integrated inner race and shaft structure.

(2) The cage makes contact with the spherical seating and boot mounting plate to limit sliding in the axial direction.

(3) Also available with a metal seal as an option.



Example of Applications



Steel manufacturing machinery
(continuous casting equipment)
Areas used: Segmented roller drive section

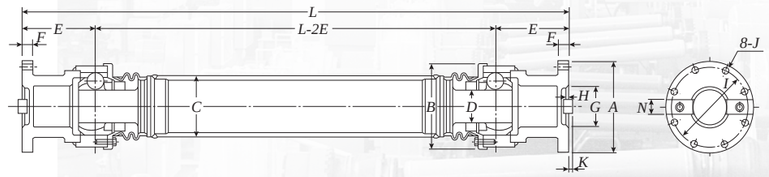
Specifications

Dimensions

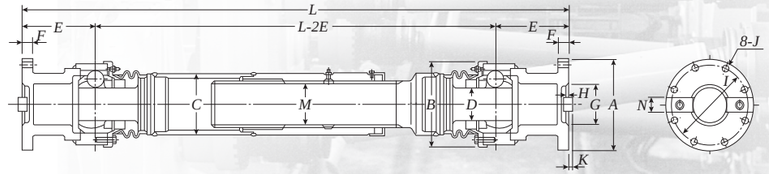
Allowable torque

Joint Size	Maximum dynamic allowable torque		Outside diameter			Shaft diameter	Width		Spigot diameter		Bolt hole		Key		Involute spline M (F4 type only)			Minimum Length L			
																		F3 Type		F4 Type	
			A	B	C	D	E	F	G	H	I	J	K	N	Nominal size	No. teeth	Module	Nominal size	Expansion	Nominal size	Expansion
	kN·m	kgf·m	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm						
HTJ200	16.5	1680	225	208	152	81.5	180	24	100	3.5	197	15	13	40	113	28	3.75	750	±10	1200	+50~0
HTJ220	20.2	2060	240	232	152	87.5	185	24	105	4.5	208	17	13	40	113	28	3.75	800	±10	1250	+50~0
HTJ240	27.0	2750	265	242	191	96.0	210	31	115	4.5	229	19	17	50	140	29	4.50	900	±10	1350	+50~0
HTJ260	35.0	3570	285	263	191	105.0	230	31	125	5.0	245	21	17	50	140	29	4.50	950	±10	1450	+50~0
HTJ280	48.0	4900	310	282	216	120.0	245	34	135	6.0	270	21	19	55	153	39	3.75	1050	±10	1500	+50~0
HTJ300	50.2	5120	330	303	216	125.0	255	34	145	6.0	286	23	19	60	153	39	3.75	1100	±10	1550	+50~0
HTJ350	86.9	8860	395	363	280	150.0	280	38	175	6.0	347	25	21	65	204	32	6.00	1150	±10	1650	+50~0
HTJ400	118.0	12000	445	413	320	198.0	310	42	205	8.0	391	29	23	70	240	38	6.00	1400	±10	1900	+50~0
HTJ450	154.0	15700	490	453	356	216.0	340	47	225	8.0	430	32	26	80	255	32	7.50	1550	±10	2050	+50~0
HTJ500	244.0	24900	570	534	400	253.0	390	50	260	10.0	504	35	28	85	285	36	10.00	1750	±10	2250	+50~0

High Top Joint F3 Type



High Top Joint F4 Type



Allowable rotational speed

Max. 300 min^{-1}

Allowable operating angle

Max. 8°

Available sizes

HTJ 200 220 240 260 280 300 350 400 450 500

Three Piece Joint

The intermediate shaft consists of three pieces, which makes it easier to replace the CVJ unit. The joint itself can also be removed to replace the boot, to significantly improve ease of maintenance.

Features

Easier boot replacement

The CVJ unit itself can be removed, allowing the boot to be replaced quickly.

Easier CVJ unit replacement

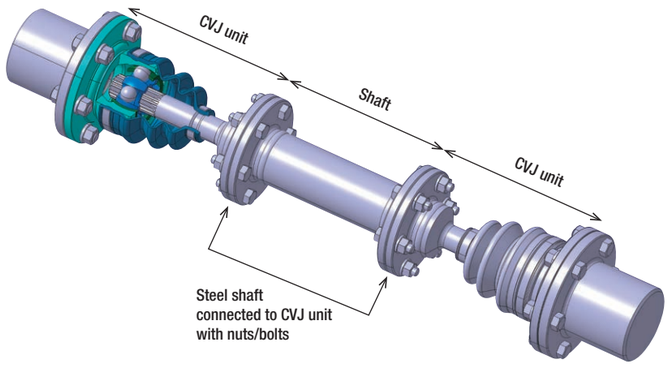
Replacement work on longer joints may be difficult due to the layout of equipment and machinery. The three piece joint can be separated to make replacing the CVJ unit easier in confined spaces.

Easier aftermarket inventory storage

The CVJ unit is compact design which requires less storage space, making aftermarket inventory control easier.

Structure

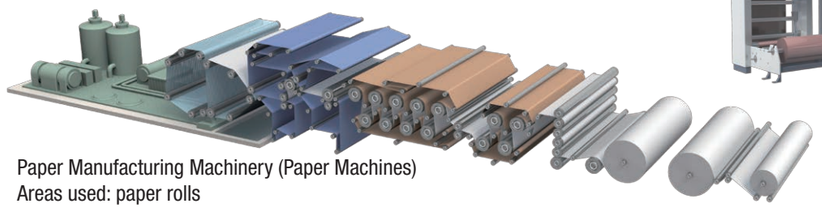
Standard type CVJs feature a single shaft that cannot be separated, however with the three piece joint, the shaft is mounted to the CVJ unit with nuts/bolts.



Standard type CVJ (reference)

Example of Applications

Magnetic tape manufacturing equipment
Areas used: magnetic tape calendar rolls

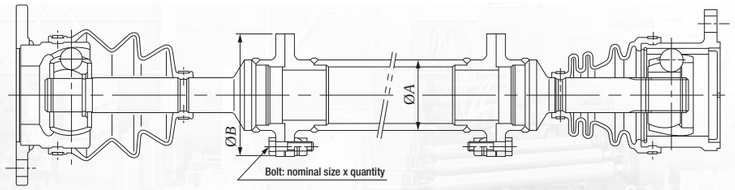


Paper Manufacturing Machinery (Paper Machines)
Areas used: paper rolls

Specifications

Dimensions

Joint Size			Steel shaft outside diameter ØA mm	Flange outside diameter ØB mm	Nominal bolt size x quantity
BJ Disc Type	BJ Cup Type	DOJ, BC			
75 95	75 95	68 75 87	48.6	91	M8 x4
125	100 125	100 125	60.5	104	M8 x8
150	–	150	76.3	129	M10 x8
175	150	175	89.1	140	M10 x8
200 225	175 200	200 225	101.6	168	M14 x8
250 300	225	250 300	139.8	215	M16 x8
–	–	350	165.2	252	M18 x8
–	–	400	190.7	282	M20 x8
– –	– –	450 500	216.3	318	M22 x10
–	–	550	267.4	365	M22 x12
		625	280.0	378	M22 x16



Allowable rotational speed

Contact **NTN** for allowable rotational speed.

Allowable torque

Same allowable torque as standard type joints.

Allowable operating angle

Same allowable operating angle as standard type joints.

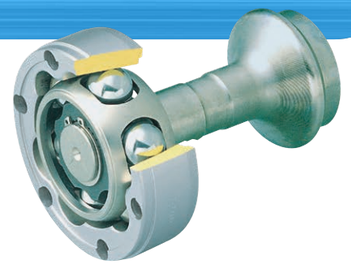
Available sizes

BJ	75	95	100 *1	125	150	175	200	225	250 *2	300 *2						
DOJ	68	75	87	100	125	150	175	200	225	250	300	350	400	450	500	550	625
BC	68	75	87	100	125	150	175	200									

*1 BJ100 available as cup type only *2 BJ250 and 300 available as disc type only

Cross Groove Joint

A CVJ with superior high-speed rotation due to elimination of backlash inside the joint. This technology is widely used in automotive propeller shafts.



Features

No backlash achievement

The Cross Groove Joint (LJ) achieves constant velocity by controlling the position of the steel balls on the crossed inner race and outer race track. The steel balls can be preloaded and no backlash inside the joint in rotating direction and radial direction.

Superior rotational balance and high-speed stability

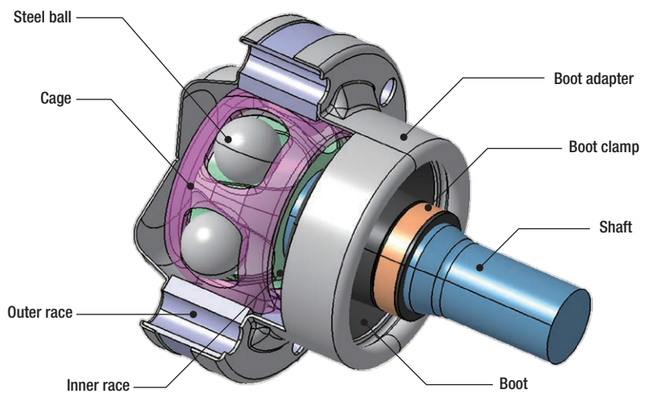
No backlash contribute to superior rotational balance and high-speed rotation.

Low vibration

No backlash contribute to superior vibrational characteristics.

Structure

The Cross Groove Joint can slide and achieves constant velocity by controlling the position of the steel balls on the crossed inner race and outer race track. In order to limit the deformation of the boot during high-speed rotation, apply a boot with a metal adapter rather than a bellows shaped boot.



Example of Applications

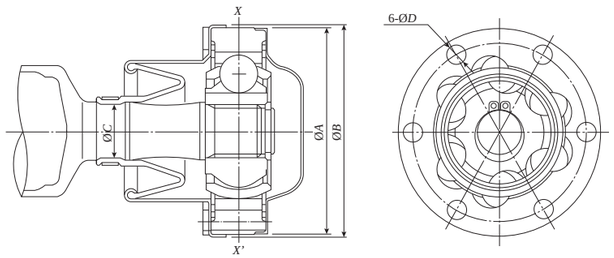
Printing machinery
Areas used: offset rotary presses

Special vehicles
Areas used: power takeoff (PTO)

Specifications

Dimensions

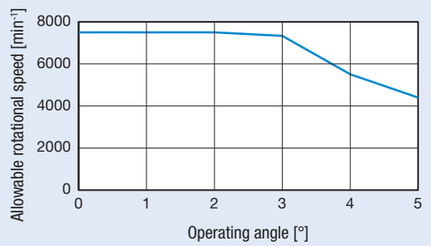
Joint Size	Diameter			
	A mm	*B* mm	*C* mm	*D* (Dia.×P.C.D.) mm
LJ75	86.0	88.0	22.0	Ø8.1×74.0
LJ87	94.0	96.0	23.0	Ø8.1×80.0
LJ95	100.0	102.0	26.0	Ø8.1×86.0
LJ109	108.0	110.0	28.5	Ø10.1×94.0



Allowable rotational speed

The allowable rotational speed of the Cross Groove Joint varies depending on the operating angle and torque load. The torque shown in Fig. 7 assumes minimal torque is applied (around 50 N·m). Contact **NTN** for considering individual specifications.

Fig. 7 LJ operating angle and allowable rotational speed



Allowable torque

Contact **NTN** for considering individual specifications.

Allowable operating angle

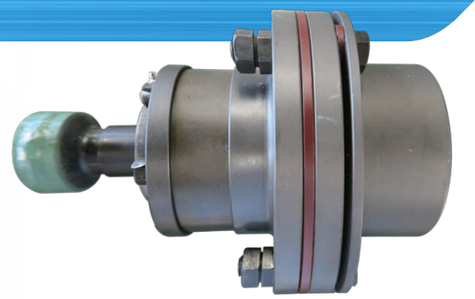
5° or less

Available sizes

LJ 75 87 95 109

Insulation Joint

A CVJ can be insulated to protect against electrical corrosion caused by straying current by applying electrical insulating material to the connecting bolts between flange of electric motor side and CVJ unit.



Features

Excellent electrical insulating properties

(1) The use of electrical insulating material prevents damage to the CVJ caused by electrical corrosion.
(2) Electrical resistivity (laminated phenolic resin): 10^7 to 10^{10} Ω·m

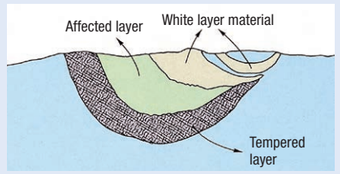
Suitable for almost all CVJ

The feature is applicable to almost all standard catalog CVJ types.

● Electrical corrosion

Currents flowing within the CVJ can generate sparks along the tracks resulting in tempering caused localized high temperatures, reducing hardness. Continuing to use the CVJ under such conditions causes peeling in areas with reduced hardness, eventually damaging the CVJ.

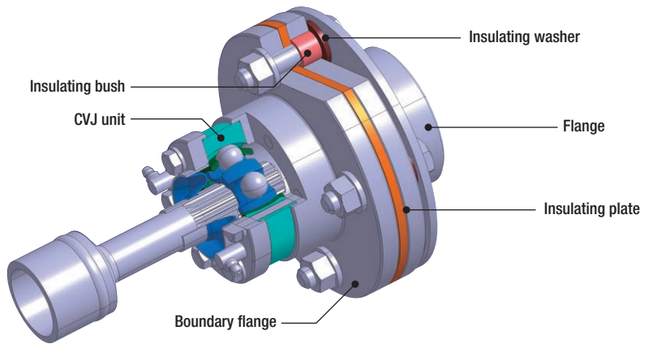
Cross-section of region with electrical corrosion



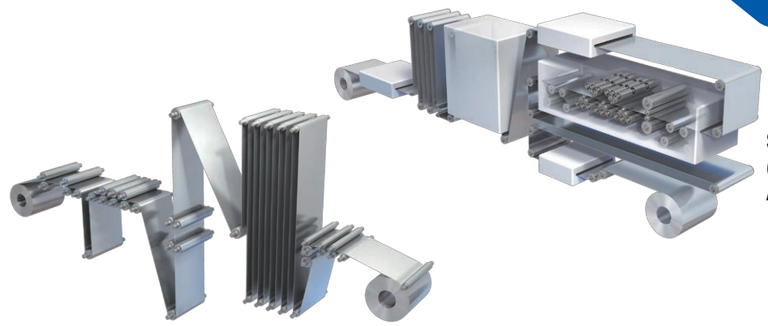
Description of region with electrical corrosion

Structure

Laminated phenolic resin is used as an insulator for the joint flange. Contact **NTN** if joints need to be made with other insulating materials.



Example of Applications



Steel manufacturing machinery (surface treatment equipment)
Areas used: electroplating line

Steel manufacturing machinery (surface treatment equipment)
Areas used: electroplating line

Specifications

Allowable rotational speed — Same allowable rotational speed as standard type joints.

Allowable torque — Same allowable torque as standard type joints.

Allowable operating angle — Same allowable operating angle as standard type joints.

Available sizes — Suitable for all CVJ models with flange outside diameter dimensions ⌀580 or less.

BJ	75	95	100*1	125	150	175	200	225	250*2	300*2					
DOJ	68	75	87	100	125	150	175	200	225	250	300	350	400	450	500	550
BC	68	75	87	100	125	150	175	200								

*1 BJ100 available as cup type only *2 BJ250 and 300 available as disc type only

Elastomer Boot

Superior flexural fatigue resistance compared to standard chloroprene rubber boots, minimal ozone deterioration and long operating life. This technology is widely used in automotive CVJ applications.

Features

Superior flexural fatigue resistance

Provides excellent repeated flexural fatigue resistance compared to rubber boots, and less prone to cracking.

Superior ozone resistance

Superior durability and reliability without being affected by ozone in the atmosphere like rubber boots.

Superior high-speed rotation

Excellent hardness and minimal deformation due to centrifugal forces during rotation mean superior high-speed rotation.

Greater ease of maintenance

Longer boot operating life means reduce replacement frequency of boots and maintenance work.

● Examples of damage to chloroprene rubber boots (reference)

Operating conditions

Areas used: paper manufacturing machining roller drive

Rotational speed: 1200 min^{-1}

Operating angle: 16°

Period of use: approx. 4 years

Cracks formed due to ozone deterioration

Cracks develop due to repeated flexing during rotation, leading to fractures

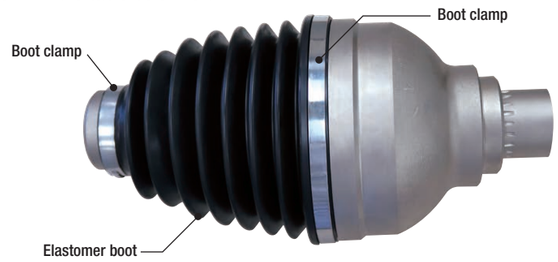
Structure

● Comparison of materials

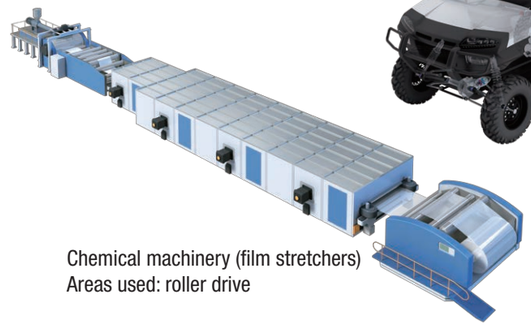
Mechanical characteristics	Elastomer boot	Standard rubber boot
Material	TPEE	CR
Hardness	Type D Durometer 40 to 50	Type A Durometer 50 to 70
Stretching	650%	300%
Tensile strength	300kg/cm²	160kg/cm²
Heat resistance	○	○
Ozone resistance	◎	○
Crack development	◎	○
Wear resistance	◎	○
Fatigue resistance	◎	○

◎: Superior ○: Good

Standard rubber boots are made of CR (chloroprene rubber), however elastomer boots use TPEE (Thermoplastic Polyester Elastomer).
The material characteristics of elastomer boots and rubber boots are shown in the table below left.

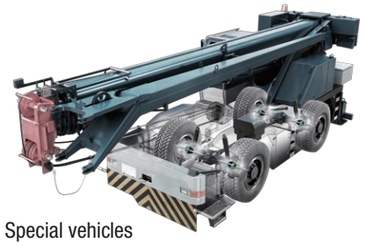


Example of Applications



Chemical machinery (film stretchers)
Areas used: roller drive

Multi-purpose utility vehicle (UV)
Areas used: driveshafts



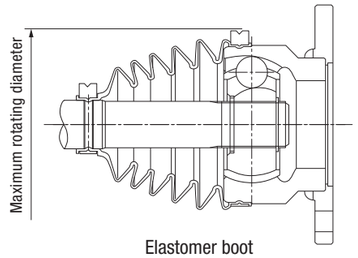
Special vehicles
Areas used: driveshafts

Specifications

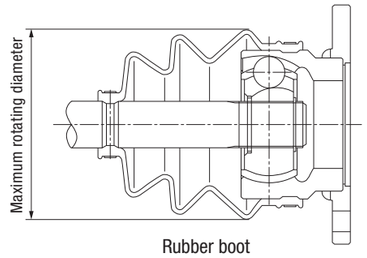
Dimensions

BJ	Maximum rotating diameter [mm]*1	
	Elastomer boot	Rubber boot
75	91.6	81.0
95	109.0	108.0
100	113.7	112.0
125	138.2	148.0
150	162.7	165.0
175	176.7	172.0
200	206.7	199.0

(Contact **NTN** Engineering for other specifications.)



Elastomer boot



Rubber boot

Allowable rotational speed

The allowable rotational speed is higher than standard type joints using rubber boots.
Contact **NTN** Engineering for specific figures of testing for individual specifications.

Allowable torque

Same allowable torque as standard type joints.

Allowable operating angle

Same allowable operating angle as standard type joints.

Available sizes

BJ 75 95 100 125 150 175 200

DOJ 68 75 87 100 125 150 175 200

*1 The maximum outside diameter of elastomer boot units and rubber boots units differs, so verify interference with adjacent components when considering replacements.

Vertical Type Joint

A CVJ can be used in a vertical position with the addition of a bush to the intermediate shaft and spherical seating on the outer race.

Features

Can be used vertically

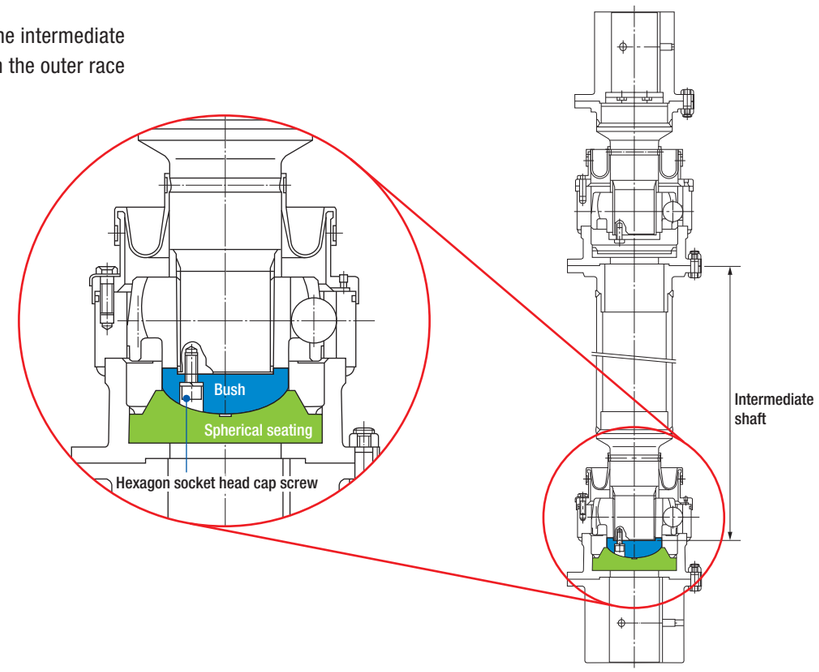
Fitting a bush to the end of the intermediate shaft provides support for the intermediate shaft.

Reduced maintenance work

The joint unit itself can be separated for improvement assembly by customers.

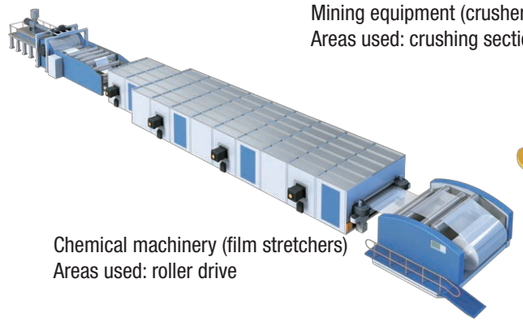
Structure

A bush is fitted to the end of the intermediate shaft, and spherical seating on the outer race provides support for the bush.

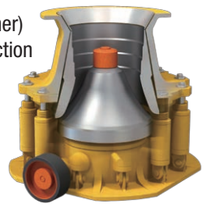


Example of Applications

Wind turbines
(vertical axis turbine)
Areas used:
power transmission section



Chemical machinery (film stretchers)
Areas used: roller drive



Mining equipment (crusher)
Areas used: crushing section

Specifications

Allowable rotational speed — Varies depending on joint type and size. Contact **NTN** for details.

Allowable torque — Varies depending on joint type and size. Contact **NTN** for details.

Allowable operating angle — Varies depending on joint type and size. Contact **NTN** for details.

Available sizes — Available for all joints regardless of joint type and size.

BJ	75	95	100*1	125	150	175	200	225	250*2	300*2						
DOJ	68	75	87	100	125	150	175	200	225	250	300	350	400	450	500	550	625
BC	68	75	87	100	125	150	175	200									
HTJ	200	220	240	260	280	300	350	400	450	500							

*1 BJ100 available as cup type only *2 BJ250 and 300 available as disc type only

Highly Corrosion Resistant Joint

CVJ with paint containing stainless steel flakes applied for a high level of corrosion resistance, weatherability and chemical proofing.

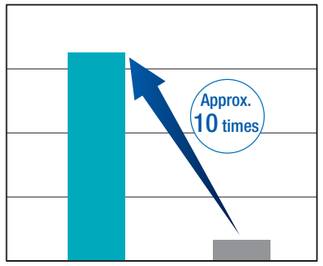
Features

High corrosion resistance

The insulating effects of the stainless steel flake laminated film against corrosive substances protects against penetration by chemicals or gases, making the joint suitable for use in corrosive atmospheres. The paint can be applied to all surfaces of CVJs.

Suitable for all joints

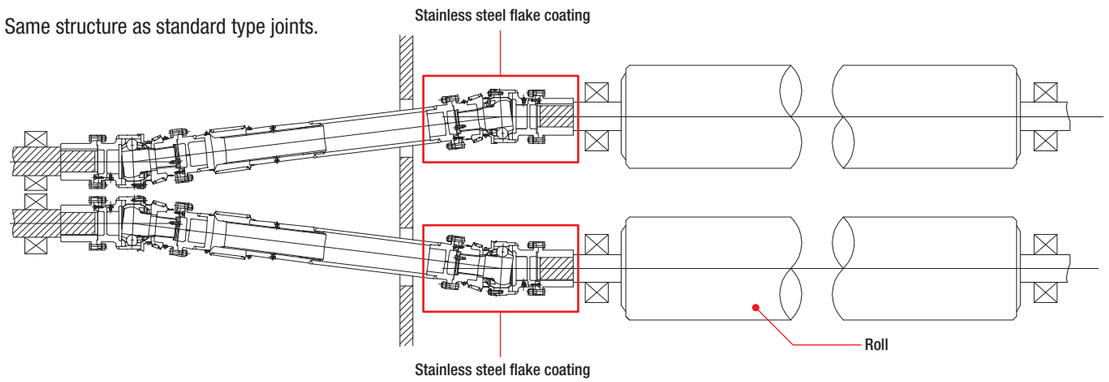
Paint is the only special addition required for standard CVJs, and it is available for all types of joints, regardless of type or size.



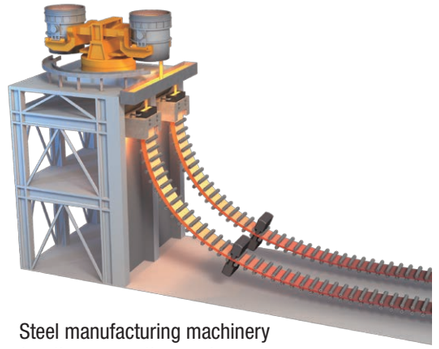
Comparison of paint durability life in salt spray test

Structure

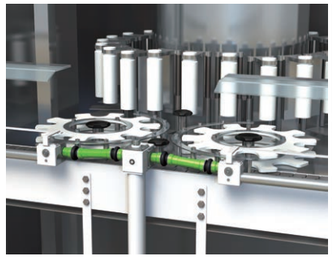
Same structure as standard type joints.



Example of Applications



Steel manufacturing machinery
(continuous casting equipment)
Areas used: segmented roller drive section



Food Machinery
Areas used: screw drive section of bottle washing machines

Areas used: screw drive section of filling machines

Specifications

Allowable rotational speed — Same allowable rotational speed as standard type joints.

Allowable torque — Same allowable torque as standard type joints.

Allowable operating angle — Same allowable operating angle as standard type joints.

Available sizes — Available for all joints regardless of joint type or size.

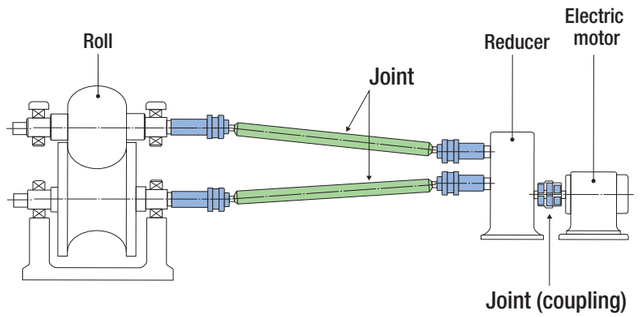
BJ	75	95	100*1	125	150	175	200	225	250*2	300*2							
DOJ	68	75	87	100	125	150	175	200	225	250	300	350	400	450	500	550	625
BC	68	75	87	100	125	150	175	200									
HTJ*3	200	220	240	260	280	300	350	400	450	500							

*1 BJ100 available as cup type only *2 BJ250 and 300 available as disc type only *3 Check the specifications on P6 for HTJ technical data

Features of **NTN** Constant Velocity Joints

NTN Constant Velocity Joints

Constant Velocity Joints are joints that transmit rotational torque from the input side (such as electric motors) smoothly through various angles and distances to the output side (such as rollers).



Constant Velocity Joints operate at a constant velocity with no change in angular velocity

When non-constant velocity joints such as cross joints (CJ) transmit rotational power from the main shaft to the driven shaft, the angular velocity of the driven shaft changes in two cycles per revolution as shown in Fig. 1, even if the angular velocity of the main shaft is constant. Thus to ensure an almost constant velocity, an intermediate shaft must be used to connect the two joints as a single system, with the two joints arranged at the opposing angles along the same plane or in parallel as shown in Fig. 2.
NTN constant velocity joints are constant velocity as a single joint, so there is no change in angular velocity between the main shaft and driven shaft. This means that even if the center line of both the main and driven shafts varies, they do not need to be arranged on the same plane, and can be set to any desired angle. (Fig. 3)

Fig. 1

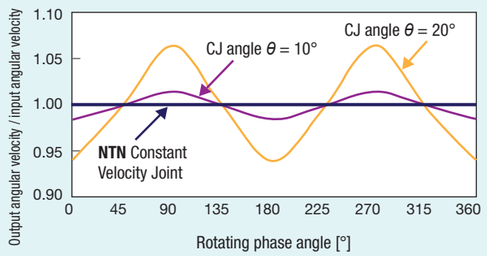
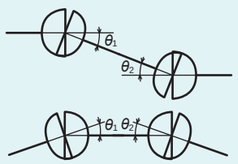
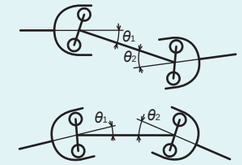


Fig. 2 Cross joint



Two joints used as a single system
Must be positioned correctly
for constant velocity so that $\theta_1 = \theta_2$

Fig. 3 Constant velocity joints



Can be used as a single joint
Does not need to be positioned
for constant velocity, even if $\theta_1 \neq \theta_2$

Superiority of constant velocity joints

1 Low vibrations and noise, smooth rotation
CVJs have lower vibrations and noise compared to other joints, and their smooth rotation (constant velocity rotation) helps to improve product quality and stable equipment operation.

2 Ease-of-handling
CVJs are easier to handle, as they do not require joint angle/positioning or centering between left and right joints like cross joints.

3 Re-greasing not needed
Boots are sealed, which means they can be used for extended periods of time without re-greasing.

4 Ambient surrounding environment
The sealed boots prevent grease scattering, helping to keep cleanliness at operating area.

5 Safety
Joints are covered by boots, so users cannot trap their fingers in the joint yoke like cross joints, which enhances safety during handling.

Constant velocity

A universal joint is required to connect the two intersecting rotating shafts.
The two intersecting shafts rotating via a universal joint move in two ways even if the main shaft has a constant angular velocity: the angular velocity of the driven shaft changes cyclically per rotation; or the angular velocity is always transmitted constantly without any variation.
If two intersecting shafts joined by a universal joint are required to rotate such that the driven shaft is always rotating at the same speed as the driving shaft (constant velocity), the intersection point must always be located on a plane that bisects the angle between the two shafts.
Fig.4 schematically illustrates two axes of intersecting shafts, point O is the center of the joint (and the intersection point of the shaft centerlines), point P is the crossing point (that is, power transmission point). When the angular velocities of the axes are $_1$ and $_2$ respectively, and the lengths of perpendicular segments from point P to the axes are $_1$ and ℓ_2 respectively, the peripheral speeds at point P are $_1 \cdot _1$ and $_2 \cdot \ell_2$. Since point P is common to both shafts, both peripheral speeds are the same, and the following relation is valid:

$$_1 \cdot _1 = _2 \cdot _2$$

If both axes are to run at a common angular velocity (that is, $_1 = _2$), the relation $_1 = _2$ must be always true (that is, the lengths of both perpendicular segments the crossing point P to the axes must be always same). This means that point P must be always located on a plane that equally divides the crossed angle between two axes.
Based on this principle, **NTN** constant velocity joints are designed so that, regardless of the crossed angle, the steel balls at the crossing point are always correctly arranged on a plane that equally divides the crossed angle (Fig.5).
Therefore, this type of joint can transmit constant velocity.

Fig. 4

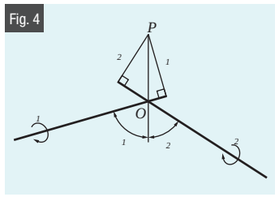
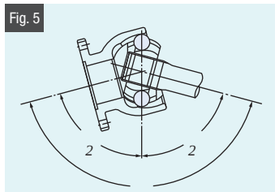


Fig. 5

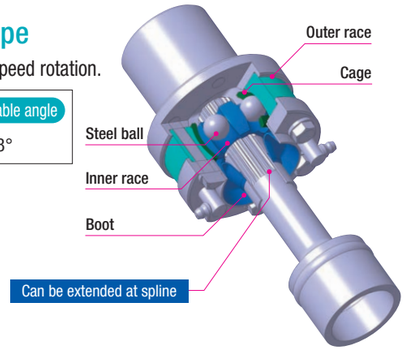


Standard CVJ types

● BJ Disc Type

Superior high-speed rotation.

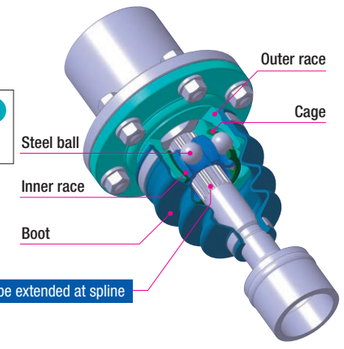
Maximum allowable angle
14 to 18°



● BJ Cup Type

Excellent sealing.

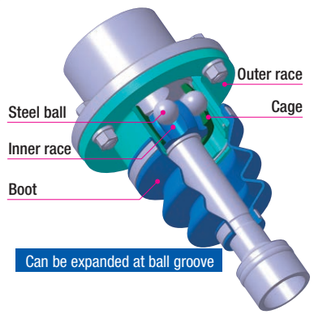
Maximum allowable angle
25°



● DOJ

Can be expanded internally with torque applied.

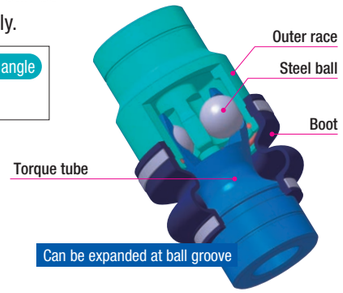
Maximum allowable angle
68 to 200 sizes: 20°
225 to 625 sizes: 8 to 10°



● TBJ (Tri-Ball Joint)

Compact CVJ that can be expanded internally.

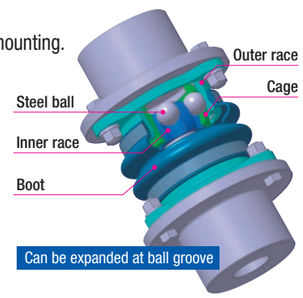
Maximum allowable angle
16 to 18°



● BC Coupling

No centering required, easy mounting.
Can be expanded internally.

Maximum allowable angle
5°



Chain Coupling | Gear Coupling | Disc Coupling | Rubber Coupling

Replacing with BC Coupling...

No centering required
Improves work efficiency, reduces maintenance work

Re-greasing not needed
Sealed boots mean operation for extended periods of time without re-greasing

Absorbs vibrations

Replace

* Replacement may not be possible depending on conditions. Contact **NTN** Engineering to verify details such as usage conditions and areas used.

Appendix

Service Conditions Confirmation Sheet

NTN can select an appropriate CVJ type and size number if details on usage conditions are supplied.

Enter the usage conditions into the following Service Condition Confirmation Sheet and contact an **NTN** office.

Company name		Date	
Machine		Areas used	

Service conditions

❶ Type of drive motor

- Motor: AC/DC — Output ____ kW/HP ____ min^{-1}
- Engine: gasoline/diesel — No. of cylinders ____ Maximum Power ____ PS/ ____ min^{-1}
  Maximum torque ____ N·m/ ____ min^{-1}

❷ Number of CVJ to be driven per unit

____ shafts

❸ CVJ rotating speed

- Constant ____ min^{-1}
- Variable ____ to ____ min^{-1}

❹ Rotating direction

- One direction
- Forward/reverse

❺ Transmitting torque

- Constant ____ N·m
- Variable Max. ____ to Normal ____ to Min. ____ N·m

❻ Shocks

- No
- Yes — Approx. ____ % of rated torque of drive motor

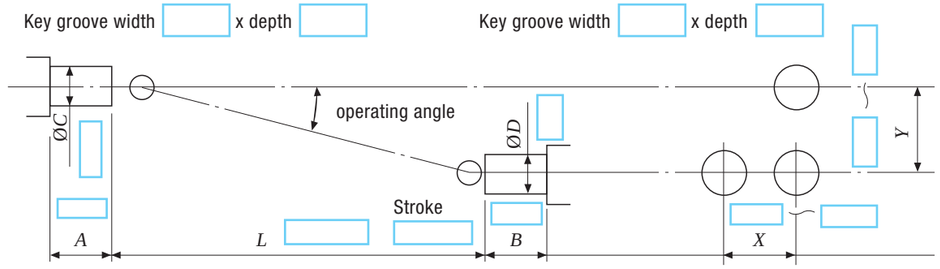
❼ Ratio of opelation

- 24 hours/day constantly
- ____ hours/day
- Others

❽ CVJ installation drawing

Driving end ( ) — Key groove width ____ x depth ____

Follower end ( ) — Key groove width ____ x depth ____



- Separate study required if drawing is not applicable.
- If installation position (L and X, Y) changes, check the changed position (amount) and applicable loaded condition at that position.

❾ Installation direction	• Horizontal	• Vertical
❿ Expansion, angle changes during torque transmission	• No	• Yes
⓫ Outside diameter limit	• No	• Yes up to ____ mm
⓬ Place and atmosphere	• Indoor	• Outdoor temperature ____ ℃ Others ____
⓭ Type and model No. of joint used currently	• New	• Current ____

⓮ Other special notes or requirements

- **NTN** will machine mounting flange hubs if dimensional specifications are provided (such as internal diameter, key groove).

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