Change Nut

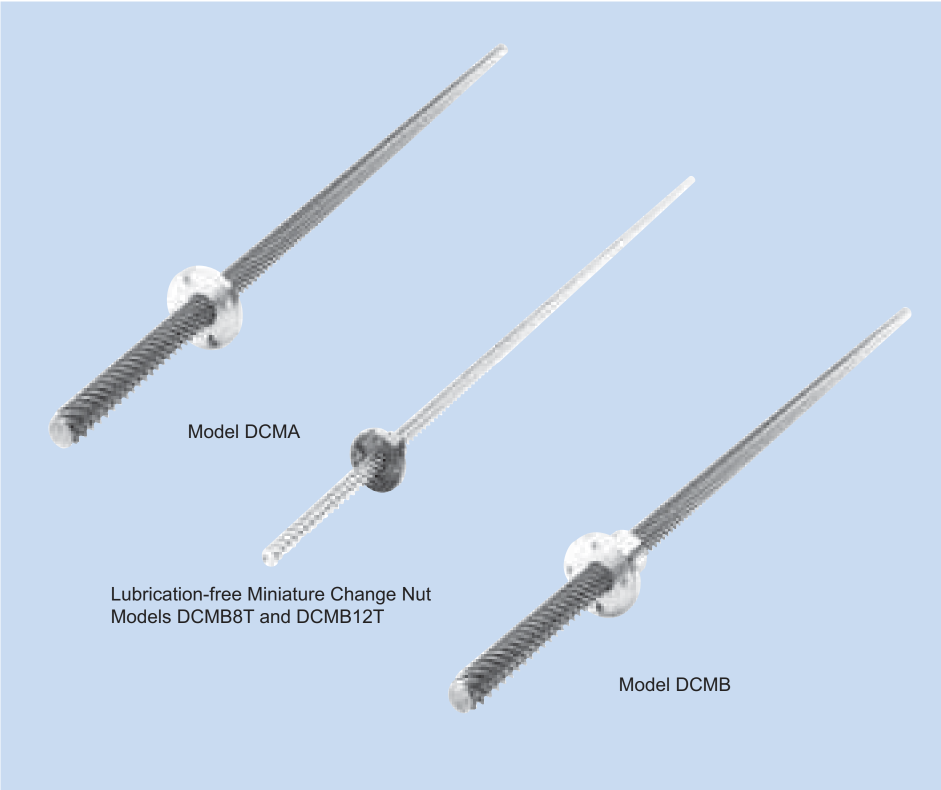
THK General Catalog

A Technical Descriptions of the Products

B Product Specifications (Separate)

* Please see the separate "B Product Specifications".

Features of the Change Nut



Structure and Features

The Change Nut models DCMA and DCMB have a lead angle of 45°, which is difficult to achieve through machining. Each model is capable of converting a straight motion to a rotary motion, or a vise versa, at 70% efficiency. Because of the large leads, they are optimal for providing a fast feed mechanism at a low-speed rotation. The multi-thread screw shafts to be combined with these change nuts are formed through cold gear rolling. The surface of the teeth is hardened to over 250 HV and mirror-finished. As a result, the shafts are highly wear resistant and achieve significantly smooth motion when used in combination with these change nuts. Models DCMA40, DCMB40 or higher are designed for use in combination with the cut screw shafts.
The Miniature Change Nuts are made of an oil-impregnated plastic, and have a wear resistance and excel in lubrication especially in an oil-less operation. In addition, since the high level of their performances can be maintained for a long period, they allow long-term maintenance-free operation.

Features of the Special Rolled Shafts

Dedicated rolled shafts with the standardized lengths are available for the Change Nut.

[Increased Wear Resistance]
The shaft teeth are formed by cold gear rolling, and the tooth surface is hardened to over 250 HV and mirror-finished. As a result, the shafts are highly wear resistant and achieve significantly smooth motion when used in combination with the nuts.

[Improved Mechanical Properties]
Inside the teeth of the rolled shaft, a fiber flow occurs along the contour of the tooth surface of the shaft, making the structure around the teeth roots dense. As a result, the fatigue strength is increased.

[Additional Machining of the Shaft End Support]
Since each shaft is rolled, additional machining of the support bearing of the shaft end can easily be performed by lathing or milling.

High Strength Zinc Alloy

The high strength zinc alloy used in the change nuts is a material that is highly resistant to seizure and the wear and has a high load carrying capacity. Its composition, the mechanical properties, the physical properties and the wear resistance are given below.

[Composition]

Table1 Composition of the High Strength Zinc Alloy
Unit: %

Item	Description
Aℓ	3 to 4
Cu	3 to 4
Mg	0.03 to 0.06
Be	0.02 to 0.06
Ti	0.04 to 0.12
Zn	Remaining portion

[Mechanical Properties]

Item	Description
Tensile strength	275 to 314 N/mm²
Tensile yield strength (0.2%)	216 to 245 N/mm²
Compressive strength	539 to 686 N/mm²
Compressive yield strength (0.2%)	294 to 343 N/mm²
Fatigue strength	132 N/mm² × 10⁷ (Schenk bending test)
Charpy impact	0.098 to 0.49 N-m/mm²
Elongation	1 to 5 %
Hardness	120 to 145 HV

[Physical Properties]

Item	Description
Specific gravity	6.8
Specific heat	460 J/(kg・K)
Melting point	390 ℃
Thermal expansion coefficient	24×10^{-6}

[Wear Resistance]

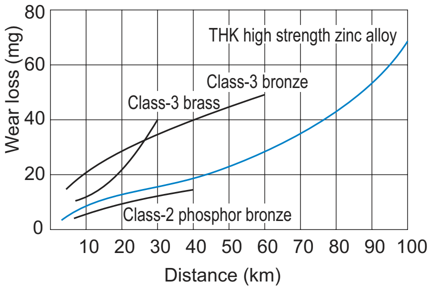


Fig.1 Wear Resistance of the High Strength Zinc Alloy

[Test conditions: Amsler wear-tester]

Item	Description
Test piece rotational speed	185 min^{-1}
Load	392 N
Lubricant	Dynamo oil

Selecting a Change Nut

[Dynamic Permissible Torque T and Dynamic Permissible Thrust F]

The dynamic permissible torque (T) and the dynamic permissible thrust (F) are the torque and the thrust at which the contact surface pressure on the tooth surface of the bearing is 9.8 N/mm². These values are used as a measuring stick for the strength of the chang nut.

[pV Value]

With a sliding bearing, a pV value, which is the product of the contact surface pressure (p) and the sliding speed (V), is used as a measuring stick to judge whether the assumed model can be used. Use the corresponding pV value indicated in Fig.1 as a guide for selecting a change nut. The pV value varies also according to the lubrication conditions.

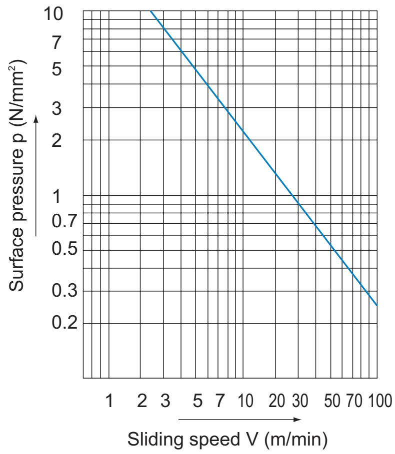


Fig.1 pV Value

● f_s: **Safety Factor**

To calculate a load applied to the change nut, it is necessary to accurately obtain the effect of the inertia that changes with the weight and the dynamic speed of an object. In general, with the reciprocating or the rotating machines, it is not easy to accurately obtain all the factors such as the effect of the start and stop, which are always repeated. Therefore, if the actual load cannot be obtained, it is necessary to select a bearing while taking into account the empirically obtained safety factors (f_s) shown in Table1.

Table1 Safety Factor (f_s)

Type of load	Lower limit of f_s
For a static load less frequently used	1 to 2
For an ordinary single-directional load	2 to 3
For a load accompanied by vibrations/impact	4 or greater

● f_T: Temperature Factor

If the temperature of the change nut exceeds the normal temperature range, the seizure resistance of the nut and the strength of the material will decrease. Therefore, it is necessary to multiply the dynamic permissible torque (T) and the dynamic permissible thrust (F) by the corresponding temperature factor indicated in Fig.2.

Note) In the case of a miniature Change Nut, be sure to use it at 60℃ or below.

Accordingly, when selecting a change nut, the following equations need to be met in terms of its strength.

Dynamic permissible torque(T)

$$f_S \leqq \frac{f_T \cdot T}{P_T}$$

Static permissible thrust(F)

$$f_S \leqq \frac{f_T \cdot F}{P_F}$$

f_S : Static safety factor (see Table1 on A-845)
f_T : Temperature factor (see Fig.2)
T : Dynamic permissible torque (N-m)
P_T : Applied torque (N-m)
F : Dynamic permissible thrust (N)
P_F : Axial load (N)

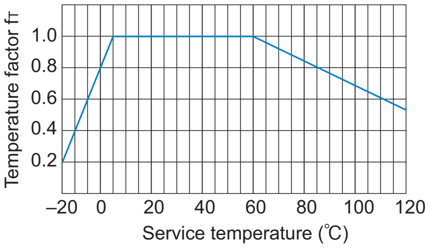


Fig.2 Temperature Factor

● Hardness of the Surface and Wear Resistance

The hardness of the shaft significantly affects the wear resistance of the change nut. If the hardness is equal to or less than 250 HV, the abrasion loss increases as indicated in Fig.3. The roughness of the surface should preferably be 0.80a or less.

A special rolled shaft achieves surface hardness of 250 HV or greater, through hardening as a result of rolling, and surface roughness of 0.20a or less. Thus, the dedicated rolled shaft is highly wear resistant.

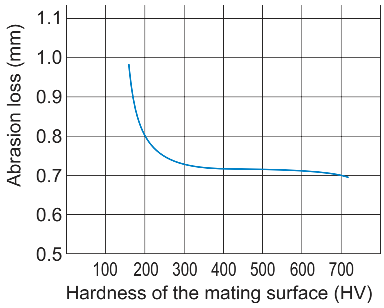


Fig.3 Hardness of the Surface and Wear Resistance

[Calculating the Contact Surface Pressure p]
The value of "p" is obtained as followed.

- **If an axial load is applied:**

$$p = \frac{P_F}{F} \times 9.8$$

p : Contact surface pressure on the tooth from an axial load (P_F N) (N/mm^2)
F : Dynamic permissible thrust (N)
P_F : Axial load (N)

- **If a torque is applied:**

$$p = \frac{P_T}{T} \times 9.8$$

p : Contact surface pressure on the tooth under a load torque (P_T N-m) (N/mm^2)
T : Dynamic permissible torque (N-m)
P_T : Applied torque (N-m)

[Calculating the Sliding Speed V on the Teeth]
The value of "V" is obtained as followed.

$$V = \frac{\sqrt{2} \cdot \pi \cdot Do \cdot n}{10^3}$$

V : Sliding speed (m/min)
Do : Effective diameter (see specification table) (mm)
n : Rotation speed per minute (min^{-1})
R : Lead (mm)

[Example of Calculation]

Assuming that Change Nut model DCMB is used, select a screw nut that travels at feed speed S = 10 m/min while receiving an axial load P_F = 1,760 N accompanied by vibrations.
Obtain the pV value.
First, tentatively select model DCMB25T (dynamic permissible thrust F = 12,700 N).
Obtain the contact surface pressure (p).

$$p = \frac{P_F}{F} \times 9.8 = \frac{1760}{12700} \times 9.8 \fallingdotseq 1.36 \text{ N/mm}^2$$

Obtain the sliding speed (V). The revolutions per minute (n) of the screw shaft needed to move it at feed speed S = 10 m/min is calculated as follows.

$$n = \frac{S}{R \times 10^{-3}} = \frac{3}{73.3 \times 10^{-3}} \fallingdotseq 136\text{min}^{-1}$$

$$V = \frac{\sqrt{2} \cdot \pi \cdot Do \cdot n}{10^3} = \frac{\sqrt{2} \times \pi \times 23.1 \times 136}{10^3} \fallingdotseq 14.0 \text{ m/min}$$

From the diagram of pV values (see Fig.1 on A-845), it is judged that there will be no abnormal wear if the sliding speed (V) is 16m/min or below against the "p" value of1.36 N/mm².

Second, obtain the safety factor (f_S) against the dynamic permissible thrust (F).
Given the conditions:
Temperature factor f_T = 1, and
Applied load P_F= 1,760 N, the safety factor is calculated as follows.

$$f_S \leqq \frac{f_T \cdot F}{P_F} = \frac{1 \times 12700}{1760} = 7.2$$

Since the required strength will be met if "f_S" is at least 4 because of the type of load, it is appropriate to select model DCMB25T.

Efficiency, Thrust and Torque

The efficiency (η) of the change nut in relation to the friction coefficient (μ) is indicated in Table2.

Table2 Friction Coefficient and Efficiency

Frictional coefficient (μ)	0.1	0.15	0.2
Efficiency (η)	0.82	0.74	0.67

The thrust generated when a torque is applied is obtained from the following equation.

$$Fa = 2 \cdot \pi \cdot \eta \cdot T/R \times 10^{-3}$$

Fa	: Thrust generated	(N)
T	: Torque (input)	(N-m)
R	: Lead	(mm)

Also, the torque generated when a thrust is applied is obtained from the following equation.

$$T = \eta \cdot Fa \cdot R \times 10^{-3}/2\pi$$

T	: Torque generated	(N-m)
Fa	: Thrust (input)	(N)
R	: Lead	(mm)

[Example of Calculation - 1]

Assuming that Change Nut model DCMB20T is used and the torque T is equal to 19.6 N-m, obtain the thrust to be generated.
If "μ" is 0.2, the efficiency "η" is 0.67 (see Table2), and the generated thrust (Fa) is calculated as follows.

$$Fa = 2 \cdot \pi \cdot \eta \cdot T/R \times 10^{-3} = \frac{2 \times \pi \times 0.67 \times 19.6}{60 \times 10^{-3}} \fallingdotseq 1370 \text{ N}$$

[Example of Calculation - 2]

Assuming that Change Nut model DCMB20T is used and the thrust Fa is equal to 980 N, obtain the torque to be generated.
If "μ" is 0.2, the efficiency "η" is 0.67 (see Table2), and the generated torque (T) is calculated as follows.

$$T = \frac{\eta \cdot Fa \cdot R \times 10^{-3}}{2\pi} = \frac{0.67 \times 980 \times 60 \times 10^{-3}}{2\pi} = 6.27 \text{ N} \cdot \text{m}$$

Accuracy Standards

Table3 Accuracy of the Screw Shaft of Models DCMA and DCMB

Unit: mm

Shaft symbol	Rolled shaft
Accuracy	T Note
Single pitch error (max)	±0.025
Accumulated pitch error (max)	±0.2/300

Note) Symbol T indicates the machining method for the screw shaft.

Change Nut

Fit

For the fitting between the change nut circumference and the housing, we recommend a loose fitting or a tight fitting.
Housing inner-diameter tolerance: H8 or J8

Installation

[About Chamfer of the Housing's Mouth]

To increase the strength of the root of the flange of the change nut, the corner is machined to have an R shape. Therefore, it is necessary to chamfer the inner edge of the housing's mouth.

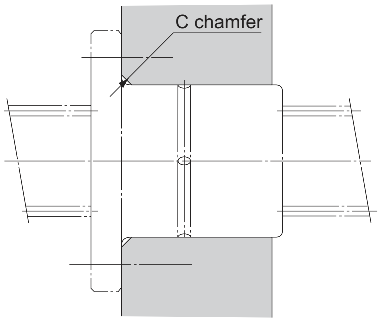


Fig.1

Table1 Chamfer of the Housing's Mouth

Unit: mm

Model No. DCMA DCMB	Chamfer of the mouth C (Min.)
8	1.2
12	1.5
15	2
17	
20	
25	2.5
30	
35	3
40	
45	
50	

[Recommended Mounting Orientation]

When vertically conveying a heavy object using the screw shaft, it is safe to mount the screw as shown in Fig.2 where supports are provided on the mounting holes to prevent the moving object from falling even if the change nut is broken due to an overload or an impact.

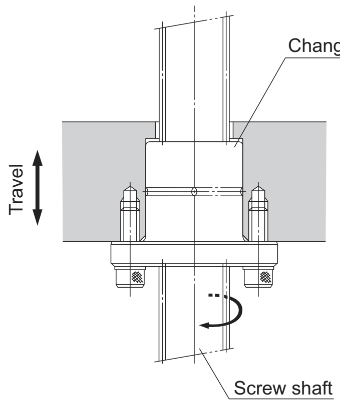


Fig.2 Recommended Mounting Orientation

Lubrication

Select a lubrication method according to the conditions of the change nut.

[Oil Lubrication]

For the lubrication of the change nut, an oil lubrication is recommended. Specifically, an oil-bath lubrication or a drop lubrication is particularly effective. An oil-bath lubrication is the most appropriate method since it meets the harsh conditions such as a high speed, a heavy load or an external heat transmission and it cools the change nut. The drop lubrication is appropriate for the low to medium speed and a light to medium load. Select a lubricant according to the conditions as indicated in Table2.

Table2 Selection of a Lubricant

Conditions	Types of Lubricants
Low speed, high load, high temperature	High-viscosity sliding surface oil or turbine oil
High speed, light load, low temperature	Low-viscosity sliding surface oil or turbine oil

[Grease Lubrication]

In a low-speed feed, which occurs less frequently, the user can lubricate the slide system by manually applying the grease to the shaft on a regular basis or using the greasing hole on the change nut. We recommend using the lithium-soap group grease No. 2.

[Initial Lubrication of the Miniature Change Nut]

Since the Miniature Change Nut is made of oil-impregnated plastics, it can be used without the lubrication during an operation. For the initial lubrication, use some oil or grease. Note that lubricants containing large amount of extreme pressure agent are not suitable.