Instruction manual of Swan100 knee joint

Swan100

M0786 Multi Axial Bouncing Type Safety Knee

U.S. Patent Number 6.508.843.B2

For safety use of the device

- Module selection, assembly and adjustment should be done following instructions of this manual.
- Torque measuring wrench is indispensable to fix screws.
- If you aware those symptoms predicting malfunction or breakage of the knee, such as mechanical noise or instable movement of the device, please inform it to the manufacturer in early phase.
- Please inform your patient that periodical inspection of the artificial limb is indispensable for safe and long use.

■ Indication

The knee is applicable for following patients.

	body weight	activity level
M0780 Swan 75	up to 75 kg(165 lbs)	low to moderate
M0786 Swan 100	up to 100 kg(220 lbs)	low to moderate

■ Features

■ Dynamic stabilizing mechanism to prevent knee buckling

At heel contact, the lower part of the knee joint bends slightly to minimize the shock of floor reaction force. In this process, the two vertical links (front & rear) become nearly parallel and the instantaneous center of rotation (I.C.R.) of the knee joint shifts upward and backward of the hip joint instantly preventing knee buckling.

After mid-stance, the knee returns to basic four bar linkage and allows knee flexion at final stage of stance-phase.

■ Bouncing mechanism for easy stance phase

The slight knee flexion before mid-stance (= stance flexion) in bipedal walking reduces up-and-down fluctuation of C.G. of the body. It absorbs floor shock, helping smooth forward movement of the body. The result is natural gait and smaller energy consumption. In case of Swan, the angle between the center line of socket and the shank tube become smaller at the early stage of stance phase. The amount of bouncing movement can be altered by tilting the knee joint in A-P plane as well as by adjustment of the hardness of bouncing bumper.

■ Compact hydraulic cylinder for easy swing phase

In general, it is considered that the hydraulic knees are heavier to swing than pneumatic knees, thus, the acceptance of inactive patients is poor. The hydraulic cylinder of Swan, however, is designed as to minimize the flexion resistance and not to inhibit the knee flexion at final stage of stance phase, as well as by small flexion moment in swing phase due to slow walking. On the other hand, the cylinder shows preferable cadence adaptability for different walking speed, up to cadence 105/min.

■ Weight and Dimensions

	M0780 Swan 75	M0786 Swan 100
weight	670g(1.476lbs)	840g(1.852lbs)
overall length	194mm	194mm
overall width	63mm	71mm
maximum flexion	150deg.	150deg.

■ Link mechanism of Swan

Swan has five links in total, combining two sets of four bar linkage. The one is “basic set” and the other is “bouncing set” (Fig. 1). At the first stage of stance-phase, only the bouncing set is actuated by loading (Fig. 2-a), because the instantaneous center of rotation (I.C.R.) of basic set is situated behind to the vector of floor reaction force and resulted extension moment cannot extend the link as the movement is inhibited by extension stop.

The floor reaction force of heel-contact push the anterior link of bouncing set backward, and shifts the I.C.R. of basic set instantly, high and posterior position of the hip joint, because the anterior link of basic set become parallel to the posterior one (Fig. 2-b).

After mid-stance, the I.C.R. of bouncing set shifts backward to the vector of floor reaction force and the resultant force allows the bouncing set (as well as the basic one) to the alignment of non loading (Fig. 2-c).

At the push-off stage, I.C.R. of basic set is returned to original alignment and allows knee flexion for swing-phase (Fig. 2-d).

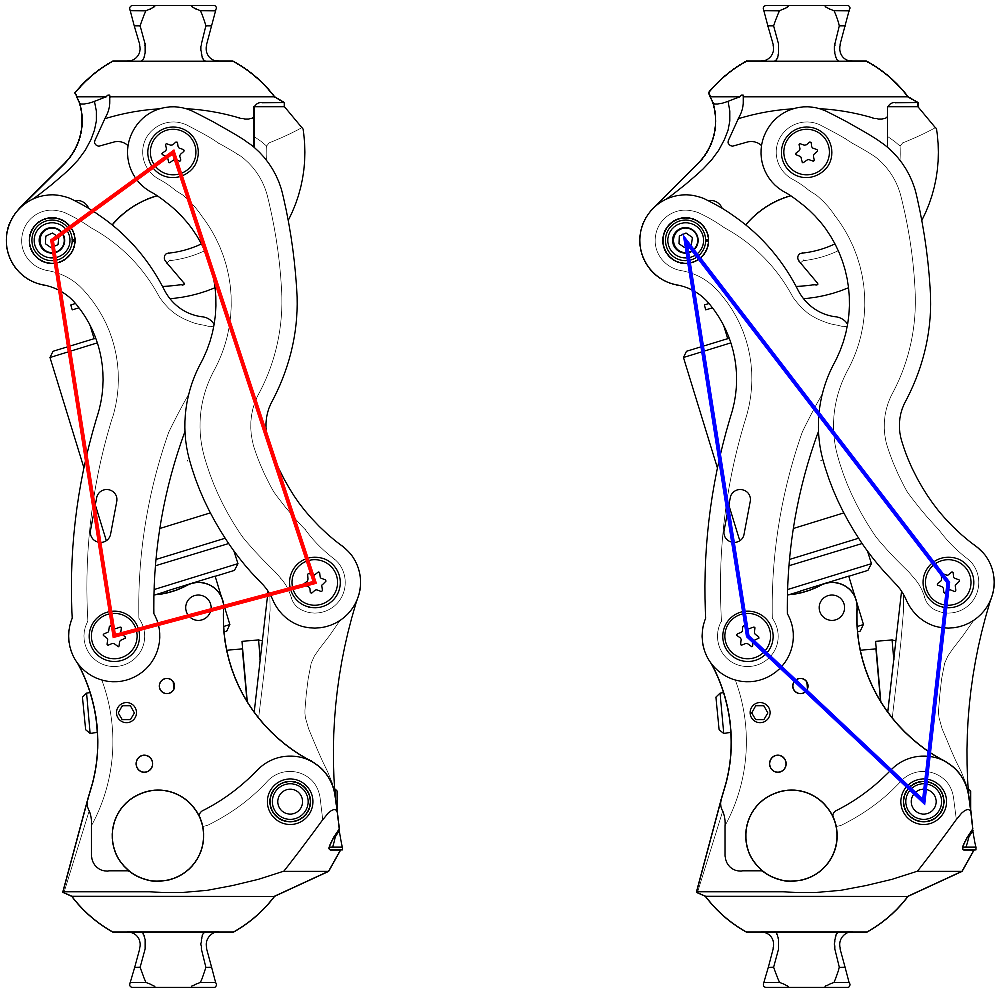
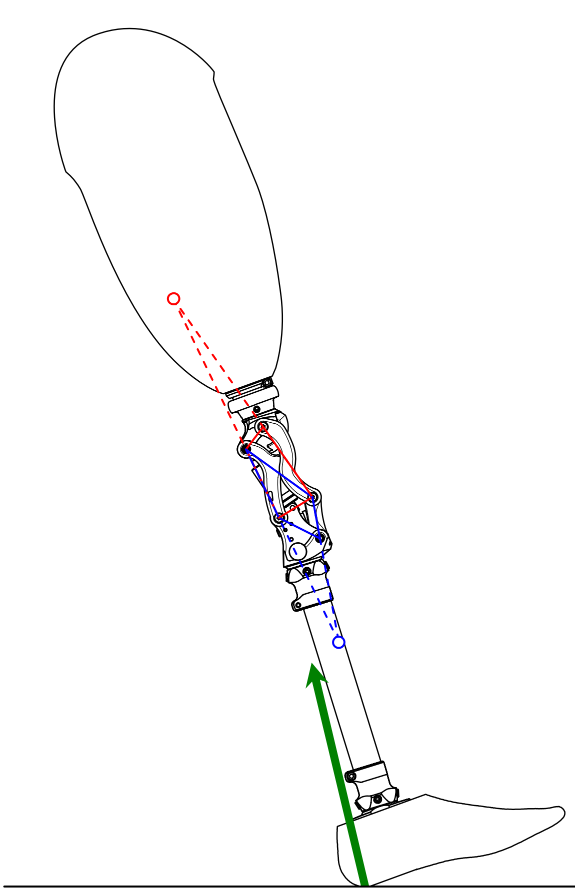
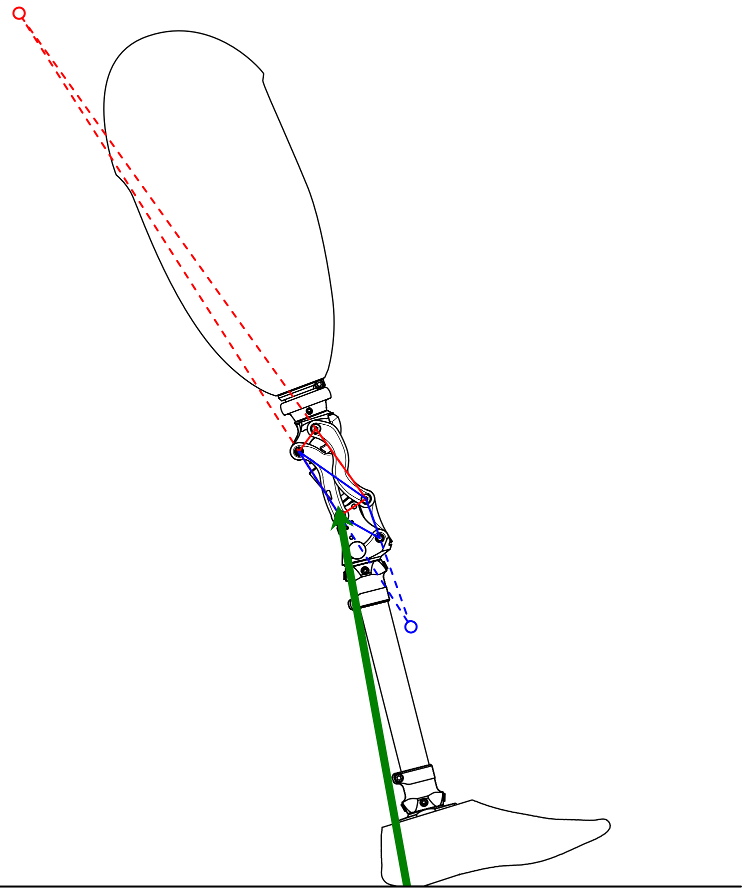


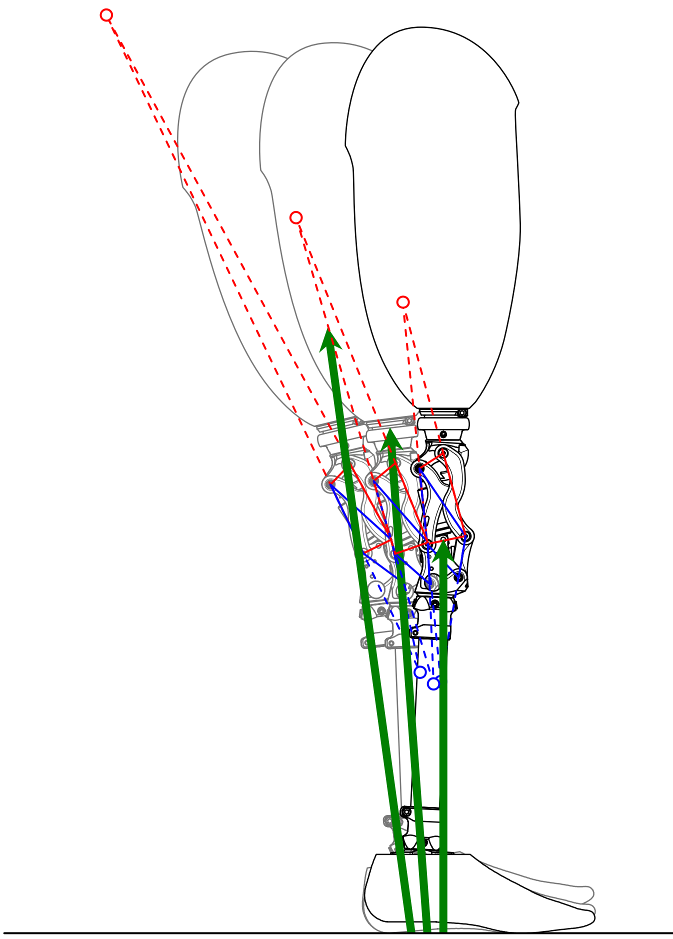
Fig. 1. Link mechanism of Swan



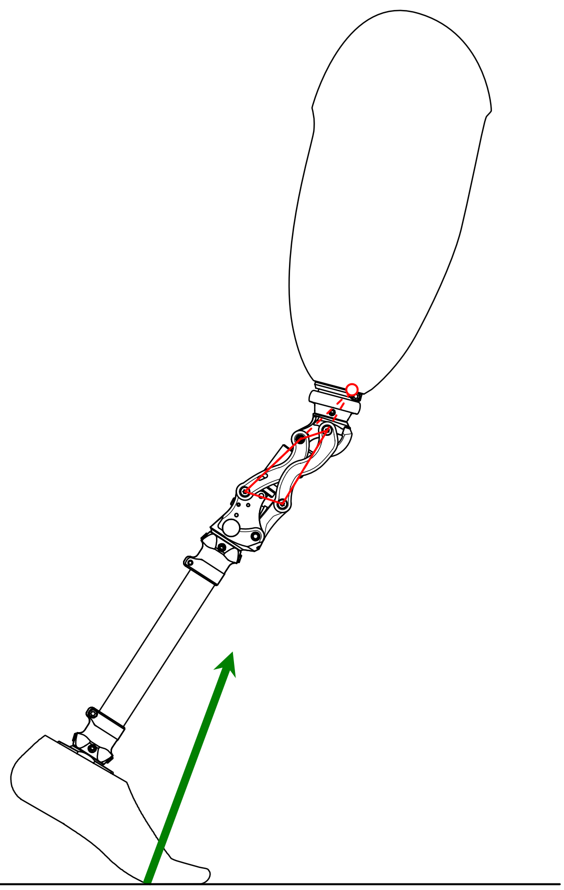
< Fig. 2-a. just after Heel-Contact >



< Fig. 2-b. between H.C. and Foot-Flat >



< Fig. 2-c. between Mid-Stance to Heel-Off >



< Fig. 2-d. Push-Off stage>

Fig. 2. Displacement of configuration of Swan links by loading

■ Bench alignment

In order to fulfill the proposed function of the knee, we recommend you to set up the prosthesis under following bench alignment.

■ in A-P plane (viewing from the outside)

The weight bearing line (the plumb line from the mid point of interior wall of the socket) has to pass the center of upper axis of anterior vertical link, lower attachment axis of hydraulic cylinder, reaching to mid of toe-break and heel edge (Fig. 3).

■ in M-L plane (viewing from behind)

The weight bearing line (the plumb line from the mid point of posterior wall of the socket) has to pass the M-L center of the knee and the foot.

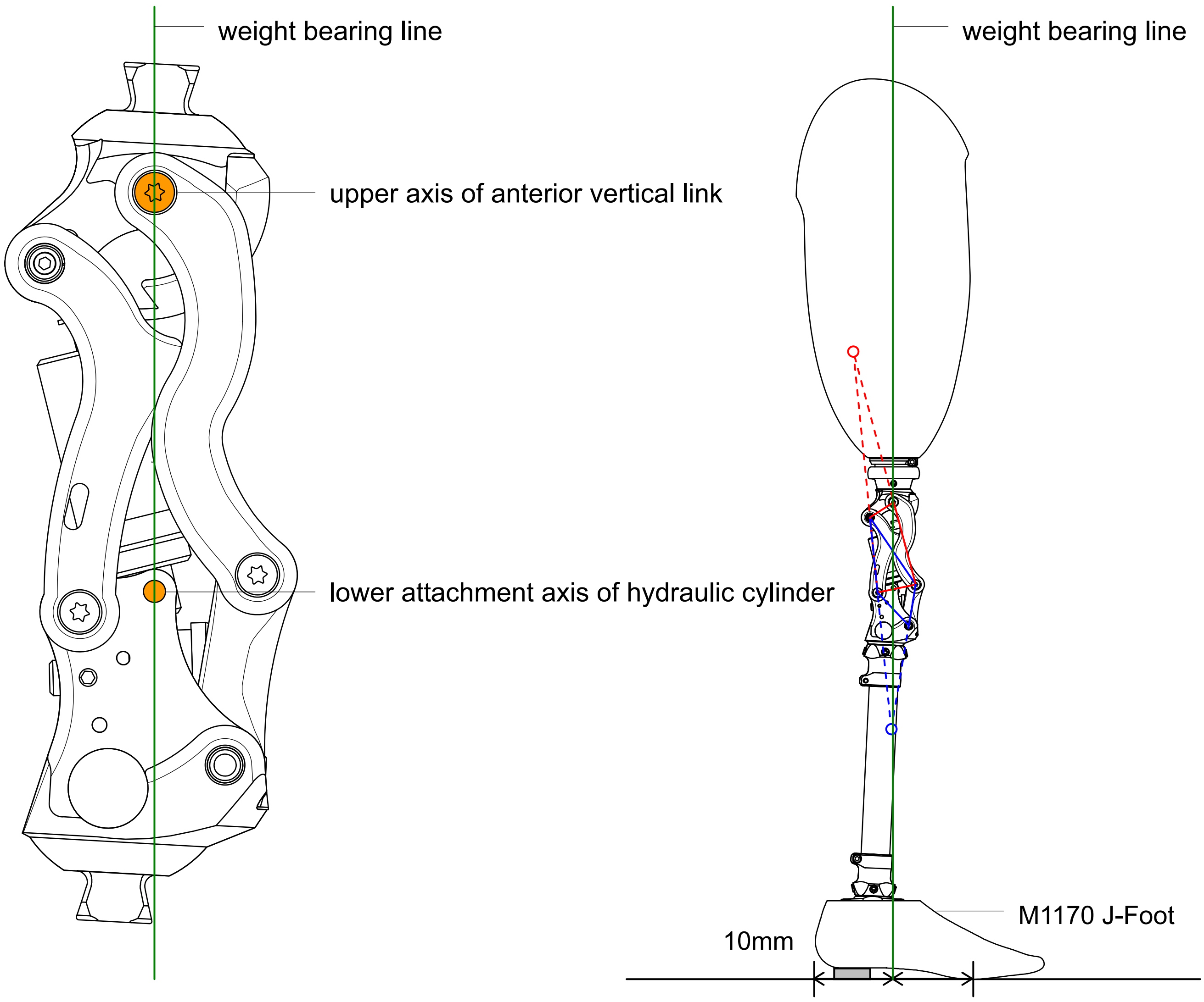


Fig. 3. bench alignment

■ Dynamic alignment

■ Adjustment of knee stability in stance-phase

A-P stability of fully extended knee at H.C. is affected by the position of knee axis.

In case of Swan, the position of I.C.R. of extended knee is changed dramatically just after loading, and become safety. The problem is in the difficulty to decide “how much and how soon” the loading should be applied on a specified case. Series of trial walk including a kind of trial and error based adjustments are required.

To minimize the difficulty, we recommend you following procedure.

□ The first step (Controlling the knee stability by “tilting the knee module in A-P plane”.)

When the knee seems too much stable,

During trial walking, if you aware following set of signals, such as

too much bouncing with mechanical noise,

natural knee flexion after heel-off seems difficult,

→ increase the forward tilt of the knee module (Fig. 4-a)

(weight bearing line passes anterior of the lower attachment of hydraulic cylinder)

(I.C.R. of basic set shifts forward)

(I.C.R. of bouncing set shifts backward)

When the knee seems instable

During trial walking, if you aware following set of signals, such as

patient feels (shows) instability at heel contact,

no bouncing movement in down slope walking,

→ decrease the forward tilt of the knee module (Fig. 4-b)

(weight bearing line passes behind the lower attachment axis of hydraulic cylinder)

(I.C.R. of basic set shifts backward)

(I.C.R. of bouncing set shifts forward)

□ The second step (Adjustment of the hardness of bouncing bumper)

In case of trial walking, patient may claim that the knee is not solid enough, thus, not reliable. Those instable feeling are usually caused by bouncing movement of the knee joint. If forward tilt of the knee is already enough and if there is no fear for knee buckling, increase of bouncing bumper hardness (i.e. increase of initial compression rate of the bumper) might be helpful to reduce those unfavorable feeling (Fig. 5).

① Loosen M4 screw (situated below of anterior vertical link, R side) using 2mm wrench.

② Rotate clockwise M8 screw (situated at behind of the knee) by **1/4 rotation (90 degrees)** using 4mm wrench.

③ Retighten M4 screw and repeat trial walk.

④ When the result found to be insufficient, repeat same procedure.

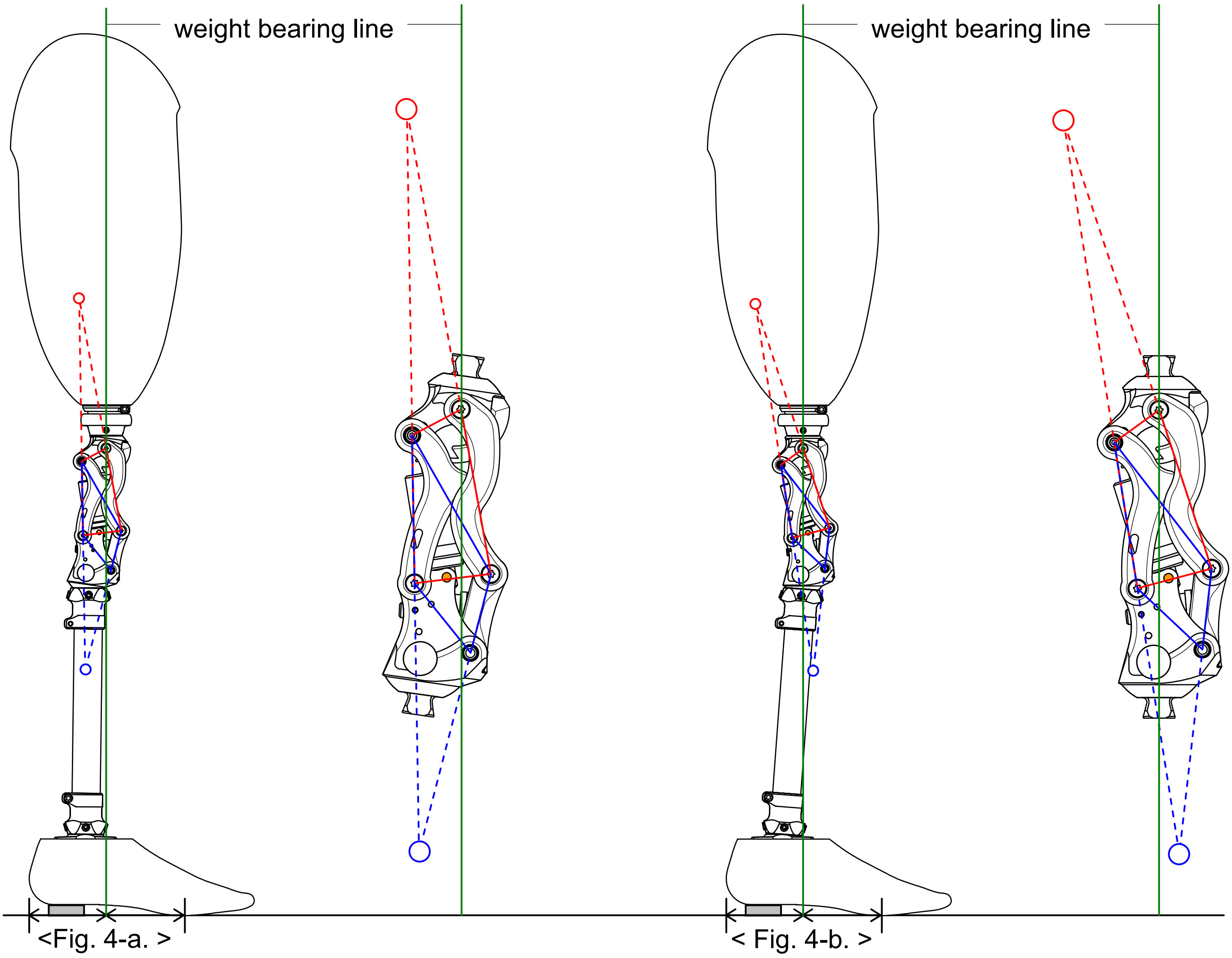


Fig. 4. Adjustment of knee stability in stance-phase

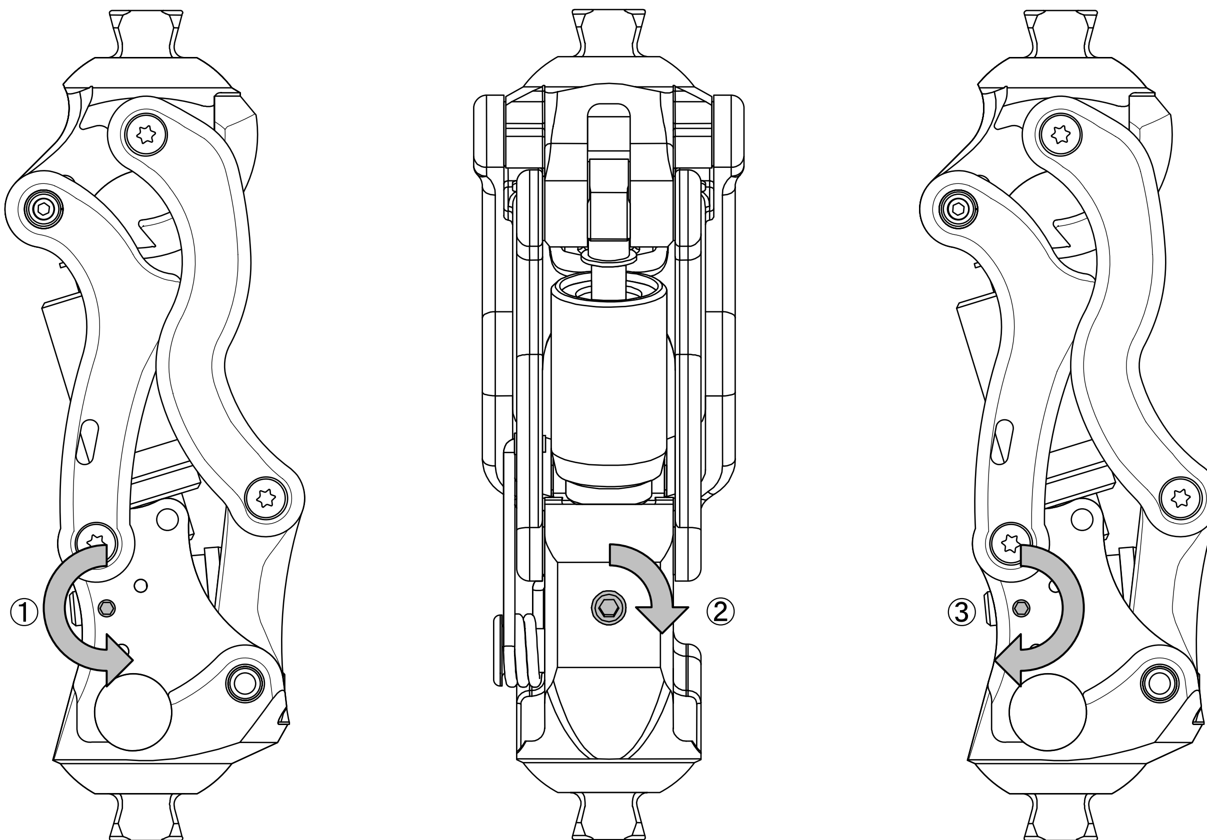


Fig. 5. Adjustment of the hardness of bouncing bumper

■ Adjustment of hydraulic cylinder for swing phase control

Adjustment of hydraulic resistance is possible for flexion only. Extension resistance is generated in accordance to extension velocity of the shank. Soon after the maximum flexion in swing-phase, the knee extends smoothly and reaches to full extension without terminal impact.

Counter clockwise rotation of the cylinder increases flexion resistance of the knee joint and vice versa. Hydraulic resistance will be changed from minimum to maximum by **1 and 1/4 rotation of the cylinder.　The device is set in minimum resistance at the time of shipping.**

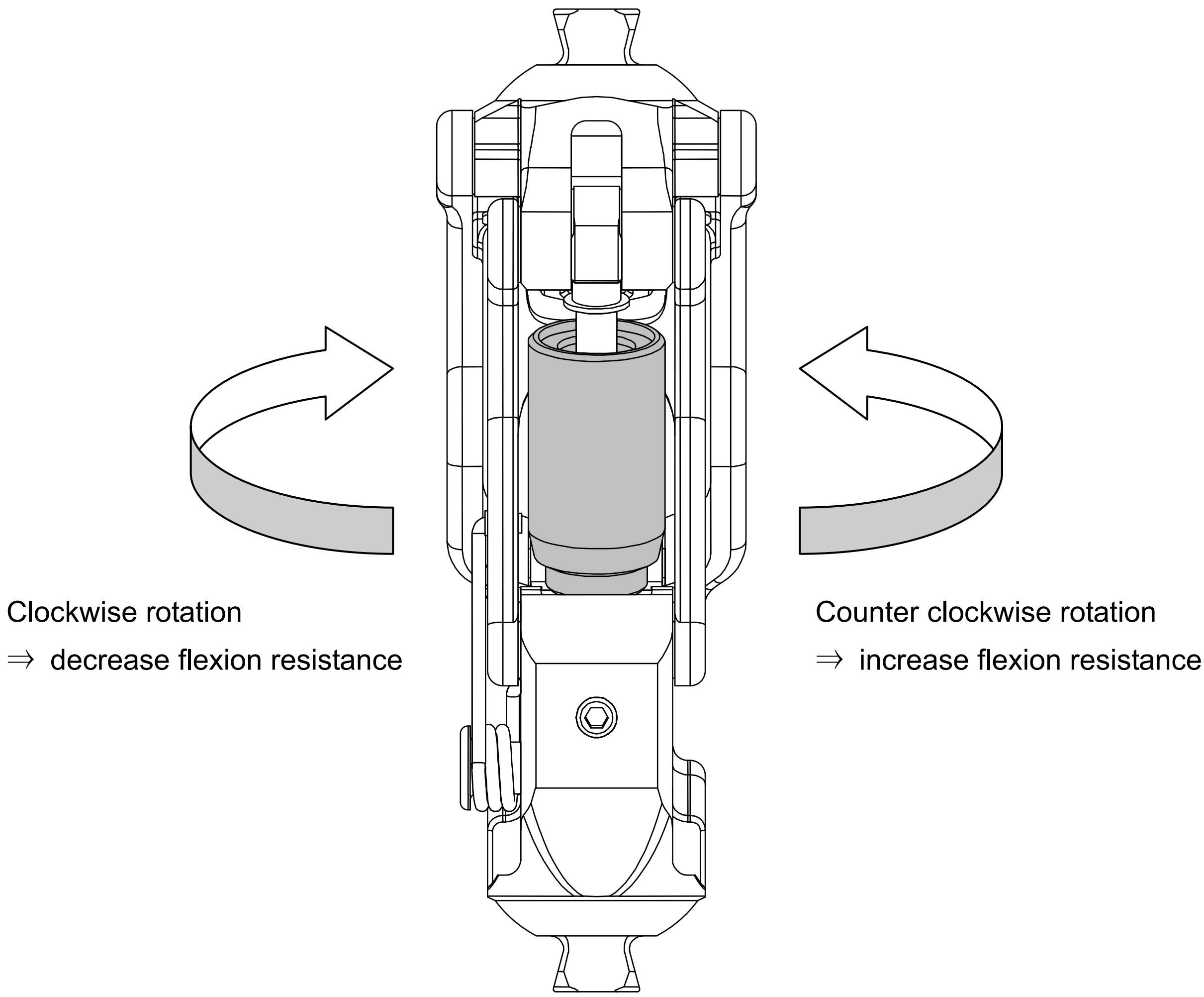


Fig. 6. Adjustment of hydraulic cylinder for swing phase control

In case of high velocity walking, higher hydraulic resistance is required.

In such cases, extension aid spring at the side will disturb the swing of the shank, and better results will be attained by the elimination of the spring.

■ Attention

1. Don't loose M8 screw (situated at behind of the knee). Before shipping, the screw is set as 2 full turns from the minimum compression.
2. Too much bouncing movement may damage dynamic stabilizing mechanism, especially in case of active patients who are able to stabilize the prosthetic knee joint voluntarily.
3. Use of very soft heel bumper or too small step length may not actuate dynamic stabilizing mechanism of the knee.
4. Heel Contact without full extension of the knee joint may cause knee-buckling.
5. If patient usually load on his prosthesis in maximum flexed position, put a shock reducing soft pads between socket and the knee (Fig. 7).
6. In case of maximum flexion of long stump, posterior end part of the socket may hit and damage the posterior link or hydraulic cylinder (Fig. 8-a). If it is inevitable, please change the hitting point to distal part of the knee to reduce moment force. Use softer material and make a new hitting point at more proximal part of the socket (Fig. 8-b).

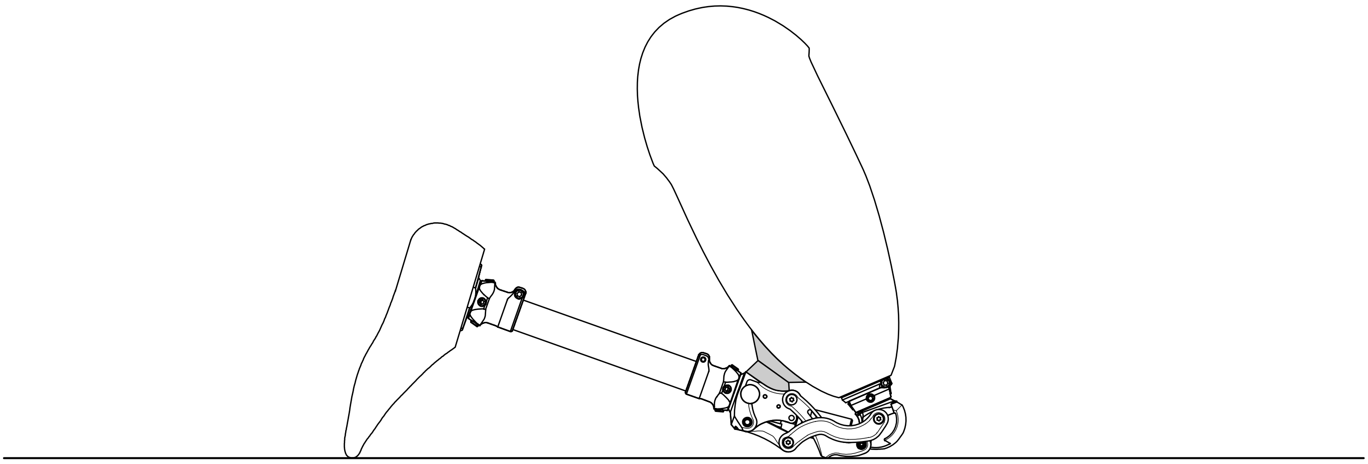
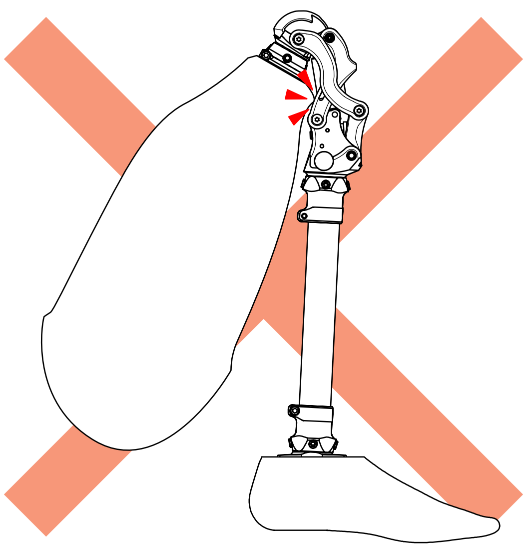
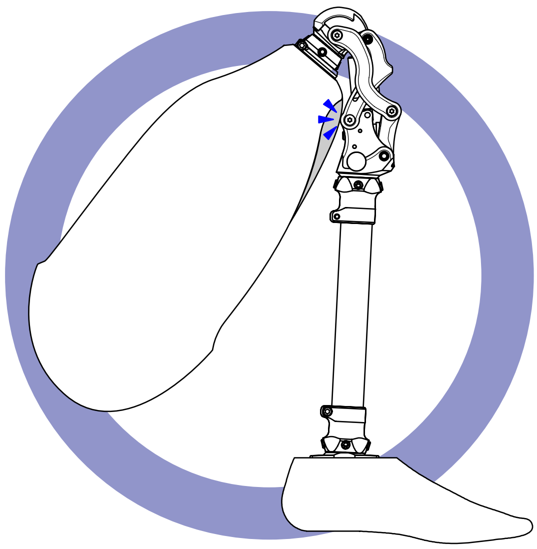


Fig. 7.



< Fig. 8-a. Bad >



< Fig. 8-b. Good >

Fig. 8.

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