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A MODIFICATION TO LOCK MECHANISM OF THE HYDRA NU-MATIC[1] KNEE CONTROL

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In the fabrication of an above-knee prosthesis, the goal is a prosthesis that provides the amputee with a comfortable, natural gait, and is light in weight.

Because of its durability, lightness, and smoothness of fluid control, the Hydra Nu-Matic knee control has been the choice of this author in many cases.

In some instances, for the severely handicapped —such as bilateral above-knee amputees, above-knee amputees with a very short residual limb, or the elderly—a locking knee control is desirable and often is prescribed. The Hydra Nu-Matic unit is provided with a mechanism that locks the knee by restricting the flow of fluid through the unit. The lock system furnished by the manufacturer consists of a string, a pulley, and a control ring.

To operate the lock, the string must be pulled in one direction to unlock, and the opposite direction to lock. In my experience, this method leaves much to be desired, because the string stretches and becomes out of adjustment and the control ring is difficult to locate and operate through the clothing.

A bilateral above-knee amputee with locked knees is at a great disadvantage because both upper limbs are occupied with a supportive device such as crutches, walker, etc., and he is not able to use his hands to manipulate bilateral locks when he wants to sit down.

To overcome these problems of a bilateral above-knee amputee, we have devised a system that adapts easily to the Hydra Nu-Matic unit

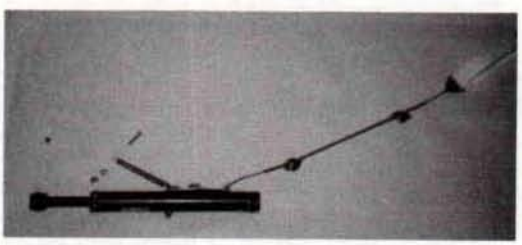

Fig. 1. Modified Hydra Nu-Matic unit. Note the coil spring that is attached distally to the slide bar.

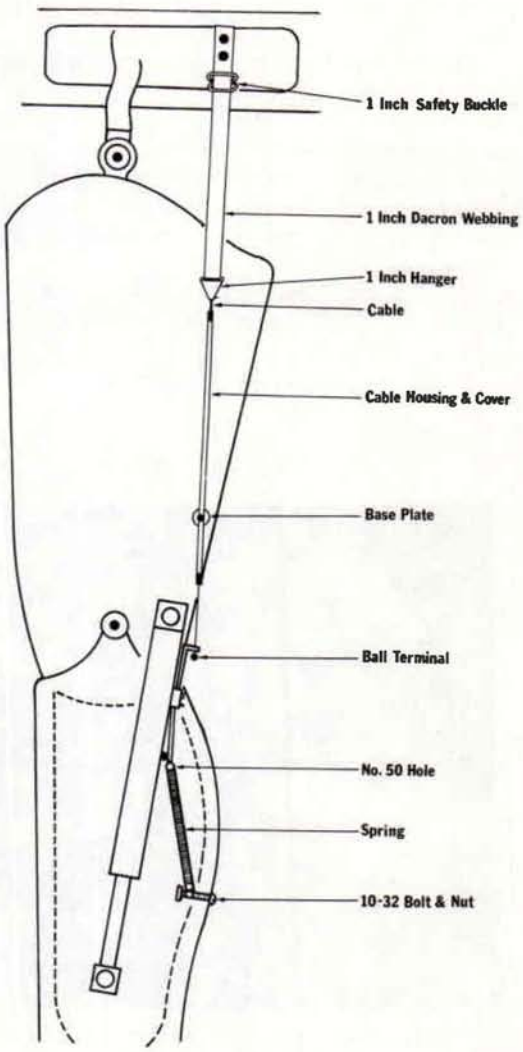

Fig. 2. Schematic of the modified Hydra Nu-Matic unit.

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with knee lock (Figs. 1 and 2), and allows the knees to be unlocked by use of hip flexion, automatically locked upon extension.

In a normal standing position the knees and hips are fully extended in balance with each other. When sitting position is begun, the hips start to flex first, and then the knees, and finally the body is lowered to the sitting position. In rising, the knees begin to extend and continue to complete extension, the body is almost in complete standing position before the hips are fully extended. At full hip extension the body is then erect and in complete standing balance. Utilizing these basic biomechanical facts, the lock control is harnessed and adjusted intimately to hip flexion and extension.

The case described here involves an 84-year-old male Caucasian with bilateral above-knee amputation with no hip-flexion contractures. Gangrene as a result of vascular insufficiency was the cause for amputation.

At the start of the cycle, the patient is in standing balance with trunk erect, hips extended, and knees locked.

Hip flexion begins and, at 15 deg.[3] of hip flexion, the knees unlock (Fig. 3) lowering the patient to the chair.

To rise, the patient pulls himself from the chair utilizing a walker and his upper limbs. The knees are extending. At full knee extension, the hips are in 15 deg. of flexion, and the automatic knee locks are engaged (Fig. 4).

The patient continues to full hip extension and standing balance (Fig. 5).

Fig. 4. As the hips extend to 15 deg., the knee locks are engaged.

Fig. 3. Hip flexion has caused the knee lock to be disengaged, and thus knee flexion is allowed.

[3]Degree of hip flexion may vary with the individual.

Fig. 5. The hip joints are extended and the knees are locked in full standing.

PROCEDURE TO ADAPT "HIP-FLEXION CABLE-CONTROL SYSTEM" TO HYDRA NU-MATIC UNIT

Drill a No. 50 hole in the extreme distal end of the slide bar for spring attachment. With unit installed, measure posterior and at midline 5-3/4 in. distal to end of slide bar and mark. Remove unit and drill a No. 11 hole through shin. A coil spring measuring 5/16 in. in diameter and 3-1/2 in. in length is attached inside the shin section with a 10/32 machine screw and nut. Install the Hydra Nu-Matic unit in the shin section, and hook the proximal end of spring through the No. 50 hole in lock slide. Complete assembly of prosthesis, thigh to shin section, with knee bolt in place.

For the cable assembly, standard component parts for an upper-limb prosthesis are used. Swage the ball terminal to distal end of cable, clip off the ball, and round the edges. Thread the cable through the posterior hole of the proximal end of lock-slide bar. Attach the cable housing to thigh section of prosthesis with base plates. Thread cable through housing, distal to proximal. Swage 1-in. hanger on the cable[4].

The control adjustment strap is riveted posterior-lateral to pelvic belt with a copper rivet to complete assembly.

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[4]Cable should be of sufficient length to allow travel of hanger during hip flexion, but not to extend over the proximal trim line of socket.