SUBSEQUENT DEVELOPMENT OF MOTORIZED ABOVE-KNEE PROSTHESES

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A motorized above-knee prostheses is developed in order to reproduce with the help of an autonomous outer energy source the active propelling function of the limbs, which normalizes the way the prostheses pushes from the support while walking on the prostheses.

First motorized a.-k.prostheses models were supplied with a drive with the effective power value of the electric motor drive = 6W and a springy accumulator with the energy capacitance 10 J for accumulating the energy during the whole double step phase and its periodical discharge in an impulse form, the power of the impulse by far exceeding the power of the drive. Said impulse is realized in the form of a moment of force performing sharp sole flexion of the foot during the "back-push" phase.

Although said prostheses models didn´t provide complete equalization of the supporting reactions both of the remained leg and the artificial leg because of insufficient drive power the study of amputee walking on the prostheses model has shown intrinsic peculiarities as follows:

- dynamic asymmetry and walking arrhythmia were considerably reduced (on the average of 50% and 25%, respectively);
- the overloading of the remained leg was reduced (by 15% according to the energy loss in the large joints);
- the general energy expenditures of the organism while walking along the plane surface were also decreased;
- thanks to the diminished time of swinging the prostheses over the support it was possible to increase the step frequency a minute;
- the control of the swinging the prostheses oyer the support was improved (the amputee is unaware of the prostheses weight in the swing phase of the step).

In order to increase the effectiveness of the motorized artificial legs, to normalize more completely walking on the prostheses, to equalize the supporting reactions of both extremities and to increase functional potentials of the motorized a.-k. prostheses a model was developed with an increased effective power of the drive (N drive = 18 W) and a new type

of reduction gear with an increased efficiency and a cam of specific profile at its outlet. Transmission relation was selected taking into consideration has conditions of fast walking.

A coil cylindrical extension spring was used as a resilient component in the accumulator; but wheras only one spring was employed previously to store energy both of the drive and of the rolling movement in the second prostheses model the energy accumulation occured separately in two springs. Thanks to this fact the resiliency of the rolling over the forefoot can be adjusted depending on the weight of the patient, his gait peculiarities and other factors.

The first motorized a.-k. prostheses was supplied with an ordinary aritificial foot used in the available lower extremity prosthesis. However, the known aritificial foots were found to be not effective enough for being used with the motorized prostheses as they don´t allow to exploit all the energy stored in the spring to intensify the "back-push" because of absorption of essential portion of said energy by the back buffer (an elastic element) or by the central shock-absorber.

A two-link artificial foot has been developed with regard to indicated peculiarities of the energy accumulation; the forefoot is connected with the heel by means of a joint.

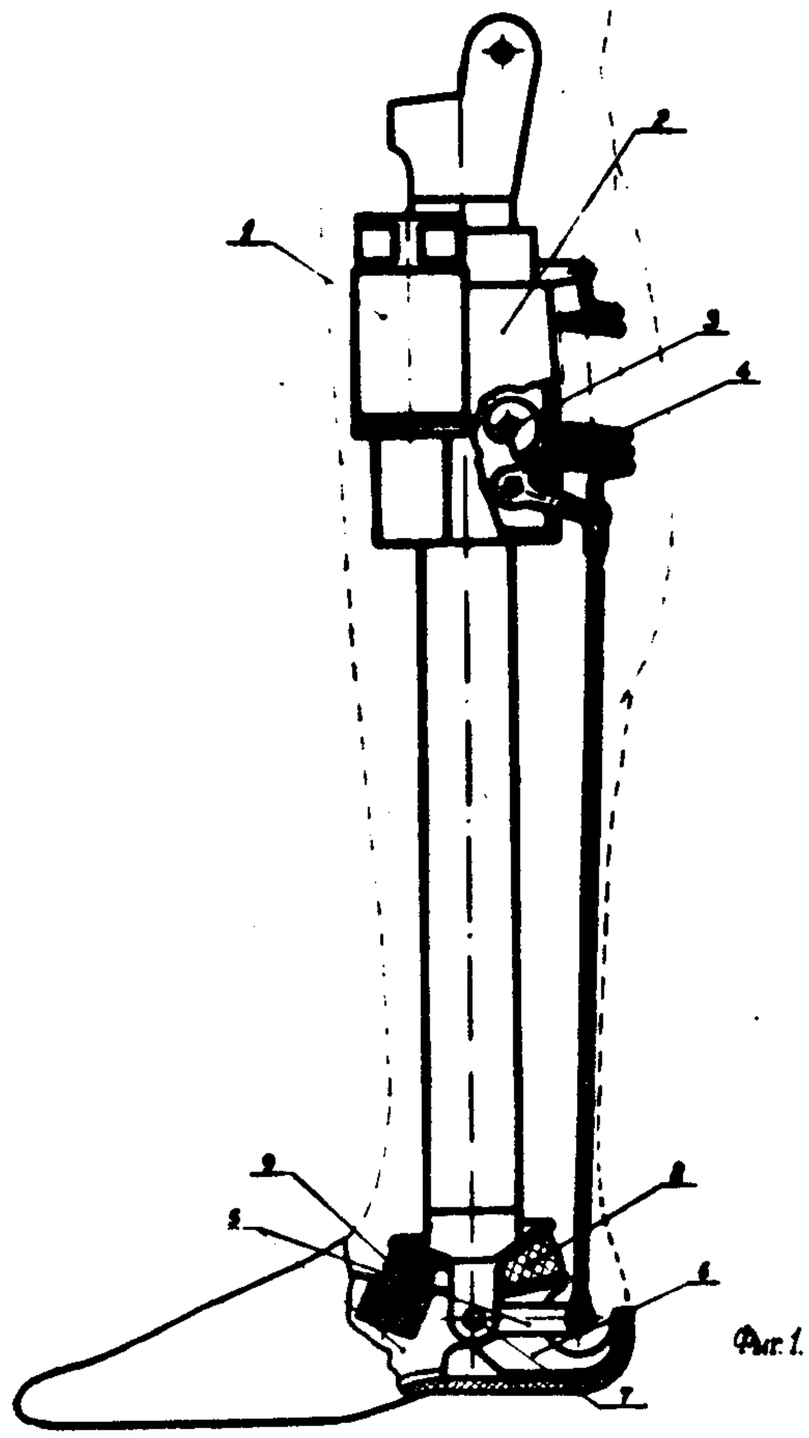
By a two-arms lever of the forefoot the potential energy accumulated in both springs was transmitted to the forefoot in order to perform the sole flexion of the foot at the end of the supporting phase and to intensify the "back-push".

The necessary absorption of the "front-push" at the beginning of the supporting phase of the step is obtained at the cost of the back buffer (the elastic element) or of the central shock-absorber, and when supporting on the foot the absorption of the vertical loading is realized in full mesure. This is promoted by the "spreading" of the two-link foot, which is built in the form of hinged arch.

The application of the two-link foot makes it possible to use almost all energy accumulated in both resilient elements during the double step phase to reproduce in the prostheses the active propelling function by means of the intensified "back-push".

The two-link foot can be used not only with motorized lower limb prosthesis but also when walking on the ordinary prosthesis.

Thus, the second model of the motorized a.-k. prostheses represents a further step in motoprosthetics.



Фиг. 1

Fig. 1 Schematic diagram of a motorized above-knee prostheses.
1 - electric motor; 2 - reduction gear; 3 - cam; 4 - springly accumulator; 5 - forefoot; 6 - heel-section of the foot; 7 - ankle joint; 8 - back buffer; 9 - front buffer (spring).