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A HEAT GENERATING SOCKET

John Ficociello, C.P.[1]
Thomas Trudell, C.O.[1]
Albert Hebert, Pros. Tech.[1]

A problem encountered often in northern climates is adaptation to cold environments. For amputees, this can be a severe problem because the laminated resin socket transmits heat readily from the residual limb to the cold environment.

In an attempt to improve the patient's tolerance to extended periods of outdoor activities, such as snowmobiling and skiing in extreme weather conditions, means of providing heat in addition to the heat generated by the body within the prosthesis was investigated and an auxilliary heating system was developed for a very active below-elbow amputee.

A number of solutions were considered and rejected before success was realized. The use of a commercially available heated foot sock proved to be inadequate because of the pressure of the wires on the residual limb as well as wrinkling of the sock inside the socket. Insulating the inner socket from the outer lamination with polyurethane foam, though functionally quite adequate, presented a cosmetic problem as a result of the increased size of the prosthesis.

The solution that seemed to be the optimum was the use of high resistance electrical wires within the laminated wall of the socket and an external source of electricity. This system worked satisfactorily for a short period of time, but wires soon fractured at the point where they emerged from the socket, rendering the embedded wires unusable. After additional research, we now have what we feel is a practical and durable heat generating system.

We used the conventional procedures for casting, modifying the cast, and we used a check socket. After an accurate, positive mold was obtained, we began with a layup of one layer of Perlon stockinet.

To this initial layer, we spot-glued #25 gauge, non-coated wire (Fig. 1). The wire was initiated at the distal end of the mold and brought proximally, in a spiral fashion, care being taken not to cross the wire on itself. A #20 gauge, coated wire was then soldered to the #25 gauge wire at the distal end of the model and then brought directly proximally to a female plug receptacle at the trimline (Fig. 2). The proximal end of the #25 gauge, non-coated wire was also brought to the receptacle and both wires were soldered to it.

Because the proximal trim line of the socket was determined accurately at the time of the check socket fitting, we were able to spot glue and laminate the receptacle so that only

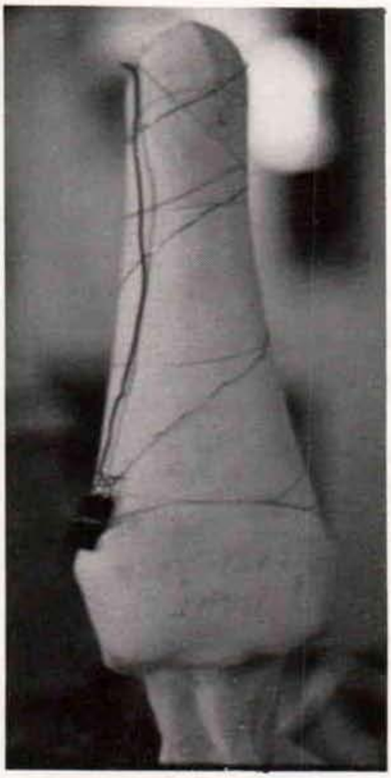

Fig. 1. A No. 25 gauge non-coated resistance wire is spot-glued to the initial layer of Perlon stockinet of the below-elbow socket. A No. 20 gauge coated resistance wire is soldered to the No. 25 guage wire at the distal end of the model and brought proximally to a female electrical receptacle located at the trim line of the prosthesis socket to be fabricated.

the two plug holes were exposed at the proximal edge of the socket (Fig. 3).

The rest of the lay-up and lamination was carried out along conventional lines. Extreme care should be taken when breaking the mold out of the socket. Obviously when any part of the wire is damaged, the system will not function.

To the male plug, we soldered #16 gauge, coated wire (Fig. 4). The #16 gauge wire was then hooked to a six-volt dry cell battery, which our patient preferred for his purposes. For skiers, hunters, or anyone that does not want the inconvenience of the six-volt dry cell, this system could easily be modified to utilize the power packs used to power myoelectric prostheses. Such a system permits location of the power source within the prosthesis or on the person.

This system, when followed correctly, supplies heat sufficient to warm the residual limb, but not enough to burn the amputee, or to affect the cured laminate. The amputee simply "plugs" in the prosthesis when the residual limb feels cold, and "unplugs" it when the residual limb is warm enough (Fig. 5). We feel that this system is not limited to upper-limb prostheses, but will be useful in lower-limb applications as well.

Footnotes

1 Roy's Orthopedic, Inc., 33 North Avenue, Burlington, Vermont, 05401.

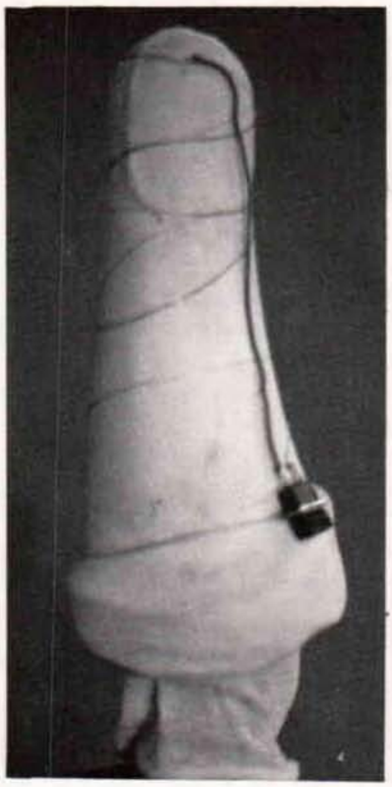

Fig. 2. Another view of the assembly shown in Figure 1.

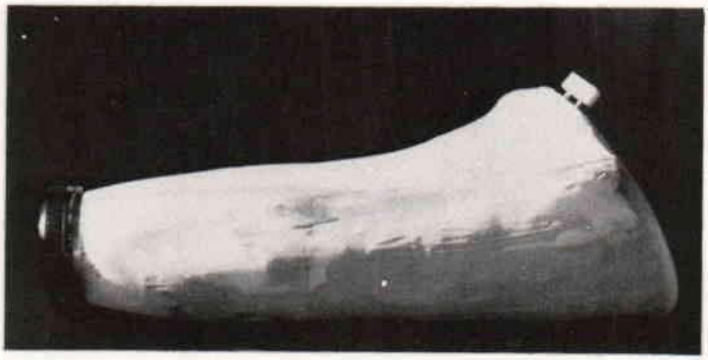

Fig. 3. The male electrical plug in this view taken during the fabrication process shows the position of the female receptacle at the trim line of the prosthesis socket.

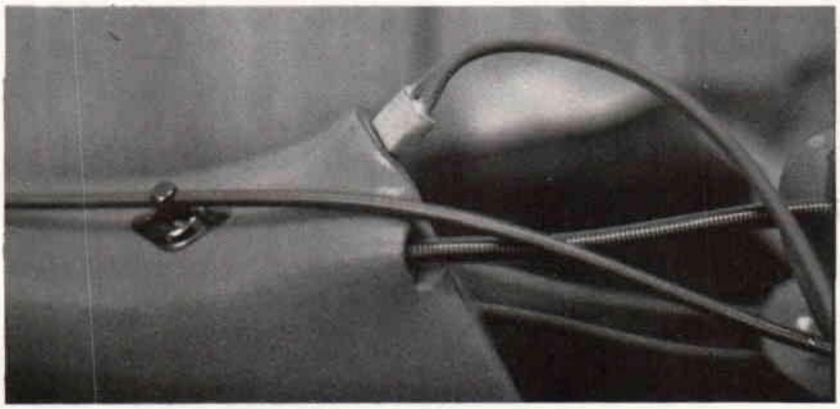

Fig. 4. Close-up view of electrical connection at the socket brim. This arrangement avoids breakage of wires that could be expected if the wires were simply brought out between the laminates.

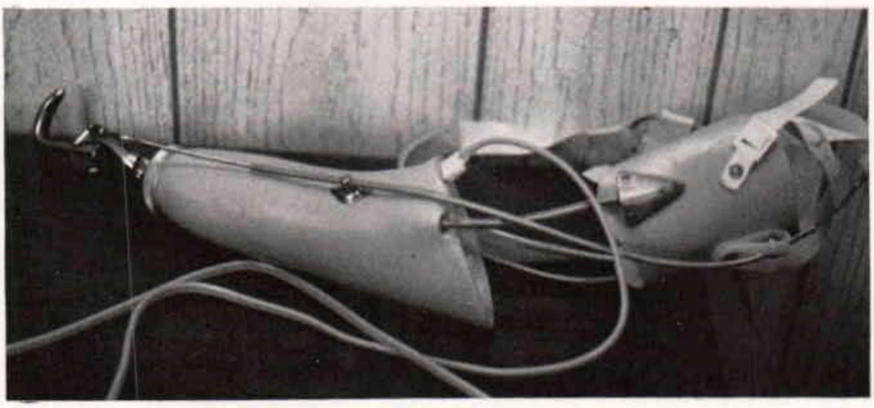

Fig. 5. The completed prosthesis with the power source plug in place.