The Navy Prosthetics Research Laboratory Impulsion Valve

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PERSPIRATION of the stump while a prosthesis is being worn has always been a problem to a sizable segment of the amputee population. As a rule, amputees perspire at a greater rate than is normal even without the prosthesis. The newer, total-contact sockets as designed and introduced offer no provision for ventilation. Although in the case of some patients who sweat profusely during the initial use of total-contact sockets the problem seems to disappear after a period, there remains a sufficient number of cases in which perspiration presents a real problem.

In an attempt to provide ventilation in sockets, many prosthetists have drilled or punched many small holes in the socket walls, but this has not proven to be very satisfactory. Because of the high concentration of sweat glands in the extremities (as many as 80 per square cm.), it is virtually impossible to provide mechanically a sufficient number of holes in a socket wall to give adequate ventilation and retain the necessary strength.

To overcome this dilemma, porous plastic laminates *(1, 2)* that permitted breathing were developed. These have proven to be quite satisfactory for upper-extremity prostheses but much less so for lower-extremity sockets where strength is a paramount problem. Except in cases where the prosthesis is subjected to only light loads, when the socket walls are made thick enough to withstand the stresses imposed the socket becomes intolerably bulky. Because porous laminates offer an almost ideal solution, work is continuing on their refinement.

Meanwhile, experiments and clinical experience indicate that the use of an inexpensive impulsion valve developed by the Navy Prosthetics Research Laboratory has been helpful to many patients, though not the ultimate solution to their perspiration problems.

The impulsion device (Fig. 1) in its present state is simply a ball-type check valve arranged so that air is drawn into the stump sock during the swing phase of walking, or when the prosthesis is not bearing weight, and the air is expelled through the stump sock when the stump is forced into the socket as in the stance phase of walking. The valve consists of only two parts, the ball and the housing. The ball is made of polyurethane to prevent clicking noises experienced with other materials. Two sizes of the valve accommodate the entire amputee population (Fig. 2). They are available commercially.[2]

The recommended method of installation for a total-contact below-knee socket with a liner is shown in Figure 3. The valve, of course, can be used without a liner and in any socket when a stump sock is used.

To determine some idea of the effectiveness of the impulsion valve, 41 amputees participated in a controlled experiment conducted by NPRL. Two subjects had above-elbow amputations, two had Syme's amputations, and the remainder were below-knee amputees. Thirty-one felt that perspiration was a problem to them. The subjects walked for 20 minutes in a controlled high-temperature, high-humidity atmosphere with and without the valve. The weight of the stump socks was compared in each instance to determine any reduction in the accumulation of sweat. The average amount of reduction was 39.7 per cent *(2)*.

Later, at New York University, 11 patients, all below-knee amputees wearing patellar-tendon-bearing sockets satisfactorily, were pro-

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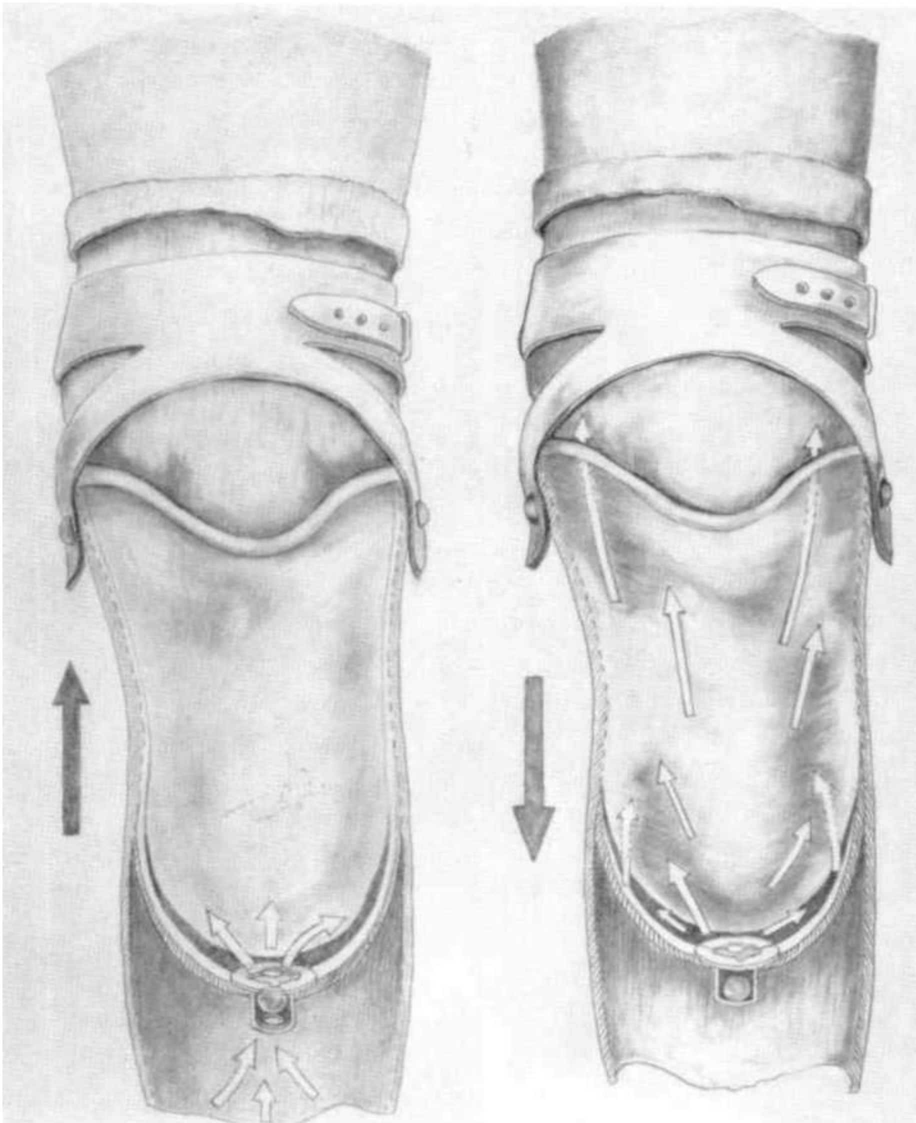
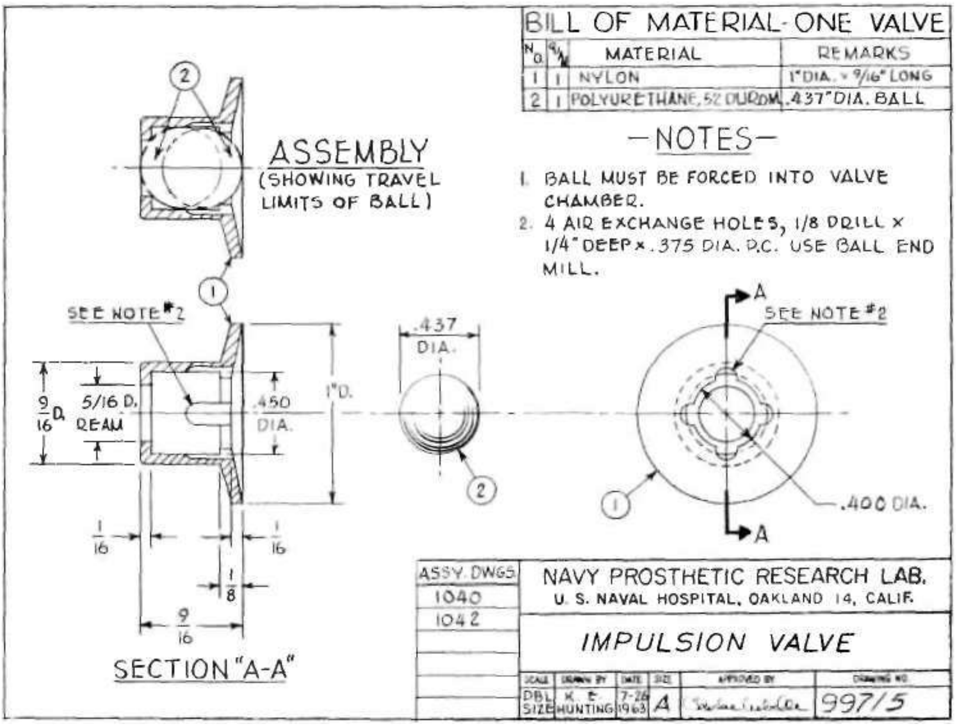


Fig. 1. The function of the Navy Prosthetics Research Laboratory impulsion valve. When the socket is in suspension, air is drawn into socket and stump sock. Whensocket is bearing weight, air is expelled around proximal periphery of the socket.

vided with impulsion valves. NYU reported as follows: *(3)*

In the first stage of the study, three subjects withdrew shortly after delivery. One subject withdrew because of a complaint that the valve produced a disagreeable sensation in his stump. He was unable to elaborate any further on this complaint and refused to cooperate in investigating this matter. Therefore this subject's contribution to the study must be viewed with reservation. Two other subjects discontinued wearing their prostheses for medical reasons not related to the installation of the valve.

The remaining eight amputees in the study reacted positively to the effects of the valve. Seven subjects reported a noticeable improvement in their sweating condition. Four subjects with serious sweating problems said that they noticed a measurable reduction in moisture accumulation in their sockets. The other three subjects whose sweating problems were relatively minor (not troubled with sweat accumulation) reported that



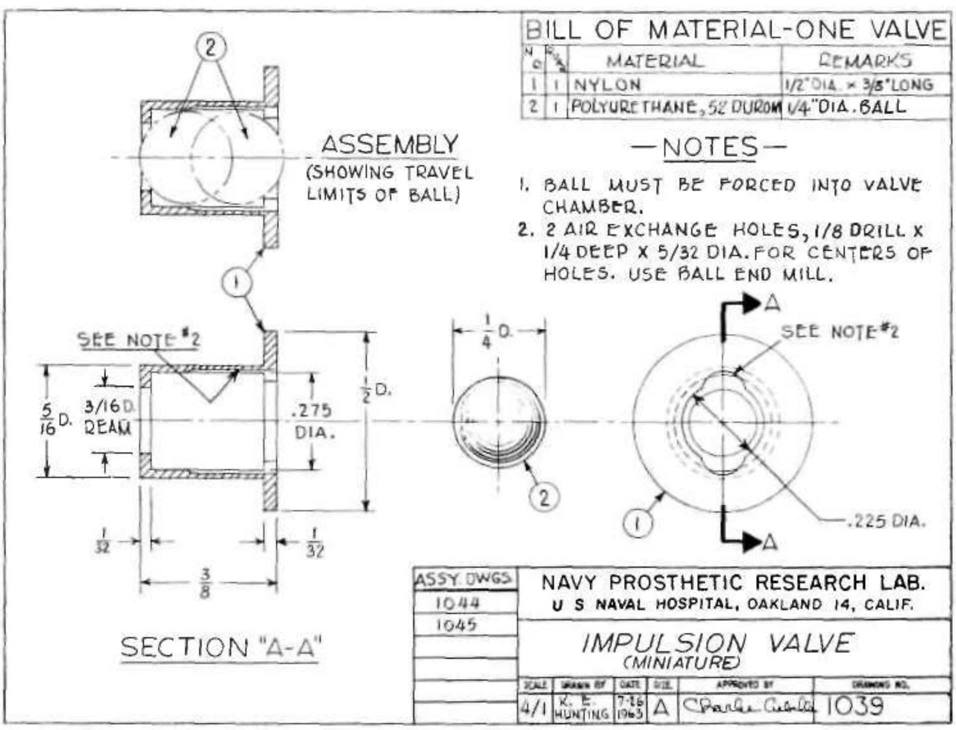


Fig. 2. Details of the two sizes of the NPRL impulsion valve.

INSTALLATION INSTRUCTIONS

Installation in Patellar-Tendon-Bearing (PTB) limb with liner (Fig. 3):

1. Make alignment marks posteriorly on socket and liner to assure replacement in the same position.

2. Remove liner and punch a mark in the bottom of socket (center) and drill a 1/2-in. hole. Countersink is not required because shaped valve flange will not be felt through liner.

3. Ream 1/2-in. hole with 9/16-in. reamer. Remove particles and dust. Trim away ends of any material remaining.

4. Coat the lower surface of valve flange and the matching area around hole in socket with a thin layer of rubber cement. Allow to dry. Press valve into hole from above, being sure that the flange seats firmly against the opposing socket surface. Do not foul inside of valve or ball with the cement.

5. Punch a clean, 3/16-in. hole through liner so that it falls directly over the valve below. Passage of air through valve and liner must be free.

6. Using alignment marks, replace liner.

7. For legs in which the. shin is not perforated, drill a 3/16-in. hole in the ankle region to assure communication of valve intake with outside atmosphere. For foam-filled shins, gouge small air channel for same purpose.

LITERATURE CITED

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3. New York University, Prosthetic and Orthotic Studies, School of Engineering and Science, *Evaluation of the Navy impulsion valve,* November 1965.