

VETERANS ADMINISTRATION PROSTHETICS CENTER  
RESEARCH REPORT

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#### I. DEVELOPMENT AND EVALUATION

##### A. Prosthetics

###### 1. Lower Limb

a. *Graphite-Epoxy Shank for Partial Thigh Endoskeletal Prosthesis.* Since the last progress report (BPR 10-27) the knee casting for the knee joint has been completed. When the prototype model is received from the manufacturer, the system will be evaluated.

The graphite SACH foot keels were produced by Browning Manufacturing Co., Morgan, Utah, and the feet were manufactured by the Kingsley Manufacturing Co., Costa Mesa, California. The feet are now ready to be attached to the shank.

b. *Prosthetic Skin.* The "prosthetic skin," i.e., cosmetic technique using cosmetic covers of soft polyurethane foam, developed under a VA contract by George Washington University (BPR 10-26, p. 217), is being used routinely at the VAPC for external cosmetic covers for the Multiplex system. The covering is also useful for below-knee endoskeletal covers made of rubber or soft polyurethane foam (Fig. 1). A durable cosmetic cover in any of eight different shades can be produced. A videotape describing the entire process is available upon request from the VAPC in New York City.

c. *Mortensen Safety Knee.* The Mortensen Safety Knee, designed and developed by the Kingsley Manufacturing Company, Costa Mesa, California, is a safety knee with a spring-backstop installed in a wood and urethane foam knee shin setup. It has a conventional wood shin with a standard knee bolt and side straps. The knee block is cast of high-density structural polyurethane rigid foam. The spring-backstop serves both as an extension stop and an extension assist; extension bias is adjustable.

Stance phase knee-locking action is accomplished by two friction brakes that clamp to the knee bolt when weight is applied to the prosthesis. Swing-phase resistance can be increased or decreased by tightening or loosening the friction brake adjustment screw. Due to the stability of the knee, the recommended alignment procedure is started with the knee center slightly anterior to the ankle center.



FIGURE 1.—Prosthetic skin for below-knee endoskeletal covers.

The Mortensen Safety Knee is included in the VA National Artificial Limb Contract.

d. *Nitschke-Tindall Ankle Rotator*. The Nitschke-Tindall Ankle Rotator, designed and developed by the Rochester Orthopedic Laboratories, Rochester, New York, is an axial rotator. The mechanism includes a rubber bumper located in the posterior section that returns the foot to a neutral position after rotation occurs. Amputee sub-



jects fitted in our Patient Care Service commented on the reduced weight as compared with other rotators. This rotator appears to be more simply designed than other rotators.

## 2. *Upper Limb*

a. *Improved Suspension for Wrist Disarticulation Prostheses.* For years, amputees with wrist disarticulations or transcarpal amputations were fitted by conventional methods: with flexible hinges and figure-eight harnessing to control the terminal device. Newer socket designs, such as the supracondylar suspension system, have provided more freedom by eliminating the need for a harness. However, this type of socket limits elbow flexion and extension, and eliminates wrist supination and pronation.

The Patient Care Service is developing a suspension system that utilizes a silicone rubber liner for long below-elbow and wrist-disarticulation prostheses. The liner, which is similar to the closed Syme prosthesis, is a separate component of the system and can be removed. The friction between the liner and the socket walls provides additional suspension to the rubber insert above the styloid process.

This system was first fitted to a transcarpal amputee who had active wrist flexion and extension, normal muscle strength, and full range-of-motion throughout the limb. He was able to flex his wrist to close the hand, and extend his wrist to open the hand. Since the friction between the liner and socket walls, together with the effect of the built-up area just proximal to the styloids, provided adequate suspension, no harness was needed. The patient could perform all activities without inadvertently opening or closing the hand. The suspension system could withstand a pulling force of up to 50 lb. After 1 year of wear, this patient experienced no skin irritation or other adverse reactions from using the system.

We are currently attempting to fit a wrist disarticulation patient with a similar system, except that this unit will be myoelectrically controlled instead of switch controlled, and a new myoelectric hook, developed by the VAPC, will be used.

b. *The Northwestern University Synergetic Hook.* The VAPC and RCP are conducting a field evaluation of a myoelectrically powered prosthetic hook developed at Northwestern University. Participating in the study are the VAPC, RCP, and the VA Hospitals at Miami, Atlanta, Houston, West Virginia, and Boston.

Twelve hooks are being tested by patients for function and durability. Also being tested are its range of applicability, and the ease of installation, maintenance, and repair. The program is being con-

ducted over a period of 3 months. The results and recommendations will be sent to Northwestern University.

## **B. Orthotics**

### *1. Upper Limb*

*Counter-Force Elbow Orthosis.* In previous issues (BPR 10-25 and 10-26) we have described a functional elbow orthosis used for incomplete brachial-plexus-injury patients. This device (Fig. 2) utilizes a shoulder cap to stabilize the shoulder and upper arm, especially during elbow flexion. A gas "spring" cylinder with strong pulling action effectively replaces weak biceps muscles. A small wrist cuff lifts the hand into position.

Patients with near-normal hand function and elbow extensors, but poor or zero elbow flexors, are ideal candidates for this system because the shoulder cap provides all the necessary support and suspension and no shoulder motion is required. Several units are scheduled to be fabricated and distributed for further evaluation at other VA stations.

### *2. Lower Limb*

*Orthotic Transverse Rotator.* Mr. John Glancy, Indiana University Medical Center, has developed a lightweight ( $\geq 12$  oz) transverse rotator for lower-limb orthoses. The rotator consists of a nylon casement or housing that is inserted into a shoe sole to permit the wearer to glide his body forward by rotating on a Teflon surface in the transverse phase. A long steel shank attaches the rotator to the shoe. The rotator reduces friction to a low level at the shoe-floor interface and thereby provides external transverse rotation to substitute for lost motion that normally occurs in the subtalar joint.

Four rotators have been fitted to various orthotic users and preliminary reports are favorable. Patients find it easier to ambulate and make left or right turns. The durability of the device over a 3- to 6-month period is currently being tested.

## **C. Spinal-Cord-Injury Rehabilitation**

### *1. Environmental Control Systems*

*a. The VIP-100 Speech Recognition Environmental Control System.* The VIP-100 Speech Recognition Environmental Control System, manufactured by Threshold Technology, Inc., Delran, New Jersey, is a voice-operated system designed for quadriplegics. An initial checkout and operational test of the system has been



FIGURE 2.—Counter-force elbow orthosis.

completed, and the device is currently being evaluated at the VA Hospital, Castle Point, New York.

b. *Johns Hopkins Remote-Manipulator* (also known as the JH Medical Manipulator/Worktable). The Johns Hopkins Remote-Manipulator (Fig. 3) was designed and developed by the Johns Hopkins University Applied Physics Laboratory, Baltimore, Md., for disabled persons with little or no use of their upper limbs. Used in conjunction with a worktable, the Remote-Manipulator provides its user with such capabilities as self-feeding with a spoon or fork, handling and reading certain magazines and newspapers, turning appliances and environmental controls on or off, and operating such pushbutton-controlled devices as a touch-tone telephone, an electric typewriter, a desk calculator, and a tape recorder.

The Remote-Manipulator is currently undergoing field and laboratory tests at the Castle Point, New York, VA Hospital. After these tests, the device will be tested at the University of California Biotechnology Laboratory in Los Angeles.



**FIGURE 3.—Johns Hopkins Remote-Manipulator.**

c. *Prentke Romich ECU-1 Environmental Control Unit.* The Prentke Romich ECU-1 (Fig. 4), previously reported on in BPR 10-27, is manufactured and distributed by the Prentke Romich Company, Shreve, Ohio. This environmental control unit allows quadriplegics to operate various electrical appliances via single-switch or dual-switch activation. Several units have been evaluated to determine their safety, effectiveness, and usefulness.

Several subjects, both homebound and hospital patients, participated in the clinical trials. The consensus reached by the participants was that the system was useful, and that operating the system was easy to learn.

d. *Remote Outlet.* The Remote Outlet is commercially available from General Teleoperators, Inc., Downey, California. The device consists of a 125 V a.c. receptacle that provides power for appliances, such as radios or lamps, that are located up to 15 ft (4.57 m) away from an environmental control unit. The device is plugged into a standard 125 V a.c. wall socket; it is controlled by a low voltage control line from the environmental control unit.

Several Remote Outlets are currently undergoing clinical trials at the VA Hospital, Castle Point, New York.

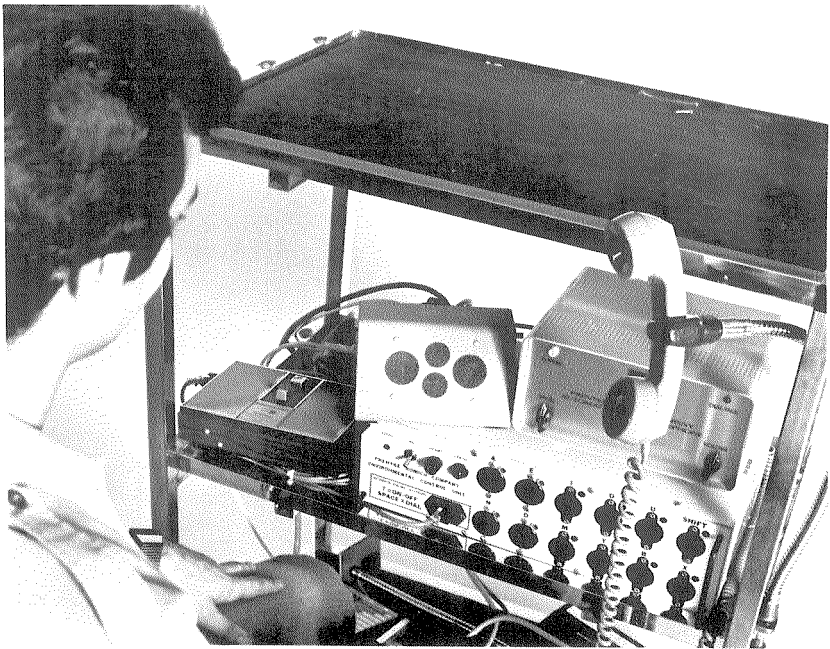


FIGURE 4.—Prentke Romich ECU-1.

e. *Adapted VAPC Hospital Environmental Control System for Home Use.* An environmental control system was modified for a legally blind, paralyzed individual who is able to distinguish between colors. The user activates or deactivates an appliance by sipping or puffing on a pneumatic tube. This action also illuminates indicator lamps, sequentially, on the Monitor Unit that correspond to the appliances being activated. To operate the system, the user must memorize a code that is related to the number and color of lamps on the Monitor Unit. White and green are used for convenience appliances and marginally essential appliances, such as electric beds and night callers. Red is used for emergency devices: an automatic telephone dialer that transmits prerecorded messages, the VAPC Patient Alarm that provides an audiovisual alarm signal within the home, and an outdoor alarm that alerts the neighbors.

Twelve selections are available: these are being utilized to activate an audio-visual alarm in the family's living room, and an audio alarm in the spouse's bedroom, a color television set, a radio, a speaker phone, a lamp in the user's bedroom, a "talking books" tape recorder, an alarm to summon family members who may be outside, and an automatic telephone used in an emergency to alert police, fire department, and neighbors, or to request medical aid through a prerecorded message. The completed device has been in operation for 5 months; clinical results are favorable thus far.

## 2. *Communication Aids*

a. *Prentke Romich Intercom System.* The Prentke Romich Intercom System (Fig. 5), designed and developed by the Prentke Romich Co., Shreve, Ohio, enables a user to selectively communicate with 2 other stations. Individual privacy is maintained by requiring the remote-station operator to depress a pushbutton manually when he is transmitting. Clinical trials are currently being conducted at the Castle Point, New York VA Hospital.

b. *VAPC Remote Alarm.* The VAPC Remote Alarm is a radio-controlled alarm designed to operate the VAPC Patient Alarm. The device may be used to indicate an emergency to advise family members of the patient's desire to reenter his home.

It consists of a radio transmitter, a receiver, and a 115V a.c. power outlet. The transmitter can be controlled either by a microswitch or pneumatically. The receiver is designed to insure that an alarm cannot be terminated by a second signal from the patient-operated transmitter. A family member or attendant must depress a switch located on the receiver to deactivate the alarm. The device is currently undergoing clinical evaluation in the homes of two outpatients.

c. *ZYGO Model 16 Communication Board.* The ZYGO Model 16 Communication Board assists paralyzed, speech-impaired (dysarthric) patients to communicate. Veterans with advanced amyotrophic lateral sclerosis or multiple sclerosis may be candidates for the device. It is commercially available from ZYGO Industries, Inc., Portland, Oregon.

The device consists of an actuator and a message board. The actuator may be a sensitive pneumatic switch, a microswitch with an acceptably large surface-contact area, or a microswitch with a long lever arm. The message board consists of a 4 in by 4 in matrix with a lamp located in each square, and sufficient space to indicate, in pictorial or written form, preselected messages.

The ZYGO Model 16 Communication Board is currently undergoing clinical evaluation.

d. *VOTRAX Handi-Voice System.* The VOTRAX Handi-Voice System is commercially available from Vocal Interface Division, Federal Screw Works, Troy, Michigan. It consists of three sections: an input actuator, a minicomputer, and two output speakers. The input actuator is available in either a touch-tone pad or a keyboard configuration. The touch-tone pad provides an audio output when associated pictures or words on the board are depressed lightly. The

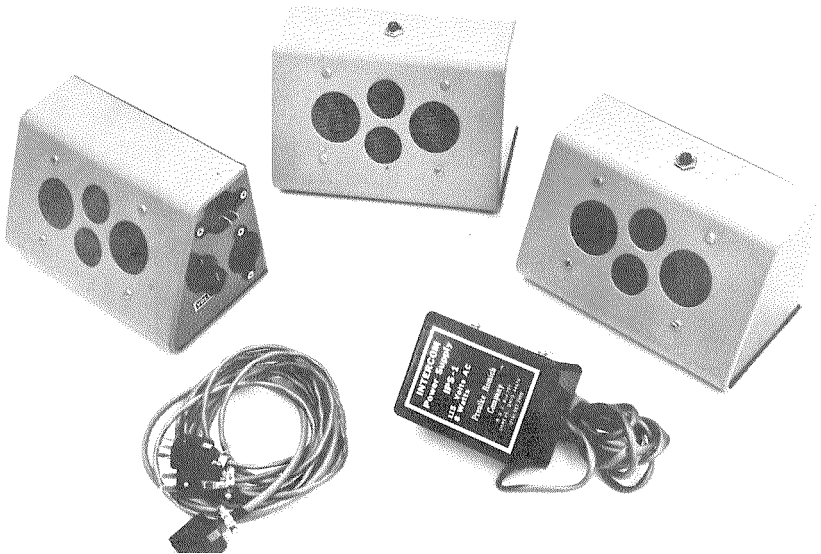


FIGURE 5.—Prentke Romich Intercom System.

keyboard, which resembles a hand-held calculator, provides an audio output when the appropriate numerical code has been selected. The keyboard can also be operated by those who are unable to manipulate their fingers or a mouthstick. A 3-digit numeric system allows selection via a microswitch or a sensitive microphone that is worn next to the user's larynx.

The minicomputer, which is controlled by the input actuator, allows for adjustment of the speech rate, audio level, and pitch. It permits reprogramming the language of this device to meet the needs of different users. Approximately 440 words, phonemes, phrases, and alphabet characters are available on the unit.

Up to 32 entries can be recalled. This allows the user to insert messages into a memory and have the unit repeat them on demand. The operator may insert a short paragraph of questions or statements that may be played back when the doctor or therapist visits the user.

Words or sentences can be repeated indefinitely: this should aid the listener if a word is not clear. Pauses between phrases, words, or sentences can be inserted by the user. The VOTRAX Handi-Voice System is currently undergoing clinical evaluation.

### 3. *Mobility Aids*

a. *Electronic Power Conversion Kit for Wheelchairs.* The Electronic Power Conversion Kit for Wheelchairs (Fig. 6), previously reported on in BPR 10-26, is designed to convert most American models of manual wheelchairs to electrically powered wheelchairs. The device is commercially available from Solo Products, West Sacramento, California. The original Solo Mark II unit was redesigned by the manufacturer to eliminate certain shortcomings. Laboratory performance testing had been completed on the original Mark II kit mounted on Rolls, Stainless Specialty, and Everest and Jennings Premier wheelchairs. Performance of the Solo package on all three wheelchairs was good; acceleration, braking, and stability were found to be satisfactory.

The manufacturer now produces the Mark III Kit, which is currently being evaluated. Preliminary testing of the Solo Mark III package has been completed and laboratory performance tests have revealed a problem with the dynamic braking of the drive system. The chair stops abruptly and does not coast. This abrupt stopping throws the subject forward in the chair, and he experiences discomfort from the safety strap. Clinical trials are continuing to determine the safety, effectiveness, and usefulness of this power conversion kit.



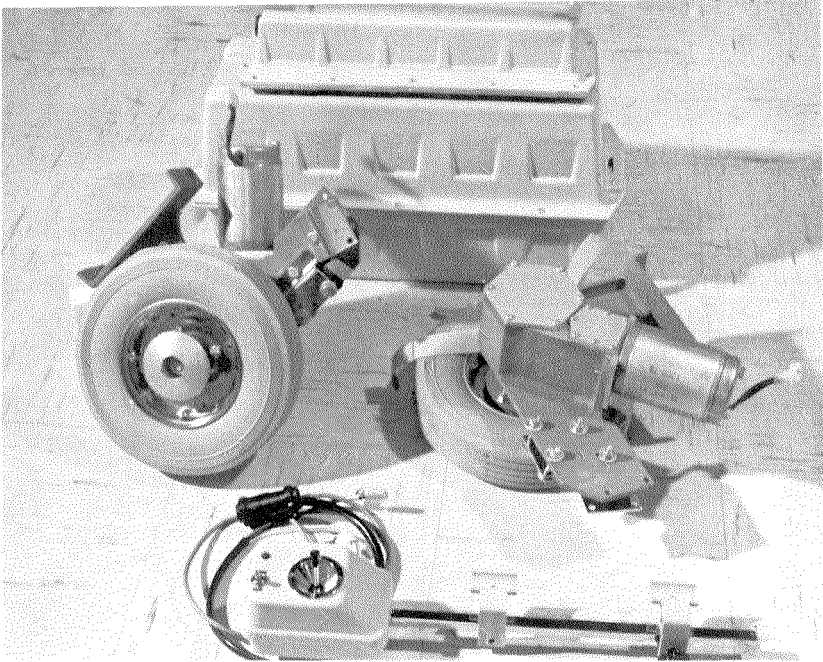


FIGURE 6.—Components of the Solo electronic power conversion kit for wheelchairs.

b. *Electric Back-Recliner Kit.* The Electric Back-Recliner Kit (Fig. 7 and 8) is commercially available from General Teleoperators, Inc., California. It is designed to convert powered wheelchairs with a full or semi-reclining back (particularly the Everest and Jennings 12-V electric wheelchair with full-reclining back) to electrically powered full back-recliners. The device permits the wheelchair-bound patient to adjust his position, through graduated steps, from an upright seated position to a full-reclining position and back again without assistance. One unit is currently being evaluated on a special powered wheelchair at the VA Hospital, Castle Point, New York.

c. *Chin Control Powered Swing Away.* The Chin Control Powered Swing Away (Fig. 9) is commercially available from General Teleoperators, Inc., Downey, Calif. This device is designed to move the chin control away from the wheelchair occupant when the wheelchair is stationary, or back into position when the wheelchair is being driven.

Two units currently undergoing clinical trials indicate the Chin Control Powered Swing Away is quite responsive and easy to activate.

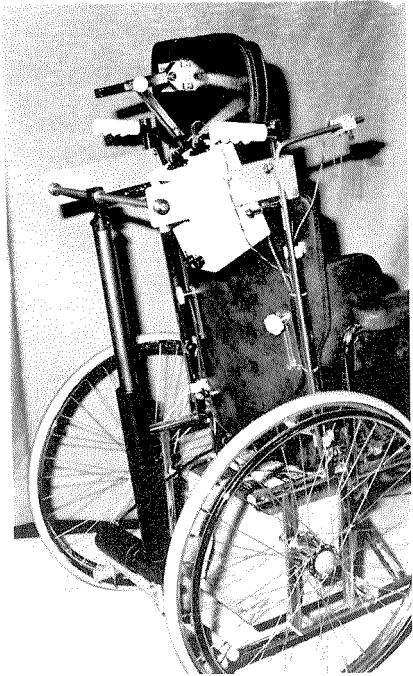
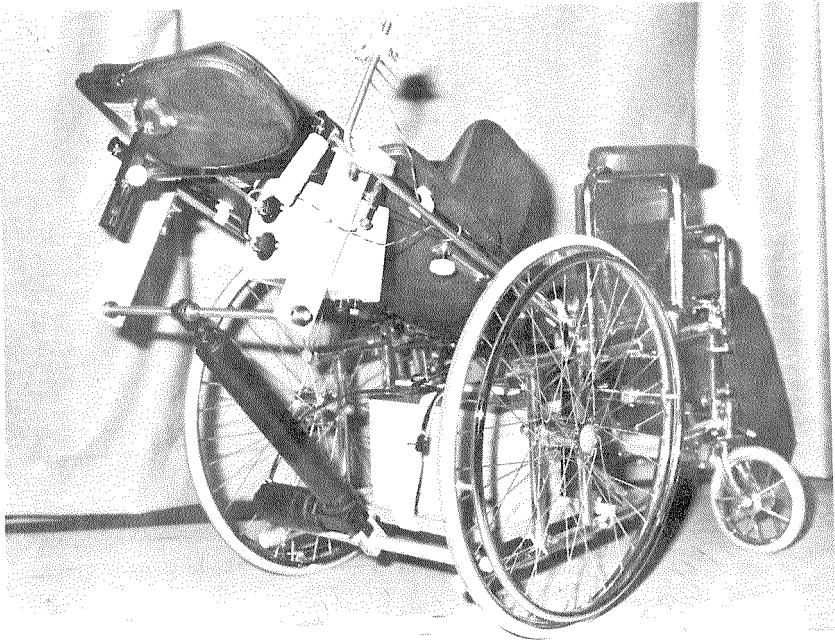


FIGURE 7.—Electric Back-Recliner Kit; at right, upright position.

FIGURE 8.—Electric Back-Recliner Kit; below, reclining position.



Patients found it a convenience to have the chin control out of the way while eating or reading. Results indicate that the multipositional bracket must be tightened securely so that driving over door sills or rough terrain does not cause the chin control to move beyond the user's reach.

d. *Pyramid Folding Quad Cane.* The Pyramid Folding Quad Cane (Fig. 10) is available from Edco/Pasco, Inc., Passaic, New Jersey. The device is a walking aid for patients who need a walker but require

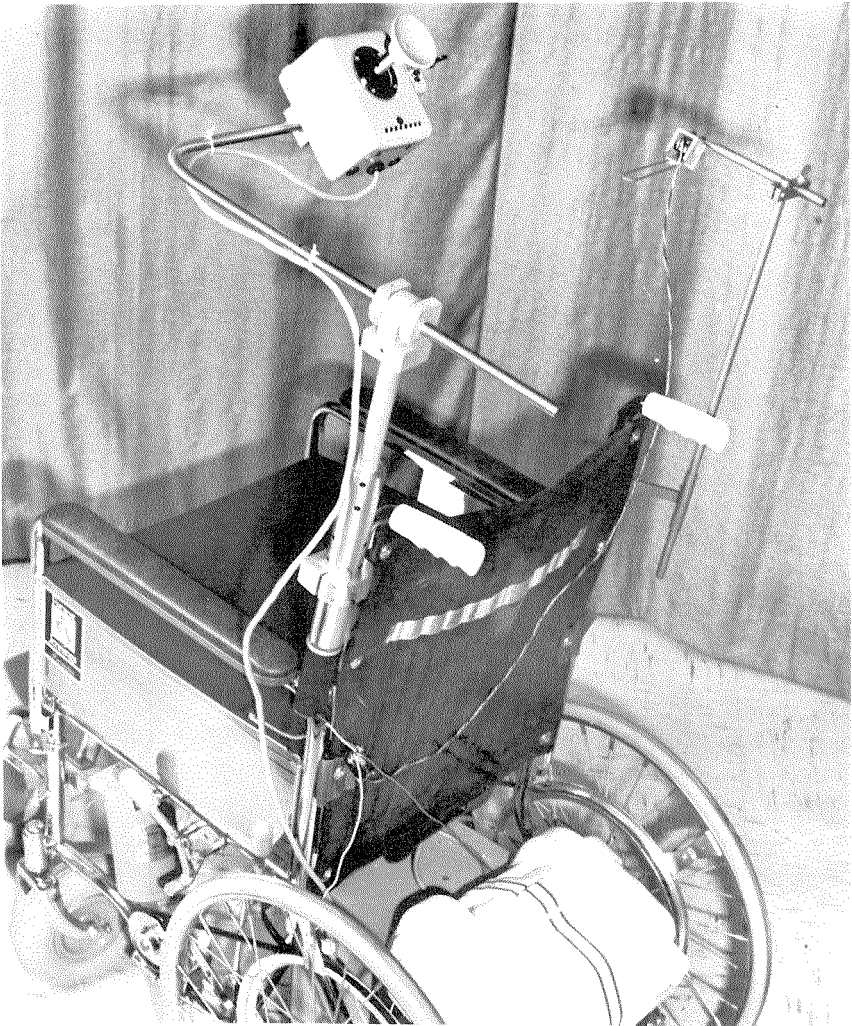


FIGURE 9.—Chin Control Powered Swing Away.

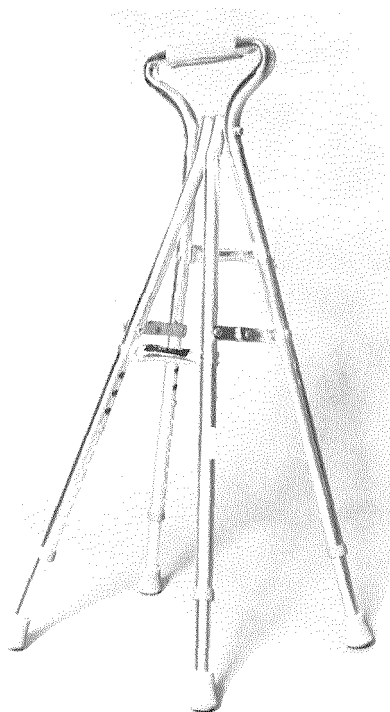


FIGURE 10.—Pyramid Folding Quad Cane.

more support than that provided by a standard cane or standard quad cane. It is intended for use by cardiovascular accident patients, patients with healing hip fractures, and lower-limb amputees with prostheses.

The height of the cane is adjustable, as are the depth and width of the base. By increasing the size of the base, greater support and stability for taller patients is obtained. The closed handle of the cane concentrates the patient's weight over the base of the cane for greater safety.

The cane is being clinically evaluated at the Castle Point, New York, and Omaha, Nebraska VA Hospitals. Preliminary results indicate that the Pyramid Folding Quad Cane is indicated for patients who have poor balance and coordination.

e. *Sun Industries Curb-Climbing Electric Wheelchair.* The Sun Industries Curb-Climbing Electric Wheelchair (Fig. 11) was provided for evaluation by the J.A. Preston Corp., New York City. This device



FIGURE 11.—Sun Industries Curb-Climbing Electric Wheelchair.

is manufactured by Japan Sun Industries, Tokyo, Japan. According to the manufacturer, this motorized wheelchair is capable of ascending and descending 3-in (7.62-cm) curbs and negotiating inclines of 20 deg and more. The wheelchair features a hand-operated joystick-controlled microswitch array and a high-low speed-selection switch. Power is derived from two 12-V, 24-Ampere-hour batteries.

Run-over sleeves on front casters help to surmount curbs. The user approaches the curb squarely and with sufficient speed so that the run-over sleeves clear the curb. The runover sleeves then raise the front casters onto the curb. (The rear tires are large enough to mount curbs without run-over sleeves.)

When tested, the wheelchair was able to negotiate 3-in (7.62-cm) curbs and a cement curb that was 4 in (10.16 cm) high with a rounded

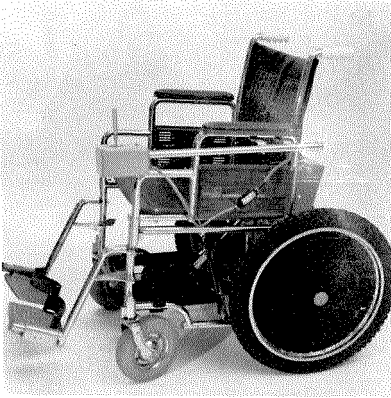


FIGURE 12.—GenTel Motor-in-the-Hub powered wheelchair.

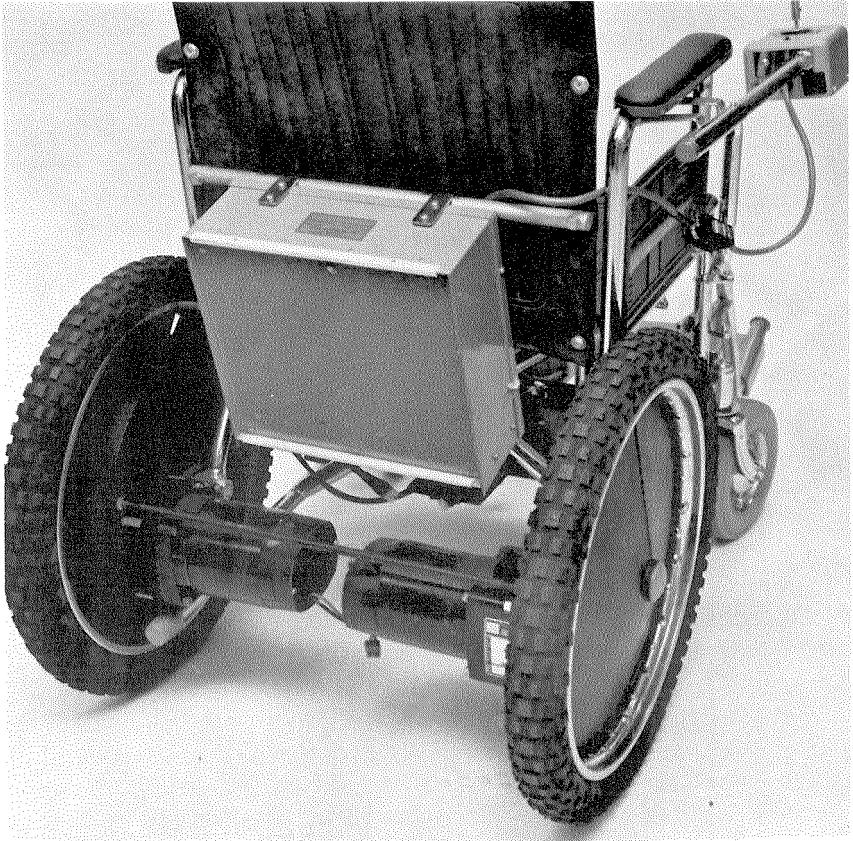


FIGURE 13.—Motor-in-the-Hub powered wheelchair has dual 12 V battery power and direct rear-wheel, drive-gear transmission.

edge that had a 1-in (2.54 cm) radius. Clinical trials and laboratory performance tests are currently being conducted to determine the safety, effectiveness, and usefulness of this wheelchair.

f. *GenTel Motor-in-the-Hub Powered Wheelchair.* The GenTel Motor-in-the-Hub Powered Wheelchair (Fig. 12) is commercially available from General Teleoperators, Downey, California. Of the units currently being evaluated at the VA Hospital, Castle Point, New York, one has an Everest and Jennings electronic control package and the other has a General Teleoperators control package. In both units, power is supplied by two 12V batteries and is applied to the rear wheels (Fig. 13) by direct-drive gear transmission. They are operated by proportional, two-speed, joystick controls.

Preliminary laboratory testing of the wheelchair has shown that the average maximum speed, with a 155 lb (70.31 kg) test subject, is approximately 4.71 m/h (7.58 km/hr).

Both Motor-in-the-Hub Powered Wheelchairs were evaluated by three subjects: two quadriplegics and one multiple sclerosis patient. The subjects liked the power, speed, and maneuverability of the device, particularly outdoors. The device functioned well indoors, outdoors, and on the type of terrain too difficult for most other powered wheelchairs. The knobby black-carbon rear tires provided excellent traction outdoors and caused no damage indoors; they did, however, track more dirt inside than other types of wheelchair tires.

It was suggested to the manufacturer that future models be supplied with wide, non-marking grey tires. Several other recommendations for improvement were made. Further clinical trials of improved models will be conducted.

g. *National Wheelchair.* The National Wheelchair (Fig. 14), produced by National Welded Products, Redwood City, California, is a battery powered, electronically controlled wheelchair. Several modifications have been introduced to the wheelchair, since it first appeared as the Advanced Wheelchair reported on in BPR 10-22. The National Wheelchair is designed for indoor and outdoor use by quadriplegics and other severely handicapped persons, particularly outdoors.

The rate of speed of the National Wheelchair with a 158 lb (71.67 kg) test subject was approximately 3.6 m/h (5.8 km/h) in the slow mode, and 6.8 m/h (11 km/h) in the fast mode. With power off at maximum low-speed mode, the chair coasts approximately 54 in (137.16 cm), and approximately 99 in (251.46 cm) in the high-speed mode. With a 158 lb (71.67 kg) test load and with the brake disengaged, the chair rolls down a test ramp of approximately 3 deg.



FIGURE 14.—National indoor-outdoor wheelchair.

With the brake engaged, it rolls downhill on a 13 deg incline. Maximum ramp-climbing ability with a 158 lb (71.67 kg) test subject at low speed is 9.5 deg, at high speed, 13 deg.

The chair is quite powerful and comfortable during operation, and performs well outdoors on grassy surfaces and on hard surfaces. But the rear wheels slip on loose dirt and it seems to need more weight in the rear. Maneuverability is good and there are a number of useful secondary features. Further clinical trials are required, however, to fully determine the safety, effectiveness, and utility of the National Wheelchair.

h. *Insta Gaiter*. The Insta Gaiter (Fig. 15), available from Instrument Components Company, Inc., Mentor, Ohio, is an electromechanical kit designed to convert standard manually propelled wheelchairs into electrical, joystick-operated, proportionally controlled wheelchairs. It is portable and can be easily disassembled and reassembled, and can be carried in a car. The evaluation of this unit is being delayed, pending necessary repairs by the manufacturer.



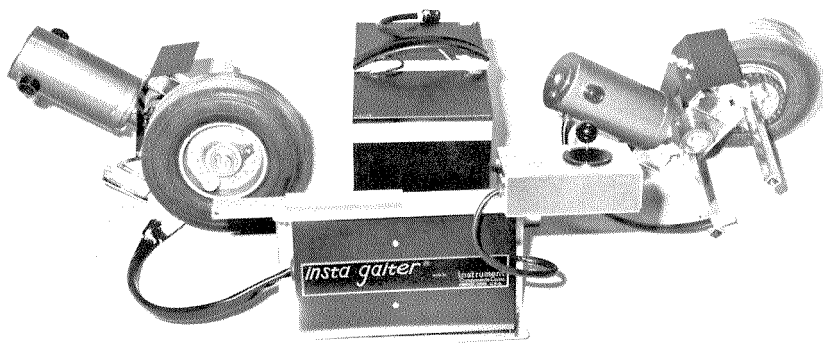


FIGURE 15.—Insta Gaiter.



FIGURE 16.—SMP Electra-12 wheelchair.

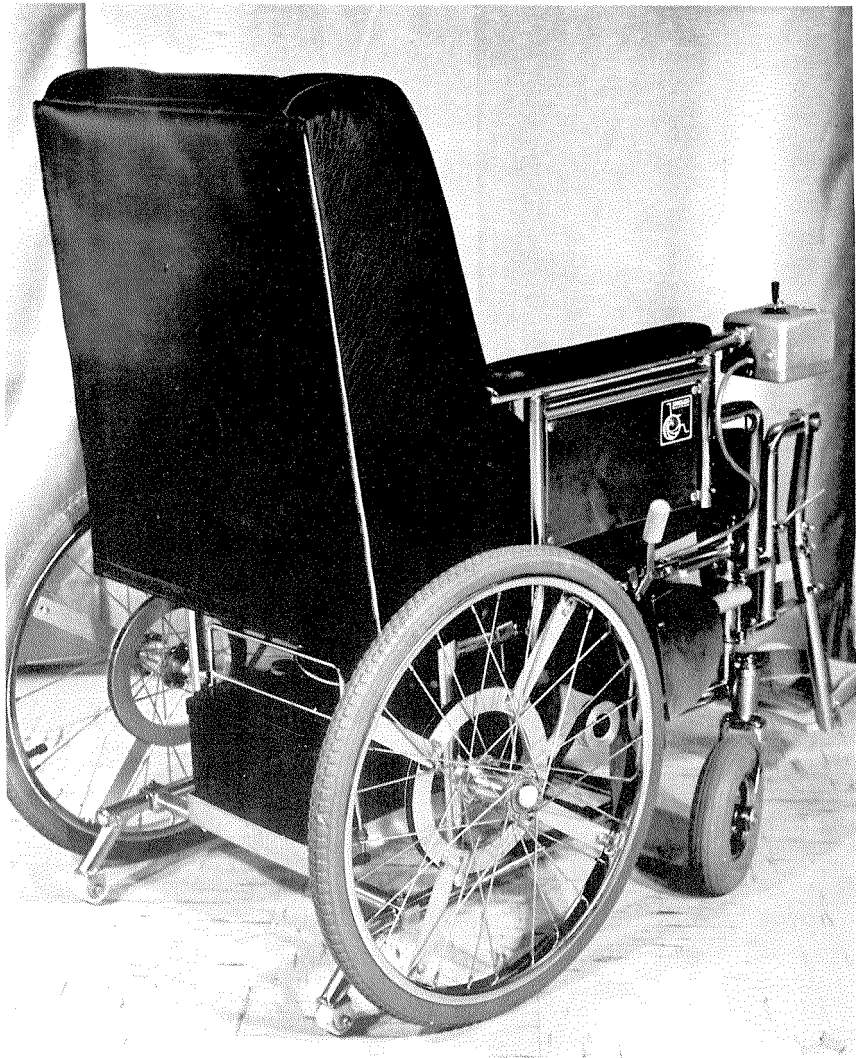


FIGURE 17.—SMP Electra-24 wheelchair.

i. *Stainless Medical Products Electric Wheelchairs.* The Stainless Medical Products (SMP) 12V and 24V electric wheelchairs (Figs. 16 and 17) (SMP Electra-12 and SMP Electra V-24, respectively), previously reported on in BPR 10-26, are manufactured and marketed by the Stainless Medical Products Company, Santa Ana, California. The evaluation results show that while the SMP Electra V-12 generally performed satisfactorily, the controller circuit should be modified

by the manufacturer to ensure against battery drain when the unit is in the "off" mode.

The SMP Electra V-24 wheelchair also performed reliably during the evaluation period: speed, ramp-climbing ability and overall performance, particularly on moderately uneven terrain, were excellent. The pneumatic tires on all four wheels undoubtedly added to the comfort and performance of the wheelchair. The SMP Electra V-24 is also recommended, particularly for those who require high-performance wheelchairs (e.g., for vocational or educational purposes). However, care should be taken that the high performance and seating configuration of this vehicle clearly matches the particular needs of the wheelchair occupant.

j. *Adult Powered Tricycle.* Non-powered adult tricycles are becoming increasingly popular among elderly persons who use them for exercise, recreation, and common activities of daily living. At the St. Albans, New York, VA Extended Care Center, one such item is now routinely used for recreation and exercise. Certain elderly veterans with weak lower limbs or amputations would like to take advantage of such an item, but are generally precluded from using them due to limited attendants.

An electrically powered adult tricycle, purchased from the Lyman Electric Co., Bridgeport, Conn., was modified to provide variable speed and adjustable seat height. The vehicle incorporates a dual brake system, and speed is modulated by a brake-type caliper handle operating on a pulse width controller: increased speed is achieved by squeezing the handle. The battery charger is a separate unit to preclude potential shock hazard; improved wiring and a heavy-duty relay increase the reliability of the tricycle.

The tricycle may be used as a totally powered system, or simply as a foot-propelled, or foot-propelled with power assist, system during warm weather. The latter method permits an above-knee amputee to pedal the tricycle for up to 50 miles. If continued interest in the vehicle is evident, additional units will be obtained for use at other VA facilities, particularly for cardiovascular patients.

k. *VAPC Powered Ambulator.* The VAPC Powered Ambulator is primarily an evaluation tool, to determine the potential benefits of a powered mobile platform that keeps its occupant in a standing position. Its possible usefulness in vocational applications appears promising for those who practice drafting or work in a machine shop, and in conducting activities of daily living. Its therapeutic value with respect to improved blood circulation, kidney function, retention

of calcium in the bones, and psychological advantages will also be investigated.

The original ambulator was fitted with small front caster wheels which occasionally prohibited the occupant from traversing small obstacles such as door saddles, a problem easily overcome by replacing them with 5 in diameter caster wheels.

If the current design demonstrates general acceptance by patients, two or three additional models will be assembled and evaluated at other VA facilities.

l. *Ausmus Moto-Stand*. The Ausmus Moto-Stand developed by the Ausmus Manufacturing Co., Independence, Missouri, is intended for paraplegics in vocational environment where standing mobile frames may be helpful.

This ambulator incorporates a three-wheel support with a single powered wheel located at rear, a 12V battery, a mechanical brake, a low/off/high toggle switch for speed selection, and a rocker switch to select forward and reverse directions. Restraining straps, to assist torso stability, are located around the level of the buttocks and the top of the T-Bar Handle.

The Ausmus Moto-Stand is currently being evaluated at the Castle Point, New York VA Hospital.

m. *Plantar and Dorsiflexion Foot Plates for Wheelchairs*. New VAPC-designed plantar and dorsiflexion foot plates for wheelchairs incorporate a simple joint, adjacent to the anatomical ankle, to assure proper foot orientation. This enhances comfort and stability for the occupant. One unit is currently being evaluated at the St. Albans, New York, VA Extended Care Center.

n. *Illuminated Reachers for Wheelchairs*. Elderly persons with cataracts commonly use reachers to help them grasp items on a shelf or the floor. A simple modification to the common mechanical reacher is a small lamp at the tip of the device, to illuminate the area of interest. The lamp is normally operated by gripping the handle and squeezing the trigger which operates the grasping function of the reacher. Two VAPC-designed units are being evaluated.

o. *LEM Power Chair*. The LEM Power Chair (Fig. 18), manufactured in Vicenza, Italy, is imported by the French-Italian Marketing Corp., Great Neck, New York, and distributed through medical equipment distributors throughout the United States. It is an electric wheelchair for paraplegics, amputees, and other handicapped individuals who are unable to ambulate but have retained the use of their

arms and hands. The LEM is unique in that the user can manually swivel the support base completely around. Two units are being evaluated.

#### 4. *Body Support Systems*

a. *Blair Bed.* The Blair Bed (Fig. 19), previously reported on in BPR 10-24, and developed by Reed F. Blair, Inc., Pittsburgh, Penn-



FIGURE 18.—LEM Power Chair.

sylvania, is intended to permit a flow of air over a bedridden patient's back to prevent or treat decubitus ulcers.

Clinical evaluation demonstrated that the Blair Bed accomplishes the purpose of allowing aeration of the patient's back. However, the effect of pressure created by the hammock when the patient is raised is a disadvantage to the healing of the patient's ulcers.

b. *Wheelchair Cushion Study.* The current Wheelchair Cushion Study is, again, a joint effort of Dr. George Van B. Cochran's Biomechanics Laboratory at the Helen Hayes Hospital, and the VAPC Clinical Evaluation Service at the Castle Point VA Hospital. (See "Experimental Evaluation of Wheelchair Cushions: Report of a Pilot Study," BPR 10-20, pp. 29-61.) Subjective patient data on the short-term performance of wheelchair cushions are being collected in clinical trials conducted at the Castle Point VA Hospital. This information will be correlated with the laboratory data from the Helen Hayes Hospital. The results should provide an approved selection of cushions.

Twenty-three different types of cushions are currently undergoing clinical and mechanical testing. These cushions represent a variety of latex and polyurethane foams, gels, impact absorbing, and water types. The patients participating in this study are on wheelchair/bed

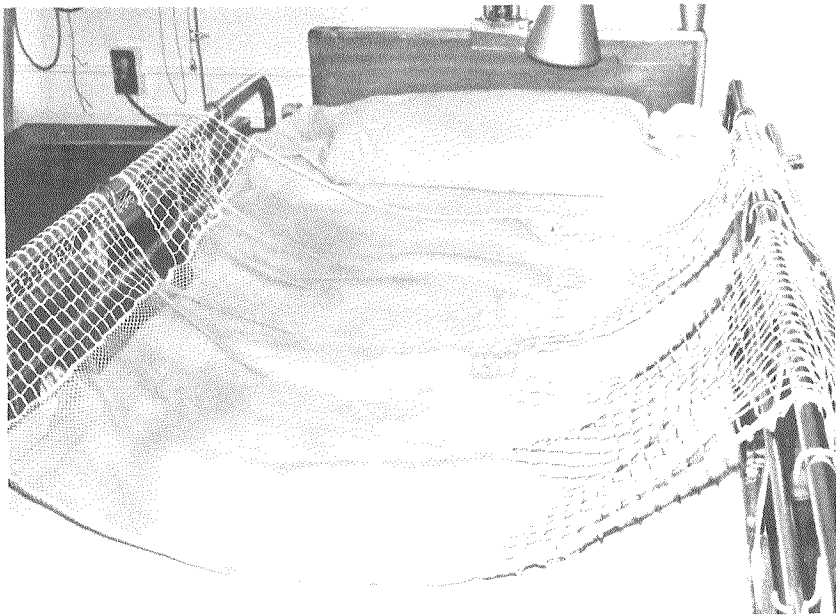


FIGURE 19.—Blair Bed.

status, with partial or complete sensation over the buttocks area. They are dependable and well-motivated. The clinical trial consists of 3 hours of use of each test cushion by each subject. The subjects are limited to one test-cushion trial per day. Each subject will test each of the 23 cushions, so that an average response can be obtained. All results from the clinical trials are being recorded by Dr. Cochran. No conclusive clinical findings are available at present.

c. *Medpro Chair Flotation Cushion.* The Medpro Chair Flotation Cushion (Fig. 20), distributed by Medpro, Inc., of East Brunswick, New Jersey, is a pressure distribution flotation cushion that is designed to prevent decubitus ulcers on wheelchair-confined patients.

It basically consists of two polyvinyl-chloride sections and an elastic cover. An inflatable, rectangular-shaped, tubular air frame surrounds the main body, which stores approximately 1.8 gal (6.81 l) of water. Guidelines and applications for the use of this cushion will be determined through further clinical trials.

d. *RoHo Balloon Cushion.* The RoHo Balloon Cushion (Fig. 21), developed and distributed by RoHo Research and Development, Inc. Belleville, Illinois, is used to distribute body weight, in a seated position, to reduce body tissue pressure and thereby either prevent or help heal decubitus ulcers.

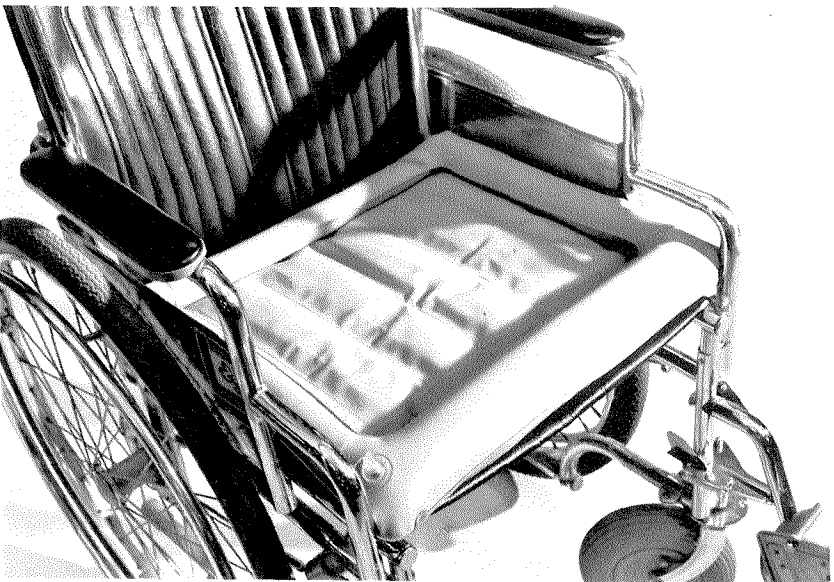


FIGURE 20.—Medpro Chair Flotation Cushion.

The cushion consists of 72 interconnected, yet freestanding, balloon elements attached to a neoprene rubber base (Fig. 22), and pressure varies between 30 and 50 mmHg. Individual balloons can be deflated and tied off to prevent contact with sensitive portions of the body or areas where decubitus ulcers have already formed.

One Balloon Cushion is undergoing laboratory testing at the Helen Hayes Rehabilitation Center, Haverstraw, New York; another is undergoing clinical trials at the Castle Point, New York VA Hospital. Further clinical trials are required to determine applications and guidelines for this device.

e. *E-Z Patient Turning System.* The E-Z Patient Turning System, Model 520 (Fig. 23), commercially available from Physical Aids, Inc., El Cajon, California, is an inflatable, two-section air mattress designed to prevent decubitus ulcers by turning bedridden patients from a supine position to a maximum position of approximately 45 deg.

A laminated air mattress of vinyl and nylon is sealed down the center to create two halves. A small 20-lb (9.07 kg) air pump plugs into a standard 110V a.c. wall socket to inflate or deflate the air mattress: each half of the mattress is inflated or deflated independently. The pump shuts off automatically when the mattress is fully



FIGURE 21.—RoHo Balloon Cushion.



inflated. The E-Z Patient Turning System is being evaluated at the VAH, Bronx, New York.

f. *Wheelchair Pad Movement Monitor.* The Wheelchair Pad Movement Monitor (Fig. 24), developed by the Southwest Research Institute, San Antonio, Texas, trains and/or reminds paralyzed wheelchair-confined persons to periodically shift their body weight during the day and thereby help prevent decubitus ulcers.



FIGURE 22.—Balloon elements shown attached to neoprene rubber base.

A battery-powered preset audible reminder sounds if the patient fails to shift his weight during a given period of time. The shifting resets the reminder circuitry via two electronic sensors (Fig. 25), secured beneath the patient's cushion. A digital display records the number of times these sensors are reset, so that the hospital staff can monitor the frequency with which the patient shifts his weight.

The Wheelchair Pad Movement Monitor will be evaluated at various VA Spinal Cord Injury Centers.

### 5. Lifts and Transfer Aids

*LaCaron Lift Chair Model 76.* The LaCaron Lift Chair Model 76 (Fig. 26), produced by LaCaron Industries, Kenilworth, New Jersey was previously reported on in BPR 10-27. It is designed to enable persons who experience difficulties rising from chairs to do so, either independently or with attendants, easily and safely. The Model 76 Chair utilizes a counterbalance system that can be adjusted to individual needs. The chair was evaluated and is recommended for veteran beneficiaries.

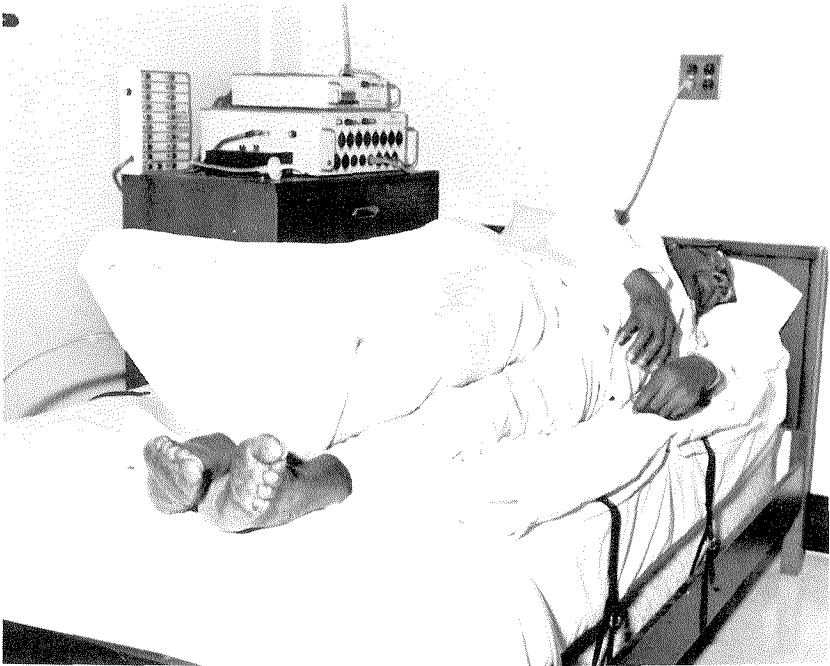


FIGURE 23.—E-Z Patient Turning System.

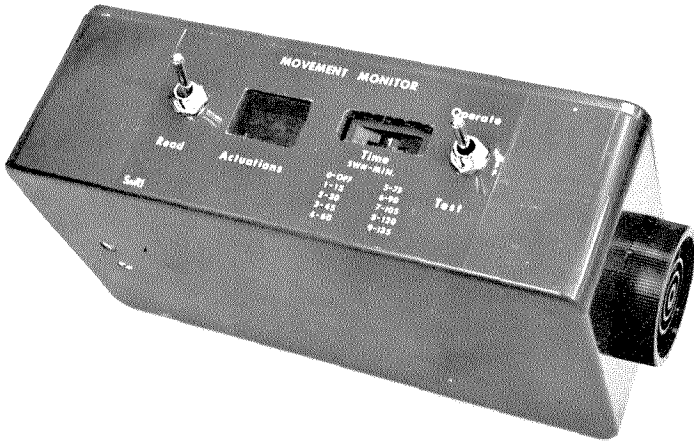


FIGURE 24.—Wheelchair Pad Movement Monitor.



FIGURE 25.—Wheelchair Pad Movement Monitor sensitivity switches.

## 6. Driving Systems

a. *E-Z Tilt-a-Board Loader*. The E-Z Tilt-a-Board Loader, Model 300 (Fig. 27 and 28), manufactured by Physical Aids, Inc., El Cajon, California, is designed to ease the loading of a wheelchair into a car trunk, a van, or station wagon cargo area.

A collapsed wheelchair is secured on the loader; with the loader leaning against the car bumper, the user bends down, grasps the handles of the loader, and lifts both loader and wheelchair, utilizing the trunk edge to support most of the weight. The loader is pushed into the trunk or cargo area on two casters.



FIGURE 26.—LaCaron Lift Chair Model 76.

One unit is being evaluated by a disabled veteran; additional candidates are being sought to evaluate this device.

b. *EZ-1 Wheelchair Carrier.* The EZ-1 Wheelchair Carrier (Fig. 29), manufactured by Wheelchair Carrier Corp., Phoenix, Arizona, is designed to facilitate wheelchair loading and unloading from an automotive trunk or cargo area by persons with limited strength.

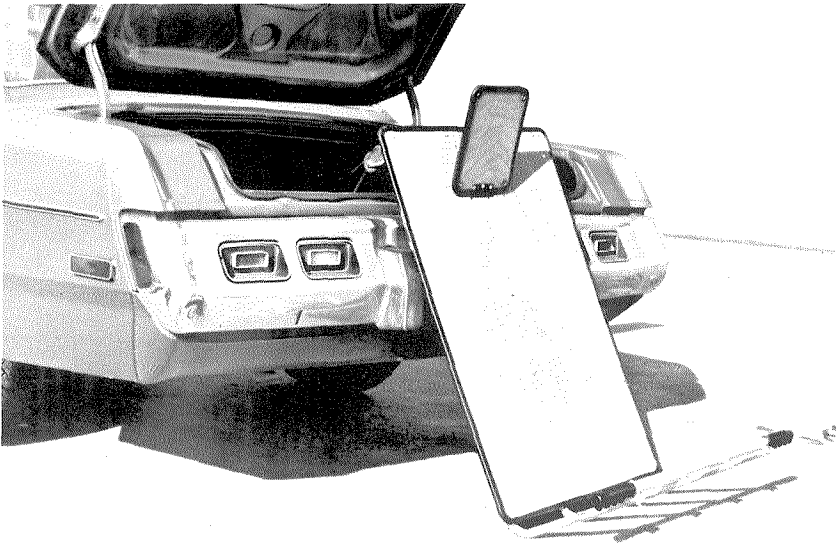


FIGURE 27.—Non-activated E-Z Tilt-a-Board Loader, above.



FIGURE 28.—Activated E-Z Tilt-a-Board Loader.

Aluminum chain-like links for leverage and flexibility designed to fit most types of automobiles that have been utilized to carry wheelchairs, are installed inside the trunk with a single screw (Fig. 30). The device is then positioned inside the trunk in such a way that the wheelchair is easily loaded without interfering with the spare tire.

Three units will be evaluated.

c. *Mann's E-Z Way Chair Lift.* Mann's E-Z Way Chair Lift (Fig. 31), commercially available from the M.E.W. Company, Tulsa, Oklahoma, is designed to load or unload a collapsed wheelchair into and out of an automotive trunk or cargo space.

The E-Z Way Chair Lift consists of a boom assembly and motor, and a wheelchair holding-bracket. The boom assembly comprises two cold rolled steel bars that are welded together: a 28-in. bar extends from a 12-in. bar at a 120 deg angle. An 80-in., 400-lb-strength steel cable is threaded through the steel bars, guided by two pulleys. A ¼ hp, 12-V motor is attached to a 40:1 ratio swivel with ball bearings; this, in turn, is attached to a metal base mounted on the floor of the vehicle. A latch at the base of the boom is used to unlatch the boom for folding the chair into the trunk.



FIGURE 29.—EZ-1 Wheelchair Carrier.

One unit was submitted for evaluation; it has been installed in the driver-training sedan at the Castle Point, New York VA Hospital for clinical trials.

### 7. Miscellaneous

a. *Bailey III Cushion Grip Tape.* Bailey III Cushion Grip Tape (Fig. 32 and 33), manufactured by Bailey III, Inc., Cheshire, Connecticut, is designed to provide a soft, comfortable, nonslip grip on such devices as mobility aids, eating utensils, and tools. It is readily available in retail hardware and sporting goods departments. Bailey III Cushion Grip Tape is composed of a rubbery plastic called Prolastic 75; it is said to be formulated to match the texture of the hands. Several rolls of the tape were evaluated at the Castle Point, New York VA Hospital. Although certain shortcomings exist in the use of the

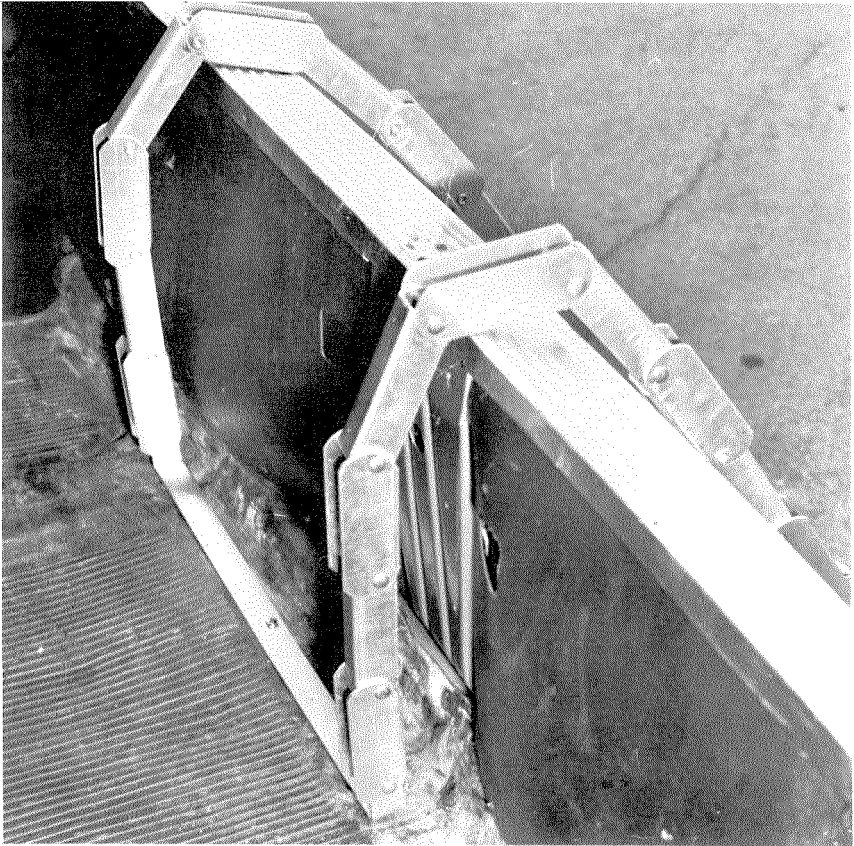


FIGURE 30.—Installing the EZ-1 Wheelchair Carrier.

tape, as revealed in the evaluation program, the tape is safe to use, and the potential applications vary widely.

b. *Winsford Feeder*. The Winsford Feeder (Fig. 34), originally identified as the Morewood Spoon Lifter, is distributed by Winsford Products, Inc., Pennington, New Jersey. It is a semi-automatic feeding device that allows a quadriplegic to feed himself independently: once the food has been placed on his plate and he has been properly positioned at the machine, the patient controls the operation of the device through head movements.

The Winsford Feeder, in its present form, was found to be useful by a small number of those veterans who used it during the evaluation. As presently designed, it is more useful to the newly injured and those with relatively mobile cervical spines. For these reasons, it is recommended that the device be made available, on prescription, to veteran beneficiaries who recognize its limitations. It has been further recommended that the manufacturer be urged to improve



FIGURE 31.—Mann's E-Z Way Chair Lift.



the utility of the device, in accordance with a number of recommended improvements, so as to make it useful to a greater number of beneficiaries.

## II. COMPLIANCE TESTING

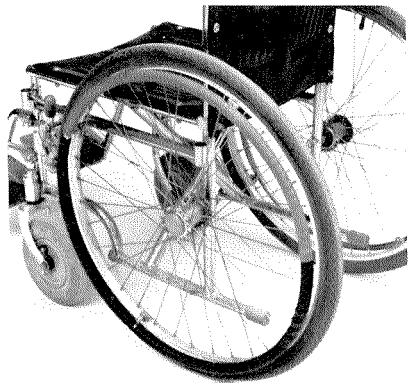
### A. Standards

A second draft of the standards for lower-limb prosthetics has been prepared (BPR 10-27), using the ASTM format. This document, now entitled *Standard Functional Requirements for Lower-Limb*



FIGURE 32.—Bailey III Cushion Grip Tape, applied to cane and tool handle.

FIGURE 33.—Application of Bailey III Cushion Grip Tape to a manually propelled wheelchair.



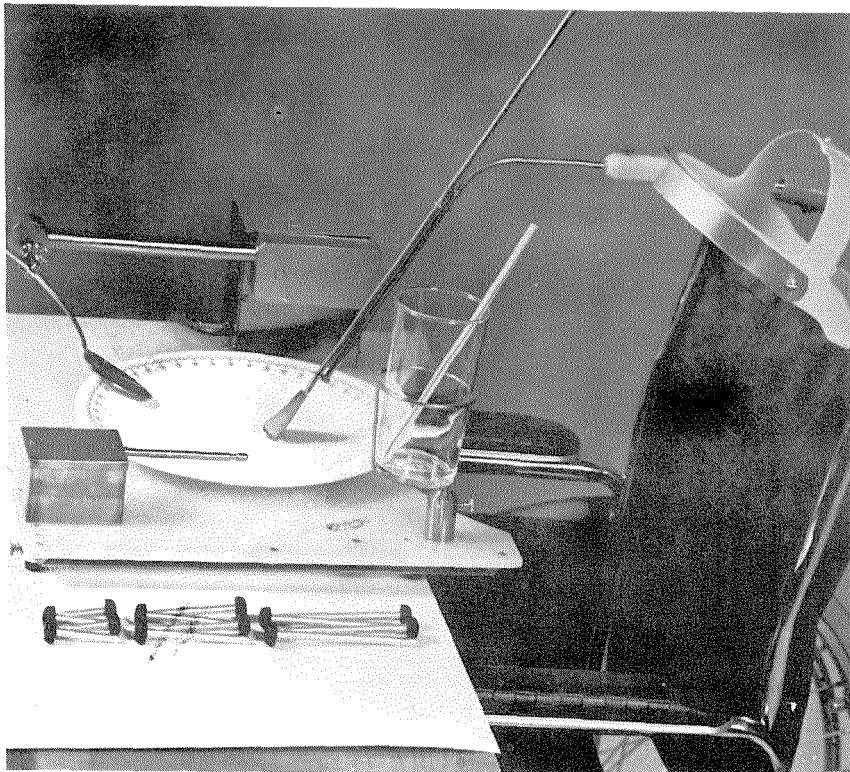


FIGURE 34.—Winsford Feeder.

*Prosthetic Assemblies and Components*, was presented at the International Conference on Standards for Lower-Limb Prostheses in Philadelphia, Pa., June 4-7, 1977. The participants concerned themselves with the section on static and dynamic testing since additional laboratory data on dynamic loads were presented at the conference by the BRADU representatives. An instrumented shank was used to collect these data.

The recommendations of the various panels have been added to a third draft of the standard now in preparation.

## **B. Testing**

### *1. Upper-Limb Components*

a. *Hosmer External Elbow Assembly*. Hosmer-Dorrance, Inc., Campbell, Calif. submitted an External Elbow Assembly for annual compliance testing. This assembly complied with the "Tentative

Specifications for Elbow, Artificial, External, Alternating for Above-Elbow Amputees.”

b. *Sierra Voluntary-Closing Hand*. Hosmer-Dorrance submitted a Voluntary Closing Hand for annual compliance testing. This item complied with the “Tentative Specifications for Hand, Adult Size, Mechanical, Voluntary Opening for Upper-Limb Amputees.”

## 2. Lower-Limb Components

a. *LAPOC Safety Knee*. The Labor Accident Prosthetics and Orthotics Center, Magoya, Japan, submitted a safety knee for testing and evaluation. The unit, a full-flexion, single-axis friction knee, is patterned after an Otto Bock modular design. An adjustable pneumatic damper, mounted within the shin tube, reduces terminal impact.

The unit was dynamically cycled to determine wear characteristics. It was flexed 120 deg at a rate of .7 Hz. Initially, the friction setting used throughout the test required 31.3 lbf · in (3.5 N · m) torque to flex the knee. The greatest amount of wear occurred during the first 50,000 cycles when the torque required dropped by 28 percent. The test was stopped at 397,000 cycles due to wear. At that time the torque required was 48 percent of the initial torque.

b. *Multiplex Mark II Above-Knee Prosthesis*. Fatigue testing of this assembly, initiated in February 1977, has four objectives:

1. To determine the fatigue life of the assembly by using the recommended loads contained in the draft standard.
2. To confirm that the recommended loads reflect the loads actually applied by a broad-based amputee population.
3. To determine whether variations in load-applications frequency affect the form of the load-feedback signals.
4. To discover the failure modes of the assembly; e.g., permanent deformation, brittle fracture, etc.

The assembly is mounted with the distal end up in the frame of the Instron biaxial servohydraulic testing machine. The linear actuator, acting through a test fixture, applies a compressive axial load and a combined AP-ML bending moment about the knee. The rotary actuator applies an axial torque. These loads, applied sinusoidally, are as follows: (i) Axial Load: 240 lb (1060 N); (ii) Bending Moment: 1065 lbf · in (120 N · m); and (iii) Axial Torque: 110 lbf · in (12.4 N · m).

The assembly has been cycled 2.2 million times at a frequency rate of 1 Hz, and then 1 million times at 5 Hz. The feedback signals

were not affected by the change in frequency. The test will continue until failure occurs.

### III. THE VAPC CLINIC TEAM

The statistical breakdown in Table 1 of the veterans treated by the VAPC Clinic Team during the first half of 1977 represents a typical case load. It is similar to those presented in previous BPR reports.

TABLE 1.—*Statistical Breakdown of Patient Disabilities January 1, 1977 to June 30, 1977*

Amputation		
Area of involvement	Specific level of involvement	Number of patients
Lower-limb unilateral	Below-Knee	153
	Above-Knee	117
	Transmalleolar (Syme's)	12
	Hip (Disarticulation)	7
	Partial Foot	3
	Mediotarsal (Chopart)	3
Lower-limb bilateral	Below-Knee	13
	Above-Knee/Below-Knee	12
	Above-Knee	7
	Transmalleolar (Syme's)	6
	Below-Knee/Transmalleolar (Syme's)	1
	Below-Knee/Mediotarsal (Chopart)	1
Upper-limb unilateral	Below-Elbow	14
	Above-Elbow	3
	Partial Hand	1
Upper-limb bilateral	Above-Elbow	1
	Below-Elbow	3
Lower-limb and Upper-limb	Above-Knee/Above Elbow	2
	Above-Knee/Shoulder (Disarticulation)	1
Triple	Above-Knee/Below-Knee/Below-Elbow	<u>1</u> (361 total)

## Neuromuscular or Skeletal Impairment

Area of involvement	Specific level of involvement	Number of patients
Lower-limb unilateral	Ankle-Foot	156
	Knee-Ankle-Foot	6
	Knee	3
Lower-limb bilateral	Ankle-Foot	1
	Knee-Ankle-Foot	13
Upper-limb unilateral	Arm-Elbow-Forearm; Wrist-Hand	7
Trunk	Lumbosacral spine	11
Lower-limb and Trunk	Ankle-Foot/Lumbosacral spine	1
Miscellaneous	Varied (Wheelchairs, shoes, etc.)	<u>24</u> (222 total)

Amputation and  
Neuromuscular or Skeletal Impairment

Area of involvement	Specific level of involvement	Number of patients
Lower-limb bilateral	Below-Knee/Ankle-Foot	2
	Above-Knee/Ankle-Foot	<u>4</u> ( 6 total)