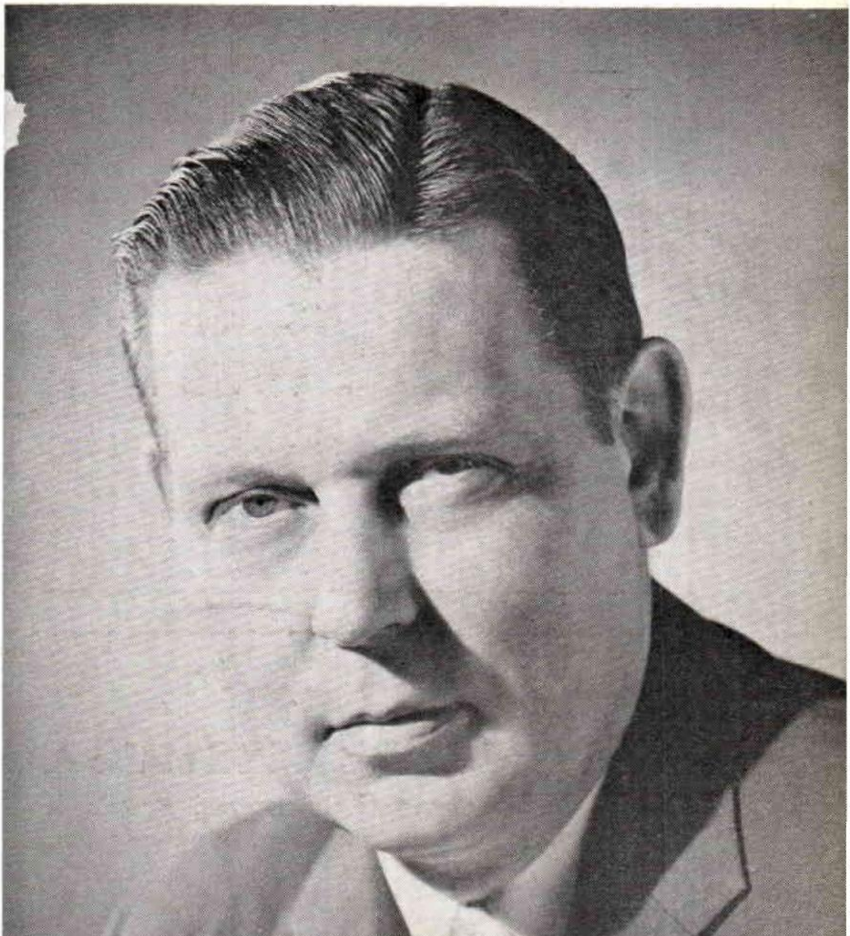
JUNE, 1963

# ORTHOPEDIC & PROSTHETIC APPLIANCE JOURNAL

*The Journal of the Limb and Brace Profession*



RICHARD G. BIDWELL
President, 1962-63
American Board for Certification
in Orthotics and Prosthetics, Inc.

***publisher:*** **American Orthotics and Prosthetics Association**

**OFFICIAL NOTICE**

The 1963 National Assembly of the

American Orthotics and Prosthetics Association

will be held November 2 - 6, 1963

at the Jung Hotel, New Orleans

**FOR PROGRAM DETAILS AND REGISTRATION INFORMATION**

See pages 150-151

of this issue

The Assembly is open to all who are interested in the

rehabilitation of the orthopedically disabled

# Orthopedic and Prosthetic

# Appliance Journal

(Title registered U. S. Patent Office)

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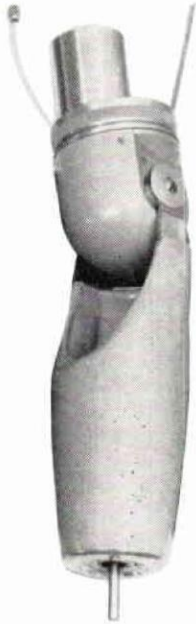

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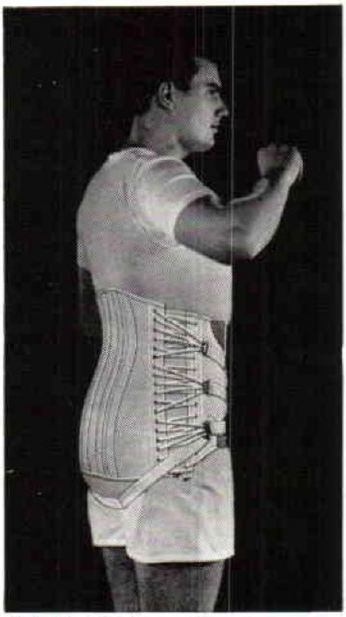
Cadenza® with Lycra®



Men's 3-Pull Lumbosacral Support

# at CAMP

**THESE NEW PRODUCTS WILL BE STEADY PROFIT MAKERS FOR SURGICAL SUPPLY DEALERS**

*Cadenza with Lycra*—A dramatically styled split-hip garment featuring Lycra, newest of the new control fabrics. Amazingly lightweight yet it assures abdominal uplift and sturdy back support . . . gives figure flattering comfort women want and need. *Men's 3-Pull Lumbosacral Support*—Triple adjustment utilizing the Camp Magic Web principle assures snug fit, permits easy release, gives firm support entire length of garment. Available in a variety of models, materials and sizes. *Adjustable Cervical Collar*—Easy-to-apply front opening plastic collar aids in treatment of neutral, extension, flexion and hyper-extension. Plastic block insert with Velcro closure gives completely adjustable size range. Easily adjusted height.

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It's being advertised and detailed to your physicians . . . they already recognize its new contribution to correct therapy and patient comfort. Be ready to fill their prescriptions . . . be ready to serve their patients . . . stock these unique Truform women's models 1173-HS and 1174-HS, and men's model 417-HS

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*Shoulder straps that are tightened by a single adjustment in front and are then held securely in the simply designed "keeper" (see drawing).*

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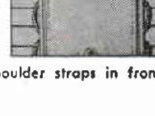
Greater height in the back, too, with two full-height steel stays to assure firm support. Comfortable adjustable underarm pads . . . 3 pull-straps to adjust and distribute tension.

Specify with confidence Truform supports that are anatomically correct and therapeutically sound . . . fitted with skillful knowledge . . . available only from the Ethical Appliance Dealer.

**UNIQUE DORSO-LUMBAR SUPPORT**



Women's models 1173-HS full skirt (pictured above) and 1174-HS regular length. Men's model 417-HS regular length. Drawing shows single adjustment of shoulder straps in front, retained in "keeper"

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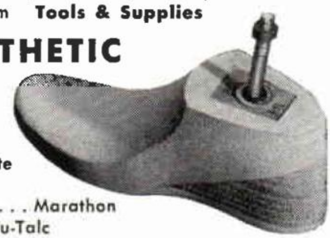
## PROSTHETIC



**KNIT-RITE STUMP SOCKS**
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**DURABLE** . . . Knit-Rite Stump Socks retain their elasticity and softness through repeated washings.

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# TITUS ANNOUNCES ASSEMBLY PROGRAM

BERT R. TITUS

Bert R. Titus, Director of Prosthetics and Orthopedic Appliances at Duke University Medical Center, Durham, N. C., and Assembly Program Chairman, has announced the Program for the 1963 National Assembly of the American Orthotics and Prosthetics Association.

Additions and changes in the program listed below will be reported in forthcoming issues of the *Journal* and the AOPA *Almanac*.

Registration for the Assembly is open to all persons interested in the rehabilitation of the orthopedically disabled. Readers of the *Journal* will be welcome, and may obtain registration blanks on application to the Association headquarters, 919 18th Street, N.W., Washington 6, D. C.

## TENTATIVE PROGRAM

## AOPA NATIONAL ASSEMBLY

### November 2 to 6

### Jung Hotel, New Orleans, La.

Saturday, November 2..................Advance Registration and Meeting of Board of Directors

Sunday, November 3:

| | |
|---|---|
| 10 a.m.-5 p.m. | EXHIBITS OPEN |
| 1:30 p.m. | Opening Business Session:<br>Reports of Officers and Committees |
| 2:30-4:30 p.m. | Relationships with Professional Associates<br>By Jack D. Armold, Ph.D. |
| 4:30-5:30 p.m. | The Evaluation of Orthotic Devices,<br>By the Sub-committee on Orthotics, CPRD<br>(Drs. Aitken, Lissner, Bennett, Fishman) |
| 7 p.m. | Reception and Buffet Supper |

Monday, November 4:

| | |
|---|---|
| 9 a.m.-5 p.m. | EXHIBITS OPEN |
| 10 a.m.-11 a.m. | Use of Silicones in Orthotics and Prosthetics<br>By Silas Braley, Director, Dow Corning Center for Aid to Medical Research |
| 11 a.m.-12:30 | Splinting the Arthritic Hand<br>By Alice Garrett, M.D., Rancho Los Amigos |
| 1 p.m. | Certification Luncheon<br>ABC Business Meeting |

Tuesday, November 5:

| | |
|---|---|
| 9 a.m.-5 p.m. | EXHIBITS OPEN |
| 9:30-11 a.m. | Principles of Total Contact in Prostheses<br>Arrangements to be made by members of the University Council on Orthotic and Prosthetic Education (UCOPE) |
| 11 a.m-12:30 p.m. | Problems in Fitting Total Contact Prostheses<br>Bruce Scott, Moderator (Panel to be announced) |
| 2 p.m.-3 p.m. | European Prosthetics and Orthotics<br>By Prof. Charles W. Radcliffe, Dept. of Engineering, University of California, Berkeley |
| 3 p.m.-4 p.m. | AOPA European Technical Mission<br>C. E. Yesalis and Carlton Fillauer, Moderators<br>(Members of the Technical Mission will participate) |
| 4 p.m.-6 p.m. | Latest Developments in Porous Laminates<br>By Members of University Council on Orthotics and Prosthetics Education (UCOPE) |

Wednesday, November 6:

| | |
|---|---|
| 9 a.m.-12 noon | EXHIBITS OPEN |
| 10-11:30 a.m. | New Additions to VA Contract List of Fluid Control Devices (Mauch, DUPACO, Kingsley Units)<br>Anthony Staros, Moderator |
| 11:30-1 p.m. | Techniques of Teaching Prosthetics and Orthotics<br>Miles D. Anderson, Ed.D. |
| 2 p.m. | AOPA Business Meeting; Election of Officers |
| 7 p.m. | Reception |
| 8:00 p.m. | Banquet—Speaker, Dr. George T. Aitken, Chairman, Committee on Prosthetic Research and Development, National Research Council |

# Prosthetics and Orthotics Research in The United States*

By A. BENNETT WILSON, JR., B.S.M.E.

*Committee on Prosthetics Research and Development, NAS-NRC*

*Washington, D. C.*

The replacement of missing limbs has been a problem facing man since the beginning of his existence. Some prehistoric men must have survived crushing injuries resulting in amputation, and certainly some prehistoric children were born with congenitally deformed limbs amounting to amputation. In 1958 the Smithsonian Institution reported the discovery of a skull, dating back about 45,000 years, of a person who was deduced to be an arm amputee because the teeth apparently had been used in a manner to compensate for lack of limb. Leg amputees must have compensated for their loss partially by the use of crude crutches and in some instances by using peg legs fashioned from forked sticks or tree branches.

In relatively modern times the advancement of amputation surgery and limb prostheses had been closely linked with warfare. In the days of knighthood it was the warrior who received an artificial limb. Indeed, some were able to return to battle with the aid of prostheses. It was the French army surgeon, Pare, who reintroduced in 1529 the application of ligatures to control bleeding and led the way toward amputation methods in use today. Pare also devised artificial limbs for his patients.

The Napoleonic Wars, the American Civil War, and World War I all led to the development of improved surgical technics and better artificial limbs. World War II proved to be no exception to the pattern.

*Research Program After World War II*

Early in 1945 the Surgeon General of the U. S. Army requested of the National Academy of Sciences (see box on next page) advice concerning the provision of artificial limbs to the large influx of soldiers who had suffered amputation. A conference of surgeons, engineers, and prosthetists, conducted by the Panel on Amputations of the Division of Medical Sciences, National Academy of Sciences—National Research Council, revealed that little scientific effort had been devoted to the development of artificial limbs and recommended that a research program in this area be initiated.

* Reprinted by permission of the author and publisher from *Rehabilitation Literature*, Vol. 24, No. 4, April, 1963.

## NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL

The National Academy of Sciences—National Research Council is a private, nonprofit organization of scientists, dedicated to the furtherance of science and to its use for the general welfare.

The Academy was established in 1863 under a Congressional charter signed by President Lincoln. Empowered to provide for all activities appropriate to academies of science, it was also required by its charter to act as an adviser to the Federal Government in scientific matters. This provision accounts for the close ties that have always existed between the Academy and the Government, although the Academy is not a governmental agency.

The National Research Council was established by the Academy in 1916, at the request of President Wilson, to enable scientists generally to associate their efforts with those of the limited membership of the Academy in service to the nation, to society, and to science at home and abroad. Members of the National Research Council receive their appointments from the President of the Academy. They include representatives nominated by the major scientific and technical societies, representatives of the Federal Government, and a number of members-at-large. In addition, several thousand scientists and engineers take part in the activities of the Research Council through membership on its various boards and committees.

Receiving funds from both public and private sources, by contribution, grant, or contract, the Academy and its Research Council thus work to stimulate research and its applications, to survey the broad possibilities of science, to promote effective utilization of the scientific and technical resources of the country, to serve the Government, and to further the general interests of science.

Such a program was activated in the spring of 1945 by the National Academy of Sciences through its Division of Engineering and Industrial Research with funds supplied by the Office of Scientific Research and Development. The Academy, acting as the prime contractor, entered into agreements with some 16 private and public facilities for the conduct of research and development on a broad front. The program was directed by the Committee on Artificial Limbs.* Shortly after the cessation of hostilities, upon the dissolution of the Office of Scientific Research and Development, fiscal responsibility was assumed by the Office of the Surgeon General. Not long thereafter the Veterans Administration provided supplementary funds. Initially many felt that the solution to the problem of limb prosthetics was simply to devise better mechanisms and apply new materials.

Although certain advances were effected by such an approach, it was soon realized that fundamental biomechanical studies were necessary for the development of truly realistic design criteria. The responsibility for such studies was entrusted to the University of California, which established on the Berkeley campus a laboratory devoted to study of the lower extremity and on the Los Angeles campus a laboratory for study of the upper extremity. Groups elsewhere based their designs on criteria developed by the California laboratories.

* For a short time at the beginning the Committee on Artificial Limbs was known as the Committee on Prosthetic Devices.

In the spring of 1947 the Committee on Artificial Limbs considered that it had established a stable program and, in keeping with the policy of the National Academy of Sciences, recommended that interested governmental agencies contract directly with the research laboratories and that the Committee itself assume an advisory role rather than that of director. Also at this time the Veterans Administration assumed complete fiscal responsibility, but the Army and Navy agreed to co-operate by continuing operation of research laboratories within their own departments. The co-ordinating group within the Academy was designated as the Advisory Committee on Artificial Limbs, later as the Prosthetics Research Board, and currently as the Committee on Prosthetics Research and Development.

In 1948, upon advice of the Advisory Committee on Artificial Limbs, an independent evaluation laboratory was established at New York University for the purpose of testing the usefulness of devices and technics emerging from the development laboratories. Thus, an orderly pattern of transition of an idea from the concept stage to a completed item was possible.

To insure continuity to the program Congress, also in 1948, passed Public Law 729 authorizing appropriations to the Veterans Administration up to $1 million annually for research in the fields of prosthetics, orthopedic appliances, and sensory aids for the blind. Since 1954, under the provisions of Public Law 565, known as the Vocational Rehabilitation Act, the Office of Vocational Rehabilitation (recently renamed Vocational Rehabilitation Administration) of the Department of Health, Education, and Welfare (HEW) has been able to support research and training projects in prosthetics, orthotics, and other areas required in rehabilitation. Grants for the support of certain fundamental research have been made by the National Institutes of Health, the Easter Seal Research Foundation, and The National Foundation. Research in the area of prosthetics for children is supported by the Children's Bureau, HEW.

By 1952 a sufficient body of knowledge concerning upper-extremity prosthetics had been accumulated so as to change radically previous concepts of management of the arm amputee. The Veterans Administration, seeking an efficient method of transmitting this knowledge to its clinic teams responsible for care of amputees, supported the University of California at Los Angeles in establishing and conducting short-term courses in upper-extremity prosthetics for physicians, therapists, and prosthetists. So successful were these courses that it was necessary to establish educational programs at two other centers—New York University and Northwestern University. Today these three schools operate at full capacity and add courses as new material is developed in the research program. Because the requirements of the Veterans Administration represent but a small percentage of the population as whole, the major support of the prosthetics education programs in the universities is by funds administered by the Vocational Rehabilitation Administration.

From the inception of the Artificial Limb Program, those responsible for its conduct realized that the need for research in the allied field of orthotics* was just as important but felt that a sound program in prosthetics would eventually provide a firm foundation for research in orthotics, much of the fundamental data accumulated in prosthetics research being applicable

* Orthotics is a coined word designed to embrace the field of orthopedic bracing. In some quarters the word *orthetics* has been used, but in 1959 the Orthopedic Appliances and Limb Manufacturers Association (now American Orthotics and Prosthetics Association), after considerable consultation with numerous lexicographers, approved *orthotics* as the most appropriate nomenclature.

to orthotics. Beginning about 1956 funds for a limited amount of research became available through the Office of Vocational Rehabilitation and the Easter Seal Research Foundation. Today some 8 to 10 institutions are conducting studies aimed at furthering knowledge in orthotics, and the Committee on Prosthetics Research and Development has assumed the responsibility for correlating this work.

*Results of Research Program*

Virtually every aspect of the management of amputees has been influenced by results of the research program. The surgeon no longer holds to the "sites-of-election" concept because suitable devices and technics are available to fit every level of amputation.

Some of the major components and technics introduced by the research groups are the ischial-gluteal-bearing suction socket for above-knee amputees, the patellar-tendon-bearing socket in below-knee cases, the solid-ankle, cushion-heel (SACH) foot, the plastic Syme prosthesis, the Canadian-type prosthesis in cases of hip disarticulation and hemipelvectomy, an array of harnessing technics for arm amputees, the alternator-type elbow, the Army Prosthetics Research Laboratory (APRL) terminal devices, and plastic artificial arms.

The concept of the clinic team evolved from the inter-disciplinary research program, and as a result there is today a much closer relationship between the medical and prosthetics professions.

Also as a result of the program an entirely new body of knowledge concerning the functions of the extremities exists. This knowledge, still being expanded, has been helpful in the development of new devices and technics and should prove useful for a good many years to come.

*Method of Operation*

The 13-man Committee on Prosthetics Research and Development is composed primarily of engineers, physicians, and prosthetists but is not limited to these disciplines. Each member is appointed by the President of the National Academy of Sciences to a three-year term and serves as an individual rather than as a representative of an organization or institution. Members of the Committee serve without pay. A small staff is employed to carry out day-to-day activities.

The objectives of the Committee are to correlate the various prosthetics and orthotics research activities supported by the Veterans Administration, the Department of Health, Education, and Welfare, the Army, the Navy, and others; to keep the sponsoring agencies advised of the scope of the program and progress made; to insure that successful new devices and technics are made available promptly to the schools of prosthetics and orthotics education for inclusion in the curricula; to determine areas where research is required and stimulate initiation of such research; and to provide wide dissemination of the results of research.

The Committee on Prosthetics Research and Development meets at least twice yearly to receive progress and evaluation reports concerning the research efforts, to consider any problems posed by the sponsors, research groups, or others, and to recommend the course of further efforts. To consider problems peculiar to the juvenile amputee, there is a Subcommittee on Child Prosthetics Problems. *Ad hoc* committees are appointed to handle special problems as they arise. Conferences on specific topics are held whenever needed. During the past fiscal year special conferences were held on the total-contact socket for above-knee amputees, upper-extremity prosthesis design, and orthotics research. In addition, the Committee organized and sponsored a pilot school in total-contact above-knee sockets in order that this concept might be introduced into the prosthetics education program.

Funds for operation of the Committee on Prosthetics Research and Development are provided by the Veterans Administration, the Vocational Rehabilitation Administration, and the National Institutes of Health.

Roy M. Hoover, M.D., Medical Director, Woodrow Wilson Rehabilitation Center, Fishersville, Va.

Alvin L. Muilenburg, President, Muilenburg Artificial Limb Company, Houston, Tex.

Herbert W. Park, M.D., 3500 Kensington Ave., Richmond, Va.

Ruth A. Robinson, Col., Chief, Army Medical Specialist Corps, OSG, Department of the Army, Washington, D. C.

Alfred R. Shands, Jr., M.D., Medical Director, Alfred I. duPont Institute of The Nemours Foundation, Wilmington, Dela.

Walter A. Thompson, M.D., Chairman, Dept. of Orthopedic Surgery, New York University School of Medicine, New York City

Frederick E. Vultee, M.D., Chairman, Dept. of Physical Medicine and Rehabilitation, Medical College of Virginia, Richmond

Harold W. Glattly, M.D., Executive Secretary

## Present Activity

At the present time at least 25 groups are conducting some type of research or development in prosthetics or orthotics, or both. A list of these groups along with their primary responsibilities is given below:

| *Organization* | *Major Area (or Areas) of Investigation* | *Sponsoring Agency* |
|---|---|---|
| 1. Army Prosthetics Research Laboratory (APRL)—John Butchkosky | Upper-Extremity Prosthetics Development and Materials Research | U.S. Army |
| 2. Navy Prosthetics Research Laboratory (NPRL) — Robert C. Doolittle | Lower-Extremity Prosthetics Development | U.S. Navy |
| 3. Veterans Administration Prosthetics Center (VAPC) — Anthony Staros | Testing and Development of Prosthetics and Orthotics | VA |
| 4. Prosthetic Research Center, Northwestern University (NU) —Clinton L. Compere | Prosthetics Development (especially with respect to the older age group) | VA |
| 5. Mauch Laboratories, Inc. (ML) —Hans A. Mauch | Development of Lower-Extremity Prosthetic Devices | VA |
| 6. Adult Prosthetic and Orthotic Studies, New York University (APOS-NYU)—Sidney Fishman | Testing and Evaluation of Devices and Technics | VA and VRA |
| 7. Biomechanics Laboratory, University of California (BL-UC) —Verne T. Inman and Charles W. Radcliffe | Prosthetics and Orthotics Design and Studies of Human Locomotion | VA and VRA |
| | Investigation of Post-Traumatic Epidermoid Cysts | VRA |
| | Energy Expenditure in Certain Types of Disabilities | VRA |
| | Energy Expenditure and Work Tolerance Studies in Hemiplegic Patients | VRA |
| | Clinical Evaluation of Experimental Orthotic Devices and Procedures | VRA |
| | Medical Aspects of Amputee Research—Lower Extremity | NIH |
| | Pilot Study in Brace Research | Easter Seal |
| 8. Biotechnology Laboratory, University of California, Los Angeles (UCLA)—John Lyman | Research on Control of Externally Powered Artificial Arms | VA |
| 9. John O. Esslinger c/o Gasow Veterinary Hospital, Birmingham, Mich. | Study on Semiburied Implants for the Attachment of External Prostheses | VA |

| | | |
|---|---|---|
| 10. University of Michigan (UM)—James W. Rae, Jr. | Research and Development in Upper-Extremity Orthotics | VRA |
| 11. American Institute for Prosthetic Research (AIPR)—Henry H. Kessler | Development of Pneumatically Powered Upper-Extremity Prostheses | VRA |
| 12. NYU Post-Graduate Medical School (APS-NYU) — Sidney Fishman | Development of a Psychological Test Battery for Predicting Success in Amputee Rehabilitation | VRA |
| 13. Albert Einstein College of Medicine, Yeshiva University (ECM) —Sidney Weinstein | Experimental Analysis of Phantom Appendages with Special Reference to Somato-sensory and Experiential Concomitants of Amputation | VRA |
| 14. American Orthotics and Prosthetics Association (AOPA)—Lester A. Smith | Survey To Determine the State of Services Available to Amputees and Orthopedically Disabled Persons | VRA |
| 15. Los Angeles County Hospital (LACH)—Vernon L. Nickel and Robert Mazet, Jr. | Influence of Prosthesis Wearing on the Health of the Geriatric Amputee | VRA |
| 16. Attending Staff Association of Rancho Los Amigos Hospital, Inc. (RANCHO) — Vernon L. Nickel | To Investigate and Demonstrate Sources of External Power for Upper-Extremity Orthotic Devices<br>Improvement of Mechanical Devices To Replace Losses Due to Very Severe Upper-Extremity Paralysis | VRA and The National Foundation<br>The National Foundation |
| 17. Baylor University College of Medicine (BUCM)—William A. Spencer | Development of Upper-Extremity Orthotic Devices | VRA |
| 18. Harvard University (HU) — Ross A. McFarland | Evaluation of the Ability of Amputees To Operate Trucks or Other Vehicles | VRA |
| 19. New York University College of Engineering, Research Division (NYU)—Sidney Fishman | Analysis and Evaluation of Lower-Extremity Orthotic Devices | VRA and Easter Seal |
| 20. Case Institute of Technology (CIT)—James B. Reswick | Applicability of Digitally Programed Control in Prostheses and Ortheses;<br>Development of Synthetic Muscle Motors for Use in Prostheses and Orthoses;<br>Development of a Micro-Miniature Signal Transducer Unit for Implantation in Human Muscle | VRA |
| 21. Eugene duPont Memorial Hospital and Rehabilitation Center (duPont)—Arthur J. Heather | Development of Hydraulically Operated Elbow Unit for an Orthopedic Brace | VRA |
| 22. New York University College of Engineering (NYU) — Renato Contini and Rudolfs Drillis | Determination of Certain Body Segment Parameters | VRA |
| 23. Child Amputee Prosthetics Project, University of California, Los Angeles (CAPP)—Charles O. Bechtol, Milo Brooks | Development of Improved Prosthetic Devices and Training Technics, and Surgical Procedures for Child Amputees | Children's Bureau and NIH |
| 24. Child Prosthetic Studies, New York University (CPS-NYU)—Sidney Fishman | Evaluation of Children's Prostheses and Collection of Normative Data on Methods of Treatment in Country-wide Clinics | Children's Bureau |
| 25. Michigan Crippled Children Commission (MCCC) | Clinical Testing of Prosthetic Devices for Child Amputees and the Development of Improved Clinical Management Procedures | Children's Bureau |

Most of the activities of the research groups can be classified as fundamental research, development, or evaluation. A list of most of the problems being pursued at the present time is given on pages 160-166.

*Dissemination of Information*

To accelerate and to insure dissemination of information concerning the management of amputees and others with orthopedic impairments are the responsibilities of the Committee on Prosthetics Education and Information, Division of Medical Sciences, National Academy of Sciences—National Research Council. Composed of representatives of all the disciplines involved in rehabilitation of the orthopedically handicapped, the Committee was formed in 1957 primarily to assist medical and paramedical schools in formulating their curricula with respect to prosthetics and orthotics, and to make available to practicing medical groups the results of research. To carry out these objectives the Committee on Prosthetics Education and Information has established a number of *ad hoc* committees.

*Outlook for the Future*

Significant as the contributions of the prosthetics research program have been, much room yet remains for advancement and the problems associated with orthotics have scarcely been touched.

Even though fitting technics have been improved vastly over the past decade and amputees in general go about their daily activities in a fairly normal manner, it can hardly be said that a comfortable socket exists. At best the level of discomfort is tolerable. The problems will continue to be studied.

More functional prostheses for the upper-extremity amputee are needed. To date it has not been possible to devote much effort to the special problems of the severely disabled with bilateral cases. Here recent advances in the use of compressed gas and electricity to operate prostheses and braces indicate hope for adding functions not heretofore possible.

Surgical studies for the development of technics that provide more functional, pain-free stumps are under way. A modest approach to determine the feasibility of attaching a limb prosthesis directly to bone in the stump is being undertaken.

Special problems of the geriatric amputee must be studied more thoroughly than has been possible in the past.

Concurrently with the studies leading to improved devices and management procedures, there should be great emphasis placed on eradication of the causes of amputation and other crippling conditions. Some work has been carried out in an effort to determine the causes of congenital malformation of limbs. The linking of thalidomide with congenital deformities offers an excellent opportunity for increasing our knowledge concerning the mechanism of malformation of limbs.

Research in the area of peripheral vascular diseases will no doubt result in the saving of large numbers of limbs. As our knowledge of the neurological system and the diseases affecting it increases, the relative need for braces will decrease. Meanwhile improved surgical procedures could eliminate in many cases the need for prosthetic and orthotic devices, and such studies should be encouraged.

Yet since as far as anyone can see there will always be a need for artificial limbs and orthopedic appliances, a continuing effort to improve both the devices and their application is needed.

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# MAJOR STUDIES BEING CONDUCTED IN ORTHOTICS AND PROSTHETICS IN THE UNITED STATES

(For key to organizations conducting these studies, see pages 157 and 158)

## FUNDAMENTAL STUDIES

### Prosthetics

*Lower Extremity*

Impedance Plethysmography (NU)

Investigation of the impedance method of estimating blood flow to determine its application to stumps in the static weight-bearing condition.

Pressure Between Below-Knee Stump and Socket (BL-UC)

The determination of the distribution of pressure over the stump, during use of a prosthesis, to assist in the development of design criteria for below-knee sockets.

Force and Range-of-Motion Studies of Above-Knee Stumps (NU)

A study to determine the available forces throughout the useful range of motion while a socket is worn.

Amputation Surgery (BL-UC)

A study to evaluate known lower-extremity amputation technics and develop improved technics, with related clinical studies to aid in the diagnosis of pain.

Influence of Prosthesis on the Health of Geriatric Amputees (LACH)

A study designed to determine the indications and contraindications for fitting elderly amputees with lower-extremity prostheses.

Functional Characteristics of Above-Knee Legs in the Stance Phase (NU)

A study of alignment of various types of above-knee prostheses to determine required stump forces during the stance phase.

*Upper Extremity*

Body Sites of Control of Externally Powered Prostheses (UCLA)

The determination of suitable sources of energy for subconscious, or reflex, control of externally powered arms. Three separate investigations are under way—electromyographic signals, nerve transplantation, and functional isolation of muscle groups without surgery.

Analysis of Existing Externally Powered Prostheses (UCLA)

A detailed study of current designs to gather data that might be helpful in future design work.

Sequential Analysis of Time-Separated Prosthesis Control Function (UCLA)

An analysis to assist in simplifying control motions in complex body-powered arm prostheses.

Variable-Ratio Mechanical Control System (UCLA)

A study to determine the practicability of control systems using changing mechanical advantage to meet changes occurring in operation of arm prostheses.

Attitude Control (NU)

A study to determine the suitability of controlling an externally powered above-elbow prosthesis by the attitude (direction in space) of the socket.

Amputee Truck Drivers (HU)

To evaluate the ability of amputees to operate trucks or other transport equipment.

Normative Survey of the Child-Amputee Population (CPS-NYU)

A census-type survey of 1,000 amputees below the age of 15 years, to gather information on such matters as amputee types, etiology, and methods of prosthetics treatment for this section of the amputee population.

*General Medical Problems*

Pain Studies (BL-UC)

The determination of the physiological mechanism of pain, with particular reference to amputees.

Nerve Patterning (BL-UC)

Neuroanatomical studies of patterning and structure of nerve fibers and endings in human skin, fascia, and tendons, to provide a basis for understanding pain processes.

Rotations of the Pelvis, Spine, and Shoulder Girdle (BL-UC)

A study of ligamentous spines to determine the extent and effects of rotational movements of the spine.

Psychological Test Battery for Predicting Success in Amputee Rehabilitation (APS-NYU)

A study to determine the role played by the patient's mental outlook on the rehabilitation process.

Skin Disorders (BL-UC)

Determination of etiology of and therapy for skin disorders of amputation stumps.

Analysis of the Phantom Sensation in Amputation (ECM)

A study to determine the factors involved in the production and continuation of the phantom sensation associated with all types of amputees.

ORTHOTICS

*Lower Extremity*

Pilot Study in Orthotics Research (BL-UC)

The determination of an efficient methodology for research in the field of orthotics. Problems associated with the ankle joint are used as examples in the pilot study.

Functional Efficiency and Comfort of Leg Braces (APOS-NYU)

An investigation of factors that influence functional efficiency and comfort of leg braces for orthopedically disabled persons.

*Upper Extremity*

Inertial Force Study—Upper Extremity (UM)

An analysis of the kinetics of certain upper-extremity motions occurring essentially in a single plane.

Spatial Location of the Hand and Elbow During Eating (UM)

The determination of the relative position of segments of the upper extremity during certain eating activities.

Physical Measurements of Upper-Extremity Segments (UM)

The determination of physical constants of segments of the upper extremity for use in establishing criteria for brace design.

Systems Analysis of Upper-Extremity Orthotics (UM)

A detailed study of upper-extremity orthotics designed to determine approaches to the problem that will be most fruitful.

Denervated Muscle as a Source of Power in Orthotic Systems (UM)

The investigation of the feasibility of applying a stimulus to denervated muscle in such a way as to cause it to contract and power purposeful movement.

Sources of External Power (BUCM)

A study to develop and evaluate functional orthotic equipment for persons with upper-extremity paralysis and to investigate sources of external power for such equipment.

PROSTHETICS AND ORTHOTICS

Energy Expenditure Studies (BL-UC)

The measurement of energy requirements for locomotion of normal persons and of persons with amputations and other orthopedic disabilities under varying conditions. Disabled persons are studied while using and not using assistive devices.

Survey To Determine the State of Services to Amputees and Orthopedically Disabled Persons (AOPA)

Survey designed to determine current practices in prosthetics and orthotics throughout the United States.

Role of the Trunk in Stability of the Spine (BL-UC)

A continuation of fundamental studies of human locomotion.

## ITEMS UNDER DEVELOPMENT

**PROSTHETICS**

*Lower Extremity*

Hydraulic Ankle (ML)

An ankle unit, independent of the remainder of the prosthesis, in which resistance to plantar flexion is provided hydraulically and the dorsiflexion stop automatically comes into effect when the shank is perpendicular to the ground regardless of the attitude of the foot.

Ankle Rotation Device (BL-UC)

A unit incorporated between foot-ankle and shank in an artificial leg to permit transverse rotation of shank with respect to foot.

UC-B Pneumatic Swing-Phase Control Above-Knee Knee Unit (BL-UC)

An air cylinder-and-piston type unit designed to fit into any crustacean shank and to provide control of the shank during swing phase.

UC-B Pylon Type Above-Knee Prosthesis (BL-UC)

A design to provide an inexpensive sturdy prosthesis for above-knee amputees. Design of a pylon-type prosthesis has been reactivated, to be used in connection with projected geriatric studies.

Above-Knee Swing Control Using Pinch-Tube Principle (NU)

The design of an above-knee swing-control unit based on the transfer of fluid as a result of compressing a flexible tube by a rolling cylinder.

Its chief advantages are low cost and elimination of the need for seals to prevent leakage between moving parts and the atmosphere.

Adjustable Pylon for Below-Knee Amputees (NU)

The development of a simplified adjustable shank for below-knee fitting. It is hoped that the weight of the unit can be kept sufficiently low to allow it to be retained in the permanent prosthesis, thereby eliminating the need for transfer of alignment.

Above-Knee Leg with Stable Knee for Geriatric Use (NU)

A design with four-bar linkage intended specifically for use in geriatrics or by persons with a particular need for a stable knee joint.

Disc Friction Unit for Standard Above-Knee Prostheses (NU)

The use of a stack of friction discs actuated progressively to provide variable friction through swing phase.

Disc Friction Unit for Knee-Disarticulation Prostheses (NU)

A shank-mounted drum containing a stack of friction discs actuated progressively to provide change in friction during swing phase, as required.

Self-Aligning Teflon Joint for Below-Knee Amputees (NU)

The use of spherical joints in below-knee side bars.

Fluid-Lined Sockets for Lower-Extremity Amputees (NU)

The development of a practical technic for fabricating and fitting a fluid-lined socket to determine the relative merits of uniform pressure distribution over the stump.

Suspension of Above-Knee Prostheses (NU)

A design for above-knee suspension for use by geriatric amputees for whom suction sockets are contraindicated due to cardiac and/or other medical complications.

Ischial-Bearing Prosthesis for Below-Knee Amputees (BL-UC)

Basic experimentation using several designs to develop an improved ischial-bearing prosthesis for use by below-knee amputees.

Adjustable Alignment Coupling for Above-Knee and Below-Knee Legs (VAPC)

An alignment coupling for above-knee and adjustable leg, designed particularly for use in alignment of hydraulic-knee mechanisms. Below-knee legs designed to overcome inadequacies of present alignment and transfer devices.

*Upper Extremity*

NU Electric Arm (NU)

A device wherein elbow flexion and extension are controlled by mercury switches that respond to humeral flexion and extension.

Hand Sizing (APRL)

The development of brass models of a spectrum of hand sizes to cover the population.

Hand, Size 1, Nylon, Right (APRL)

A design for a nylon model of the APRL-Sierra hand that will be cheaper, lighter, and more easily and quickly fabricated.

Two-Load Hook, Child Size (APRL)

A voluntary-opening hook with two selectable prehension forces.

Micro-Miniature Signal Transducer (CIT)

The development of a micro-miniature transducer for implantation in a human muscle.

Axial-Control Hook (CAPP)

A hook in which the control force is applied through the axis of the wrist unit to eliminate change in effective cable length upon rotation of the terminal device.

Voluntary-Opening Hand with Single-Position Backstop (APRL)

A voluntary-opening hand with a one-position lock to provide security of grasp for certain critical activities.

Hand, Resilient Covering (APRL)

A limited-function hand with shell, fingers, and mechanism covered with a layer of plastic foam to give soft-touch approach.

Cosmetic Gloves (APRL)

A continuing project with the development of materials for cosmetic gloves with better properties than those presently available.

Control Cable System (CAPP)

The development of a more efficient power transmission system.

NU Electric Wrist (NU)

An electric-powered wrist unit incorporating pronation, supination, flexion, and extension.

Separation of Controls (CAPP)

A braking device for cables to prevent interaction of control forces in bilateral above-elbow systems.

Below-Elbow Step-up Hinge with Lock (APRL)

An elbow unit for short below-elbow stumps with limited force and range of motion.

Lower- and Upper-Extremity Sockets with Graded Flexibility and Hardness (VAPC)

The development of sockets with flexibility properties varying as required to alleviate the "Donnell effect."

Adjustable Laminate Sockets (APRL)

The development of a method of making sockets by shrinking a preformed plastic laminate cone to a mold. It is hoped that changes in the configuration of the socket can be effected readily.

Upper-Extremity Socket Fitting Study (APRL)

A study to evaluate the various methods used for fitting in below-elbow cases.

Bellows-Type Actuator (APRL)

The development of a bellows-type actuator for use with upper-extremity prostheses.

AIPR Arm (AIPR)

AIPR arm is basically a series of four pneumatically powered prosthetic components that attempt to replace the functions and motions of the hand, the wrist, the elbow, and the shoulder; these components provide sufficient design flexibility to facilitate their assembly into a prosthesis in order to cover amputee situations ranging between long below-elbow sites to forequarter-amputation sites. The pneumatic components are actually rigid, pneumatic servo motors that are controlled by multipurpose miniature valves.

## Orthotics

### *Lower Extremity*

Below-Knee Adjustable Brace (VAPC)

A design developed to provide the orthotist with a means of adjusting ankle axis, the bands, and bars at first contact with patient so that final fitting may be accomplished at second visit.

Below-Knee Weight-Bearing Brace with Patellar-Tendon-Bearing Socket (VAPC)

A design for a below-knee weight-bearing brace using the patellar tendon as a bearing area instead of the ischium.

System of External Control for the Impaired Ankle (BL-UC)

A basic dual-axis mechanism to permit all normal ankle motion to which assists and constraints can be added as required.

*Upper Extremity*

Feeder Devices (UM)

An improved device to support the paralyzed arms of patients to permit placement of hands for use.

Pneumatic Proportional Controls (UM)

A study to determine the feasibility of developing pneumatic proportional controls for use in powering upper-extremity motion.

Experimental Gas-Liquid Pressure Transmitter (UM)

A "muscle"-type actuator containing gas and liquid separated by a diaphragm. Use of liquid gives saving of gas without changing force-pressure length characteristics.

Concentric Cylinder-McKibben Muscle Torsional Actuator (UM)

A woven McKibben-type actuator to provide torque about the long axis of the tube.

Upper-Extremity Brace (UM)

The fabrication of an upper-extremity brace embodying the results of previous design experimentation in components, sources of power, etc., at the University of Michigan.

Electric Feeder (RANCHO)

The development of electric control system for feeders.

Powered Ball-Bearing Feeders (RANCHO)

The development of a hydroelectric power system for feeders.

Power Steering for Monodrive Wheel Chairs (RANCHO)

A kit was designed to provide power steering for monodrive wheel chairs.

Rotary Actuators (RANCHO)

The development of an inexpensive rotary actuator for externally powered feeders.

Photo Control (RANCHO)

An instrument designed to demonstrate the feasibility of using photo detection apparatus to control an actuator.

Implant Transducers (RANCHO)

The development of transducers suitable for implantation in muscle.

Force Transducers (RANCHO)

The development of a means of measuring axial skeletal loading at the heel.

Synthetic Muscle Motors (CIT)

The development of synthetic muscle motors for use in prostheses and ortheses.

Digitally Programed Control (CIT)

The development of the applicability of digitally programed control in prostheses and ortheses.

## ITEMS BEING EVALUATED

PROSTHETICS

*Lower Extremity*

Henschke-Mauch Swing-Phase Control Knee Unit (VAPC)

A field study to evaluate methods of application of hydraulic swing-phase control knee unit for above-knee amputees and to determine the durability of production units.

UC-B Pneumatic Swing-Phase Control Above-Knee Knee Unit (BL-UC)
An air cylinder-and-piston type of unit designed to fit into a crustacean shank and to provide control of the shank during swing phase.

UC-B Polycentric Knee (Pneumatic) (APS-NYU)
A combination of the UC-B polycentric prosthesis and the pneumatic swing-control unit.

Henschke-Mauch Swing- and Stance-Control System (APS-NYU)
The evaluation of a hydraulic leg designed to provide both swing and stance control.

UC-B Ankle Rotation Device (APS-NYU)
The evaluation of an ankle unit incorporated between foot-ankle and shank to permit transverse rotation of shank with respect to the foot.

UC-B Total-Contact Above-Knee Socket-Fabrication Technic (APS-NYU)
Evaluation of UC-B technic using prefabricated adjustable socket brims in the fabrication of total-contact above-knee sockets.

Long-Term Study of Patellar-Tendon-Bearing Below-Knee Prosthesis for Children (CPS-NYU)
A long-term study of the effect of the prosthesis on growing children with particular reference to bone changes and effects on ligamentous structure of the knee.

*Upper Extremity*

APRL-Sierra Child-Size Hand, Size 1, Model A, Left (CPS-NYU)
The evaluation of a voluntary-opening left hand for children in the four-eight year range.

Voluntary-Opening Hand with Single-Position Backstop (APRL)
A voluntary-opening hand with a one-position lock to provide security of grasp for certain critical activities.

APRL Dilaminar Cosmetic Gloves (APS-NYU)
The evaluation of a two-layer glove, an outer layer of thin stain-resistant material over a thicker layer of flexible material.

NU Single-Control Elbow (APS-NYU)
The evaluation of an elbow prosthesis in which flexion, locking, and terminal-device prehension are controlled from a single energy source.

# New Techniques In The Modification Of The Milwaukee Brace

By LeROY COOK, C.O.
Snell's Artificial Limb Co., Nashville, Tennessee

With an Addendum By
PHILIP B. WILLIAMS, M.D.

The use of plastics is by now an old story to prosthetists, but orthotists have been somewhat slower to make use of them in braces. This article is intended to call the attention of orthotists to the possibilities of a plastic lamination for the Milwaukee Brace as a jacket foundation for the brace.

Plastic, being a nonporous material, is far superior to leather jackets in the sense that there is no deterioration as often experienced in the old method. There is no breakdown vertically as was the case in leather. Cosmetically, it is cleaner and can be made to fit much better than leather and the exterior metal frame.

The Orthotist can cut his work time in half by using the plastic lamination.

Basically the negative cast is taken in the usual manner, having the patient in a vertical position. By the use of overhead traction the spine is partially straightened, making sure the anterior superior spine and the crest of the Ilium are marked with indelible. The cast should cover one-half of the Gluteals, and extend upward over one-half of the mandible and occiput. The indentation over the crest should be deeply pronounced. After the positive cast is made and dried the indention over the crest of the Ilium should be more pronounced by skiving in deeper with a cast knife or drawing knife. All build-ups for nonpressure points should be done with plaster instead of the traditional felt as the resin will soak in the felt during lamination.

The anterior superior spines and the crest of the Ilium should be built up with plaster so that no pressure is acquired from the jacket when the traction of the chin and occiput plates are applied. The indentation just over the crest keeps the jacket from slipping over the pelvis when traction is applied. It should be so placed on the cast as not to give any pressure on the lower thorax on the curved side. The side of the cast opposite the apex of the curve should be built up with plaster to match the afflicted side to give a more uniform exterior appearance. This also gives more room for the pressure pad to correct the Scoliosis when applied with vertical traction. The cast is now ready for about three coats of Parting Lacquer which should be allowed to dry thoroughly (about one day).

Next the patterns for the metal strips are made and the metal is cut and bent anterior to posterior from the bottom of the jacket up and over the crest of the Ilium. In these strips, one-fourth inch holes are drilled and staggered about one-half inch apart over the crest of the Ilium only. These one-fourth inch holes allow resin to run through into the indentation over the crest during lamination. After the metal is bent and drilled, it is then removed from the cast. A circumference measurement is taken around the thorax, pelvis and over the crest of the cast. From these three measurements a paper pattern is made and the first layer of Dacron felt, one-fourth inch thick, is made, folded in half and sewed in a seam. By cutting the Dacron from a pattern the necessary tightness is acquired between cast and Dacron. The Dacron is then stretched over the cast, the seam being in back where the jacket is opened, and stapled around the axilla line to the cast. After the first layer of Dacron is applied to the cast, cut six strips of Dacron about one-and-a-half inches wide and long enough to cover from anterior superior spine to posterior superior spine. Lay these Dacron strips, three to each side, into the indentations over the crest of the Ilium. The metal strips that have been cut and pre-bent are now ready for pre-application to the cast. Next place the metal strips back in place over the Dacron strips, making sure the one-fourth inch holes are drilled, and apply the second layer of Dacron felt, using the foregoing process. The metal work is thus between the interior and exterior surfaces of the lamination.

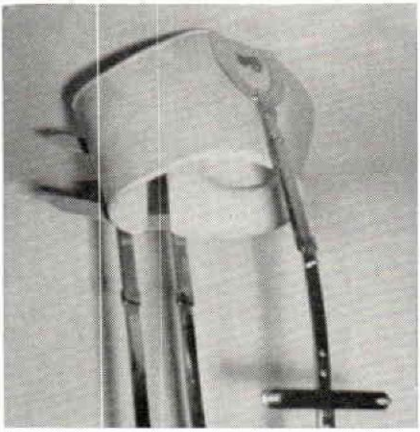

**Figure 1—Showing the plastic lamination. Notice the indentation over the crest inside.**

**Figure 2—The plastic jacket and exterior metal frame showing adjustability of the Orthosis.**

After two Dacrons are applied, pull on three nylon stockinettes sewed square across and tie off on the pipe inserted into the cast. Make a Poly Vinyl Alcohol bag long enough to extend at least twelve inches beyond each end of the cast. The cast is put in the vise, in an inverted position and is ready for lamination. Mix enough resin to thoroughly saturate depending on the size of the cast. A mixture of 70 per cent 4134 to 30 per cent 4110 will give sufficient flexibility. Add to this the catalyst and color depending on whether Negroid or Caucasian. After soaking in wet towel and applying the bag tied off over the head of the cast, the promoter is added to the resin, allowing about 40 minutes setting time.

The resin is poured in from the bottom of the inverted cast and worked down into the layers of material making sure to saturate thoroughly over the crests. After complete saturation of the material is acquired tie the bag off at the bottom and hook up the current vacuum machine used in Prosthetic laminations on Hemipelvectomies, hip and shoulder disarticulations, etc. The vacuum will suck the bag into the material and the Dacron strips over the crest will be pulled in pronouncing the indentation on the cast to a maximum degree. As the vacuum pulls out air the excess looseness of the bag can be pulled posteriorly in a vertical seam which will be cut out in the posterior opening of the jacket. The vacuum continues to run until the lamination is firmly set, then released and the lamination is allowed to cool. After cooling, the Orthotist can immediately remove the jacket from the Orthosis by means of a stryker cast cutter. After the jacket is removed and cut to the desired shape, it is then reapplied to the cast and the metal work may begin.

The jacket, in finishing, may be covered with thin horsehide inside and turned over the edges or left as is. The metal strips laminated inside the jacket serve as anchor points for the attachment of the exterior metal uprights. The vertical uprights are of stainless steel, made adjustable by welding a T on the bar and bending over the overlapping bar. The long bar, anteriorly, after being shaped is welded to the horizontal bar under the mandible. From here it passes downward through the bent T on the lower bar and a number 18 hole is drilled in the end. This one hole corresponds with a series of holes number 29 drilled and tapped in the short bar for adjustments vertically. As the child grows, more pressure is applied through the mandible and occiput plates. The posterior bars are made in the same order. Each bar is set in a piece of rectangular tubing corresponding to the bar size used.

The two posterior pieces of tubing are riveted with stainless steel rivets through the plastic and metal strips laminated inside. The anterior tubing is silver soldered to a horseshoe shaped stainless steel bar and then riveted on, making sure the ends of the bar are directly over the inserted metal strips. The neck piece is made of three individual pieces of metal. A stainless steel bar is placed directly under the mandible in a horizontal position. This bar should be long enough to give ample room on each side of the neck. Cut two other bars with sufficient length to give adjustment and lay up vertically. By using heat put a twist in the ends of each vertical bar until the short end crosses the body of the long end. After twisting the bars, we have two vertical bars with a three-fourth inch horizontal twist on one end of each bar. Over-lap the horizontal twists of the vertical bars on the ends of the horizontal bar under the mandible, drill through both and rivet, making a hinge. These two vertical bars are now slotted. The occiput bar is made in the same manner with a hinge on one side only and the other side solid.

**Figure 3—The head piece assembly with posterior and anterior hinges.**

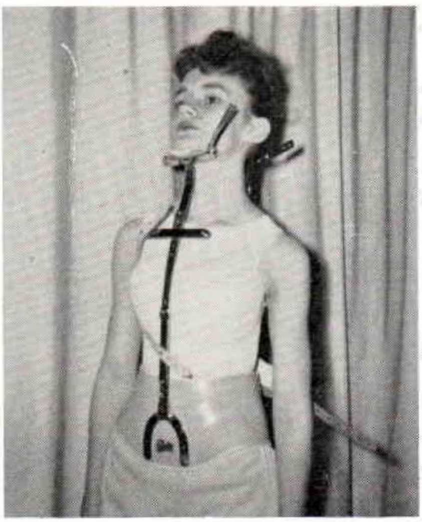

**Figure 4—The complete lateral opening of the head assembly on its axis.**

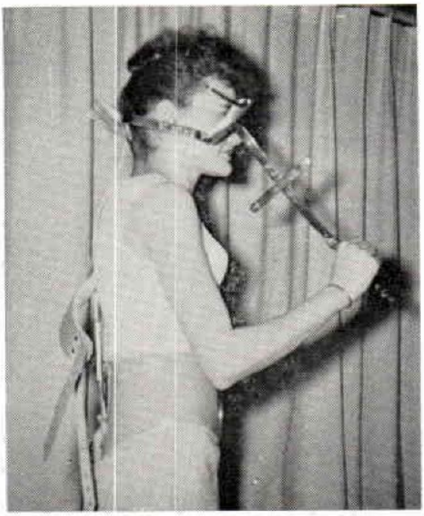

Figure 5—Displacing of the anterior bar showing metal frame swinging out.

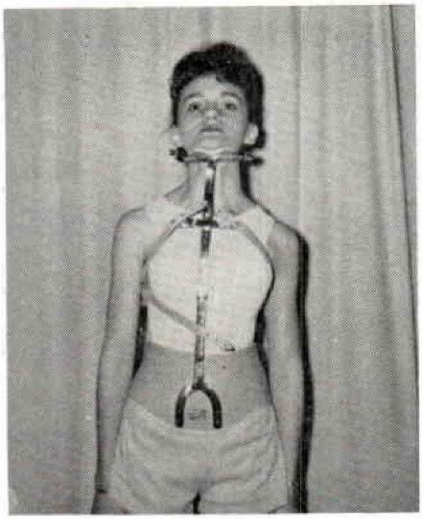

Figure 6—Anterior view. The T bar anteriorly keeping the straps of the pads off the busts.

The ends of the occipital bar extend anteriorly down each side of the neck with the anterior bars extending posteriorly. These bars are overlapped and are cut leaving room for future adjustments of the head piece. Two screws are tapped and screwed in from the inside of the lateral vertical bars of the posterior head piece. The body of these screws passes through the slotted ends of the anterior vertical bars and are secured with wingnuts. The head piece is now assembled in a three hinge affair. The solid side of the head piece is left fastened while the double hinged vertical bars on the other side are undone and both vertical bars swing out on their axis leaving a complete opening of the head piece laterally.

The chin and occiput plates are cupped to fit, padded with foam rubber, covered with horsehide and sewn with a baseball stitch by hand. After the brace is applied, the patient may easily disassemble it for removal. The patient removes the wingnuts on the double hinged side allowing the vertical bars to swing out on their axis leaving the complete side of the neck piece open. The head and neck pass laterally through this opening as the anterior bar is pulled upward out of its tubing. Once the anterior bar is displaced from its tubing it swings on its hinges to the opposite side, taking with it the chin piece. The patient may then reach over his head as in removing a sweater and pull upward on the posterior uprights displacing them from the tubing. The complete metal frame is removed intact by the use of the solid side of the neck piece. The posterior straps are then undone and the jacket removed. The brace is reapplied reversing each step.

A moveable T bar was found essential on the anterior upright in keeping the straps of the pressure pad off of the busts. The straps of the pressure pad are held in place by truss studs, so placed on the metal frame that the pressure pad may be placed at the apex of the curve, furnishing the pad with a maximum degree of correction. A sling type counter pressure pad is used on the opposite side under the axilla. It should fit loosely and serve as a crutch and a means of keeping the patient centered in the brace.

By using this method, the Orthotist saves himself valuable time which may be utilized for other things. He has saved time used in bending and cupping the metal strips in over the crests and moulding the leather and waiting for it to dry. The finished laminated jacket is nicer exteriorly and interiorly, has a better, closer fit and retains a longer flexibility than leather without cracking. The plastic jacket may also be relieved inside with a sand cone if necessary. Approximately three hours are required to use this method.

Working in close unison with the Doctor and Therapist, several of these types of braces have been clinically checked out and successfully used at the Jr. League Home for Crippled Children at Nashville, Tennessee.

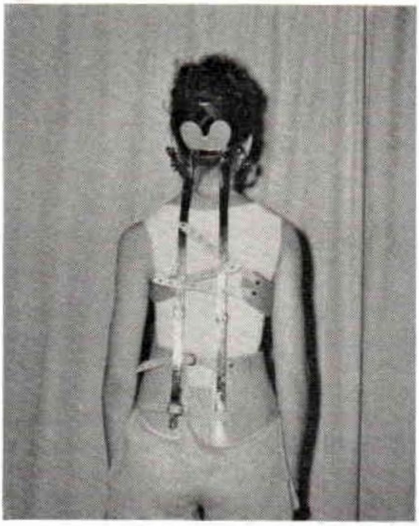

Figure 7—Posterior view. The pressure pad at the apex of the curve on a right Scoliosis.

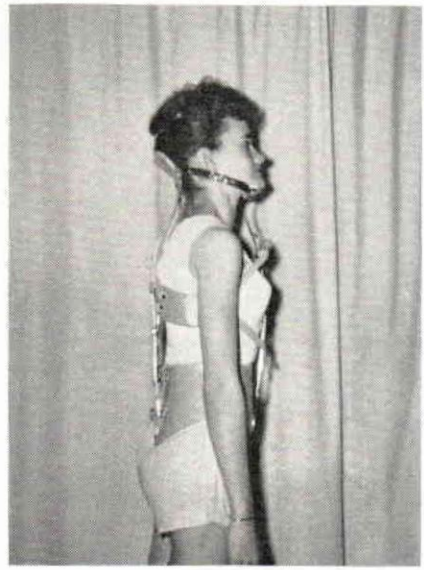

Figure 8—Lateral view. The complete Orthosis applied to the Patient.

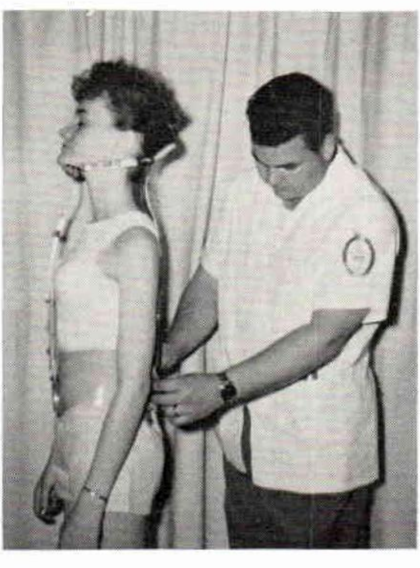

Figure 9—Initial fitting and application of the Orthosis.

Figure 10—Clinical Checkout.

May 7, 1963

Maximal utilization of the Milwaukee type brace for the correction of spinal curve problems has been hampered in the past by several problems. One such initial problem has been that of acquiring an adequate fit of the pelvic girdle experienced with the moulded leather process. Since such a precise fit has been found to be a vital part of the function of the device, it has been felt that the use of the plastic laminate jacket affords a method of faithful reproduction of the cast contours.

A second problem, and probably the most important consideration, has been one of assuring sufficient patient comfort and facility to endure the necessary wearing of the brace. The use of the hinged girdle and neck piece, as described above, has been an important contribution to this aspect. This allows ease of entry and exit from the brace for brief periods of rest and for personal care, that seem to please the patients and their families, and thereby contribute to more intensive co-operation on their part.

Thus far, the use of this modified type of Milwaukee brace has been deemed as effective, if not more so, than the previous types in the correction of the deformed spine.

Philip B. Williams, M.D.

## VRA OFFICIALS RECEIVE HONOR AWARDS

Secretary Anthony J. Celebrezze presented honor awards this spring to outstanding employees of the Department of Health, Education, and Welfare at the Annual Awards Ceremony. The employees were recognized for their contributions to health, education, and welfare and for their achievements in the service of the Department.

James F. Garrett, Ph.D., Assistant Commissioner, Research and Training, Vocational Rehabilitation Administration, Washington, D. C., received the Distinguished Service Award, the highest honor conferred by the Secretary. Dr. Garrett was one of nine so honored.

Three other Vocational Rehabilitation Administration members received the Superior Service Award. They are:

Russell J. N. Dean, Chairman, Policy Planning and Legislation Staff, Washington, D. C.

William M. Eshelman, Assistant Chief, Division of State Program Development, Washington, D. C.

Corbett Reedy, Regional Representative, Charlottesville, Virginia

# Prosthetic Rehabilitation After Hemipelvectomy

BY ARTHUR L. WATKINS, M.D.

*Chief of Physical Medicine, Massachusetts General Hospital*
*Medical Director, Bay State Medical Rehabilitation Clinic*

In a recent follow-up study of ten years experience in rehabilitation of patients who had had an hemipelvectomy, it was pointed out that in our experience the Canadian type prosthesis was most successful.[1] As this report dealt primarily with end results of surgery, it was thought worthwhile to elaborate a little on prosthetic rehabilitation and report a few additional cases.

First of all let us review the end results of the reported cases. It was found that the first case had survived ten years since her operation at age 27 without evidence of recurrence. This was tthe longest follow-up in the series. The pathological diagnosis was chondrosarcoma. The same diagnosis was found in six other patients.

There were three patients who had fibrosarcomas without recurrences. Two of the patients who had chondrosarcoma had metastases which were under treatment either by surgery or chemicals. These metastases occurred in the first two years after surgery.

The first four patients of our series who came to the Clinic between the years 1952 and 1956 were first fitted to a tilting-table type of prosthesis which was the only one available to us for prescription as that time. From that date on during the next seven years all patients received a prosthesis which is known as a Canadian type hemipelvectomy prosthesis. Three of the patients who first received the tilting-table prosthesis were later changed to the Canadian type. Each one of these benefited greatly by the use of this newer type of artificial limb.

The following points were commonly observed. First of all the limb was lighter weight and was more comfortable both to sit in as well as to use when walking. Secondly, we have noted that it is easier to keep clean and cooler in the summertime. Our poorest results have been in treating ladies whose occupation is sedentary in type and who do not like to use the limb to sit in all day. For example, one librarian fails to use her limb although this particular individual never had a Canadian type prosthesis. Another individual works as a seamstress but doesn't use her prosthesis when working. She also has a tilting-table type of limb.

The occupations of those using the limb include a barber who uses his limb only to move about from place to place but sits without his limb on a special chair while cutting hair. Other men using the limb at work include a night watchman and a shoe factory worker. One young man is going to college and uses his limb constantly. Another man uses his limb occasionally, not wearing it at his job as a traveling salesman. Another wearer is still looking for work with the help of the Massachusetts Rehabilitation Commission. One is still in vocational training and using his limb.

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[1] Watkins, A. L.; Rehabilitation after Hemipelvectomy, J.A.M.A., 181: 793, 1962.

Three additional patients have recently been seen, all of whom are learning to use their limb except one who has had a recurrence of infection, the operation being for osteomyelitis. He is temporarily in the hospital.

A single case received a saucer type prosthesis for hip disarticulation. She learned to walk with crutches and returned to school, but had an awkward gait.

The amount of training required is dependent upon natural ability, coordination and balance. The extremes vary from a single day of instruction to as long as three to four weeks in a Rehabilitation Clinic. The factor of utmost importance in the use of the limb is the proper manufacture and fitting of the prosthesis for comfort.

*Manufacture of the Limb*

After consultation with local limb manufacturers it was found that the publication used for reference by the manufacturers is the Autumn 1957 issue of Artificial Limbs, sponsored by the Prosthetics Research Board of the National Academy of Sciences, National Research Council. The various details of biomechanics and construction are utilized as indicated in these detailed and illustrated articles, with the prosthetist using his judgment as to the height and extent of the corset around the waist.

As the limb is made from a direct mold of the subject, an excellent fit is possible using a plastic laminated socket and waist band with minimal soft padding as necessary. In general, special alterations have not been necessary nor have we had particular difficulty with sensitive wound areas once healing has been complete. We accordingly do not recommend fitting of the limb until there is sound healing of all soft structures involved in the stump.

An occasional case has felt the need of a manual hip and knee lock although this is most unusual and represents an idiosyncrasy on the part of the patient rather than a necessity or limitation of the prosthesis. The proper alignment of the hip and knee joint is posterior, thus allowing automatic locking after a few periods of training. A shoulder harness is occasionally added for support.

There has been considerable variability as to the amount of padding which is used by individuals. Some require specially woven woolen stump socks for protection of the weight bearing areas of the stump. Most patients have sufficient protection simply by sewing up a short leg of the underpants.

*Summary and Conclusions*

Experience has shown that the Canadian type prosthesis for hemipelvectomies, when constructed as recommended by the Committee on Prosthetics Research and Development of the National Academy of Sciences, is the best available. Most patients after a short period of training are able to wear the limb all day and do so except for prolonged sedentary occupations. End results are reported.

# Application of AK Suction Socket Prosthesis By Means of Elastic Bandage

BY WILLIAM A. TOSBERG, C.P.O.

*Technical Director, Prosthetics Services*
*Institute of Physical Medicine and Rehabilitation*
*New York University Medical Center, New York City*

Mr. Raymond R. Rodriguez, senior physical therapist at the Institute of Physical Medicine and Rehabilitation, New York University Medical Center, recently wrote a very informative article regarding the "Application of Above-Knee Prosthesis" which was published in the Journal of the American Physical Therapy Association.[1] Mr. Rodriguez points out that in a limited number of amputees the application of an above-knee suction socket prosthesis has been facilitated by the use of an Ace bandage.

It is well known that the suction socket suspension offers many advantages over the shoulder harness type or the pelvic belt suspension, but we also are aware of the fact that under certain circumstances it is rather difficult to insert a stump fully by the conventional means of a stockinette. We "old-timers" well remember the blisters we had on our hands when we tried to force a well developed stump into a suction socket which was usually much smaller than was required for the type of muscular stumps which we fitted in the beginning phases of the suction socket program. We have since learned that the application of the suction socket requires a great deal of knowledge about the tissues within the stump and a very close conformity of the socket to those tissues with proper consideration not only for anatomical but also biomechanical requirements of fit and alignment of above-knee prostheses.

Dr. Miles Anderson has developed a tension analysis chart, as published in *Prosthetic Principles—Above Knee Amputations*.[2] This has been of considerable help in the construction of suction sockets. The type of amputees presently being fitted differs widely from the "ideal." It is almost an exception when today such a stump is seen at the prosthetics service of the Institute of Physical Medicine and Rehabilitation. Many of these amputees have a flabby stump as a result of many months of inactivity preceding and also following surgery. Most of the stumps presented by our female amputees consist to a great extent of soft tissue which would atrophy rather rapidly as soon as weight-bearing on a prosthesis is attempted. Quite often our elderly amputees have an impaired sense of balance and the insertion of a stump into a suction socket by means of a stockinette frequently creates problems with which these elder amputees cannot or do not care to cope because it requires a certain amount of effort to be applied in a position where these people would be off balance.

While visiting Europe recently I discussed these problems with Dr. Goetz-Gerd Kuhn and Mr. Hellmut Habermann, who informed me that under similar circumstances they had utilized an elastic bandage instead of the

[1] Journal of the American Physical Therapy Association, Vol. 43, No. 1, January 1963.

[2] *Prosthetic Principles—Above Knee Amputations,* Charles C. Thomas, Publisher.

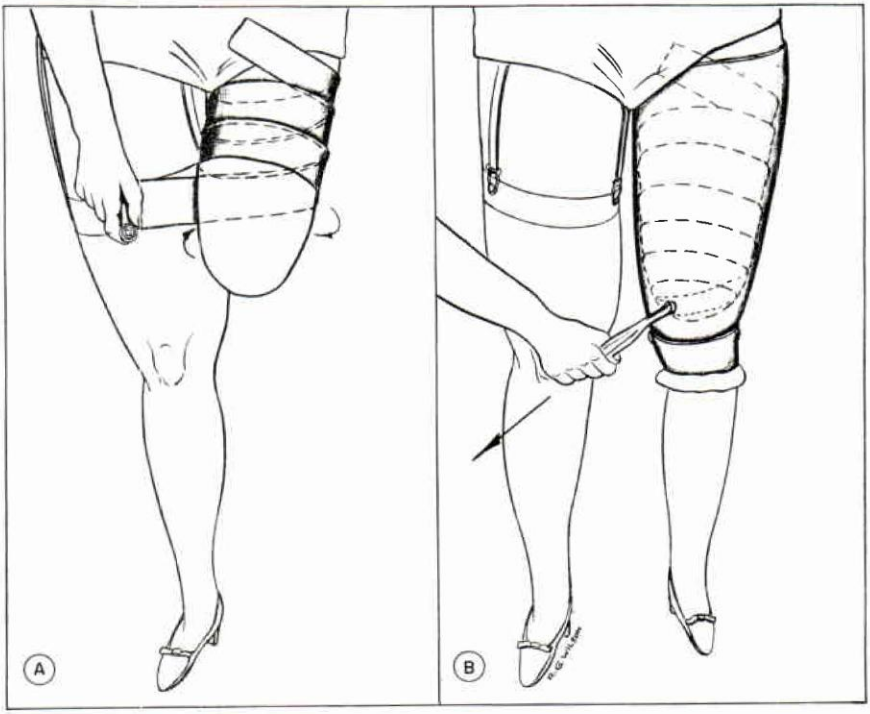


Figure A—Application of bandage to stump. Figure B—Withdrawal of bandage through valve hole.

standard cotton or nylon stockinette. When I returned to the United States we started to experiment with this method of application and have found it quite helpful in those cases where the standard application created problems.

Mr. Rodriguez has described this method very well in his article. For the benefit of those colleagues who might experiment with this method, may I just repeat the technique which we are presently using and which has been adopted by several prosthetists attending our clinics.

An Ace bandage of 4-inch width or narrower is wrapped around the stump in a spiral fashion, starting in the midline or slightly medial to the midline proximally. We now bandage towards the lateral side, making the first turn around the stump high enough to include all tissues which should normally be inserted into the socket, such as an adductor roll if present. The tension on the bandage is varied depending upon the amount of soft tissue. There should be a certain amount of overlap with every turn.

We have found that only minimal tension needs to be applied to the bandage because the tissue will be further compressed when the bandage is withdrawn through the valve hole. The free end of the Ace bandage is pulled out through the valve hole in the normal manner after the stump is well inserted into the socket. I am not aware of any patient who experienced any difficulties in inserting all of the tissue into the suction socket without need for any pumping motion such as is required if stockinette would be pulled out of the valve hole. The Ace bandage is withdrawn very smoothly and a slight pull is all that is necessary to insert even the flabbiest, most voluminous stump into a tightly fitted socket.

I would state that the method as described by Mr. Rodriguez offers advantages where indicated. It should, however, never be used as a substitute for good and accurate prescription and fitting of a socket. All problems created by a poor fit would still be the same, or even be aggravated, because it is easily possible by means of an elastic bandage to pull a stump into a socket which is much too small for the patient.

In a new stump we have once or twice experienced a problem in removing the limb after the initial period of ambulation. Perspiration probably created a high amount of adhesion between stump and socket. It is also possible that there was a certain amount of swelling in the stump, with the patient unable to relax the tissues as a result of nervous tension, or just an initially tight socket.

We have made it a general practice for the patient to wear a nylon stocking between stump and socket. The stocking should be long enough to extend beyond the proximal end of the socket, should be closed on the bottom, and worn tightly against the stump when the leg is applied. Such a stocking does not cause leakage of air but prevents the tight adhesion of stump to socket which was mentioned previously.

The application of a total contact plastic socket has been greatly simplified by this method of application because such sockets can generally be considerably tighter than ischial bearing sockets. We all know that in a flabby soft stump an ischial bearing socket requires considerable undercuts in order to insert all the soft tissue into the socket and therefore a rather tight proximal socket opening is required. The withdrawal of stockinette in such a socket is often almost impossible. In a total contact socket these problems can quite often be overcome by distributing weight over the total socket with the result of less damaging constrictions. We have found the application of a suction socket utilizing the Ace bandage in these cases of great benefit.

The elastic bandage offers great advantages, also, for the bilateral amputee on account of the ease of application, and in the case of children for whom the parents may have to apply the limb. Where a suction socket is applied by means of stockinette it is quite often difficult to harmonize the pull of the stockinette with the relaxation of the stump. This cooperation is not quite as essential in the application by means of elastic bandage.

I would appreciate discussion of this method by any colleagues who might have utilized the Ace bandage in a similar manner. I realize that the problems of the cotton stockinette must have occurred to others and have probably been worked out by means of other methods, the discussion of which would be of benefit to all.

# The Patellar-Tendon-Bearing Below-Knee Prosthesis: Fabrication of A Silicone Rubber Soft Insert

By ALAN FINNIESTON, C.O.

Arthur Finnieston, Inc., Miami, Florida

The Patellar-Tendon-Bearing Below-Knee (P.T.B.) Prosthesis, as developed by the University of California Biomechanics Laboratory, was first introduced to the field through courses the latter part of 1959. Three and one half years of experience has shown that this limb has a definite place in the armamentarium of the field of Prosthetics.

The P.T.B. Prosthesis, as described by Radcliffe and Foort (1), consists of three major components with suspension: a. The Soft Insert; b. The Plastic Shell; and c. The SACH Foot.

The Soft Insert was fabricated from 4 to 6 oz. horsehide, or its equivalent, and Kemblo (2113). This fabrication process has proven to be time-consuming, the wearing characteristics of the insert have not been satisfactory, and the insert is only a fair reproduction of the cast over which it has been formed. Therefore, it seemed desirable to search for a technique for fabricating the soft insert and materials that would mold to the stump model, wear indefinitely, and be easy and quick to use. Silicone rubber was the answer to our search.

Silicone rubber is chemically inert, that is, it does not corrode metals and does not cause allergies when brought in contact with the amputee's skin. It is heat stable, and does not age, that is, it neither hardens nor softens with heat or age. In addition, nothing sticks to silicone rubber, a property that is an advantage in fabricating P.T.B. soft inserts, but a disadvantage for many other uses. Finally it is hygienic.

Materials needed for fabricating the silicone rubber soft insert:

(1) Silicone rubber and catalyst (Dow Corning's R.T.V. Silastic 5391)
(2) Ban-lon Stockinette
(3) Nylon Stockinette
(4) Vaseline
(5) Ambroid
(6) P.V.A. Sheeting
(7) Suction System
(8) Silicone foam and catalyst (Dow Corning's R.T.V. Silastic 5370)
(9) Injection Gun

The preparations for fabricating the silicone rubber soft insert begin with the pouring of the stump model and its modification. The stump model is prepared for suction by creating an air chamber, usually done by inserting a paper cup in the plaster slurry to a depth of the patella, and drilling the stump model, where maximum "pull" is desired, and the mandrel, (Figure 1). The stump model is modified in the way described in the P.T.B. Manual, (1), except that build ups of pressure sensitive areas are made with the use of tacks, to determine the amount of build up, and plaster slurry, (Figure 2). Instead of contouring the distal portion of the stump model, build this area up at least ½". This will create a void in the

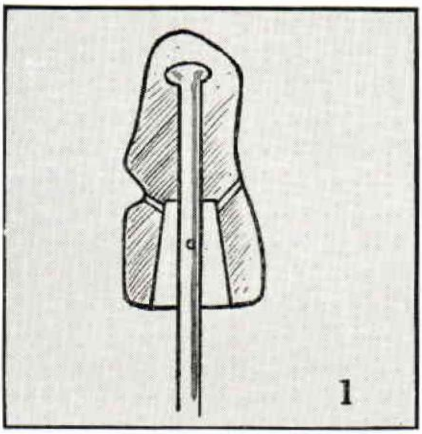


Figure 1—The stump model is prepared for suction.

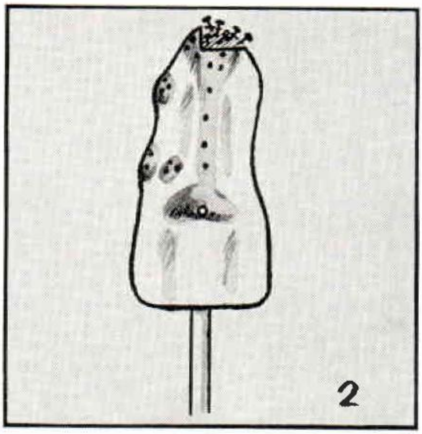


Figure 2—The stump model is modified using tacks to determine the amount of plaster build up on the pressure sensitive areas.

soft insert into which silicone rubber or foam will later be injected. Plaster of Paris must be used for these build ups instead of leather, as leather tends to leave rough edges in the silicone rubber soft insert.

When the stump model has been modified to the satisfaction of the prosthetist for the patient he is to fit, the mandrel should be placed securely in a vise with the model in a vertical position. The stump model need not be dry. Ambroid is used to seal the damp cast, then vaseline is applied and the P.V.A. bag is pulled over the model, (Figure 3). This acts as a parting agent between the model and the silicone rubber insert, but, more important, gives a smooth surface to the inside of the insert.

The layup for the silicone rubber soft insert consists of an inner layer of Ban-lon stockinette, six layers of nylon stockinette, and an outer layer of Ban-lon stockinette. Ban-lon is the type of stockinette used for the outer covering of porous laminates. Eight layers of nylon stockinette can be used, but the finish is not as satisfactory. Each layer of stockinette should be seamed distally, according to the contour of the stump model. A second P.V.A. bag is pulled over the layup and tied to the mandrel, (Figure 4).

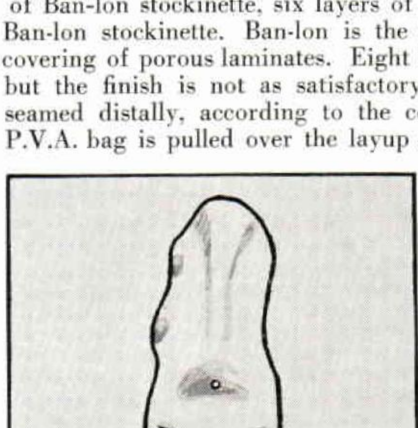


Figure 3—The stump model prior to Layup.

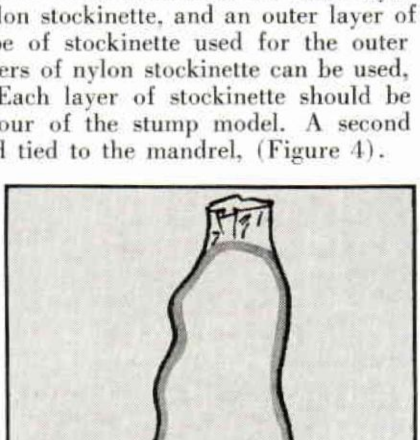


Figure 4—The stump model prepared for lamination.

Next, prepare the silicone rubber resin for lamination (Dow Corning's R.T.V. Silastic 5391). The average soft insert will require 400 grams of resin. Thirty drops of catalyst per hundred grams of resin should be added. The resin will set in 10 minutes and cure in 30 minutes. Pour the resin and catalyst mixture into the P.V.A. bag. Apply suction and string out the resin-rich areas. A suction system is necessary for the successful completion of the silicone rubber soft insert. A suction pump with about 20 inches vacuum capacity should be sufficient.

The silicone rubber soft insert cures at room temperature in approximately 30 to 45 minutes. It can be cured more quickly by adding more catalyst. It is not necessary to heat cure silicone rubber. The P.V.A. bag may be left in place to act as a separation for the lamination of the plastic socket.

Proceed with the completion of the P.T.B. Prosthesis. When the plastic socket has been cured and been removed from the stump model, the socket and insert can be trimmed. The edges of the insert can be sanded, then buffed, with a high speed grinder, and felt wheel.

When fitting the prosthesis on the adjustable leg cut a small hole in the distal portion of the socket wall and soft insert. Have the patient stand with equal weight on both legs. Inject either silicone foam (100 parts of Silastic 5370 to 100 parts of Silastic 5391) or silicone rubber (Silastic 5391) into the insert. This procedure insures perfect total contact.

Twenty patients have been fitted with the silicone rubber soft insert. They found it no warmer than the Kemblo and horsehide insert.

Several of these patients had previously worn P.T.B. Prostheses. They feel that the fit of the silicone rubber insert is better than that of the Kemblo and horsehide insert, and that the silicone rubber insert is easier to keep clean.

The silicone rubber soft insert discussed in this article gives the amputee a stronger, more durable insert that is easy to keep clean. It reduces the fabrication time for a P.T.B. Prosthesis from 1½ to 2 hours and gives a more accurate reproduction of the stump model.

## REFERENCE:

(1) Radcliffe, C. W. and Foort, J. *The Patellar-Tendon-Bearing Below-Knee Prosthesis:* Biomechanics Laboratory, University of California, Berkeley, 1961.

# Modification For Pregnancy of a Hip-Disarticulation Prosthesis

By J. M. McFARLEN, C.P.

J. E. Hanger, Inc., of Texas

A twenty-two-year-old patient recently was referred to us by her obstetrician for a new fitting to accommodate pregnancy and sustain ambulation until as near delivery time as possible.

History of the patient revealed amputation at the age of nineteen due to a malignant bone tumor. Six months later she was fitted with a Canadian-type prosthesis offering a free hip and free knee. This prosthesis had been well accepted by the patient and used continuously, although it was now quite ill-fitting and unstable. In the interest of safety the patient was again using crutches.

I was unable to locate any information on accommodating a prosthesis for pregnancy in an amputation of this level, and assumed the only course was for the patient to discard the prosthesis during the latter months and become inactive.

However, the challenge to fulfill the obstetrician's request was accepted. As the patient's present prosthesis was in good condition mechanically and cosmetically, I set out to fabricate a new socket only. The following changes were made in the usual technique of fabrication:

1) The entire anterior wall of the socket was removed to a point just medial to the anterior superior spine.
2) Extra structural material was placed in the lateral walls to insure constant contouring of the fitting about the iliac crest.

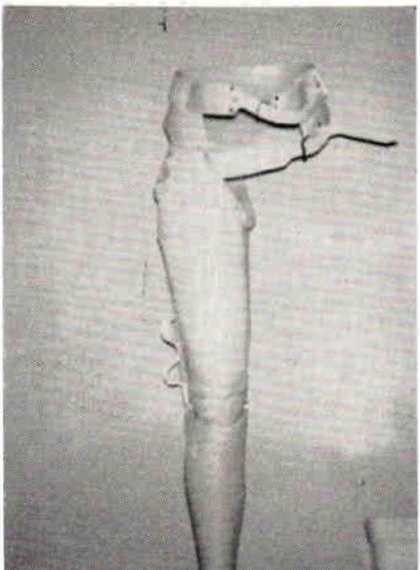

Figure 1.

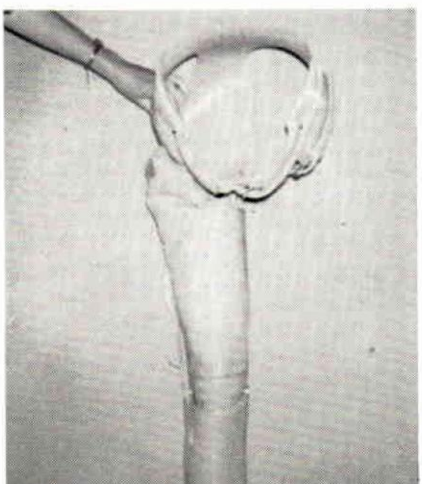

Figure 2.

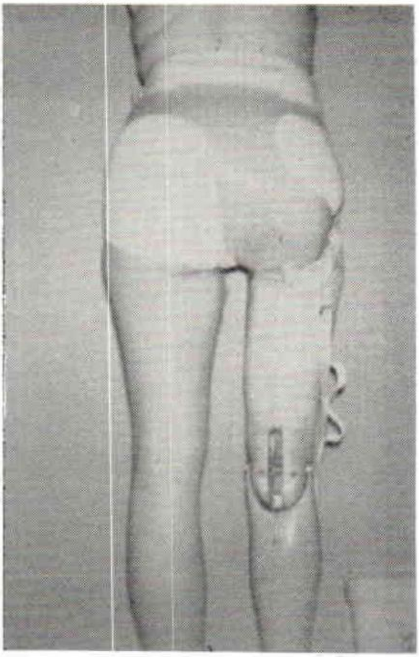

Figure 3.

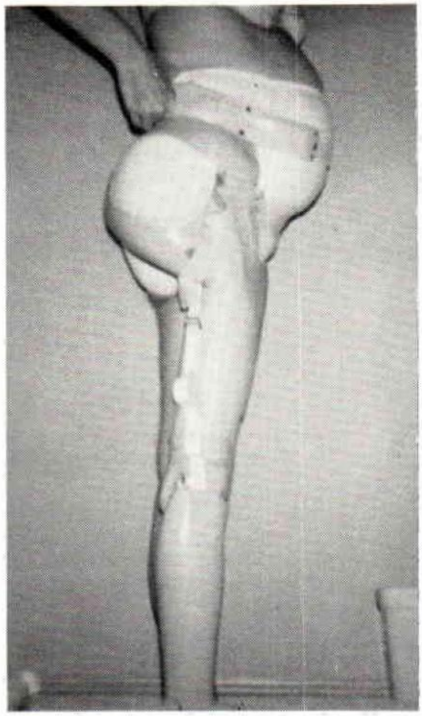

Figure 4.

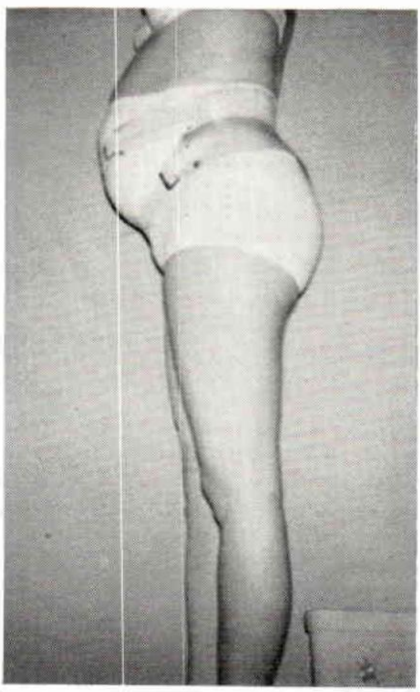

Figure 5.

3) A large opening was made in the lateral posterior wall of the socket to accommodate the increase in weight of the amputated side without distorting the fitting of the skeletal areas.

4) Padded metal bars were added to the lateral walls and contoured very loosely around the lateral aspect of the abdomen. A strap across the ends of these bars held the socket firmly against the iliac spine without forces on the abdomen.

5) A wide padded strap across the socket just superior to the anterior pubes completed the anterior wall system. This wide strap was found to be very comfortable and offered support to the abdomen.

*CONCLUSION*

The modification of the prosthesis was fitted at 4½ months of pregnancy, and was used continuously until the evening of January 23, 1963. The next morning the patient gave birth to a very healthy 7 pound 13½ ounce baby girl. Delivery was normal with no complications.

One week later the side bars and wide anterior strap were removed and retained for possible future use. A soft front was installed and supported by three 1" dacron straps using Velcro for fastening. Ambulation continues at the present time.

The pictures accompanying this report were made at twenty-eight weeks of pregnancy. The prescription was filled to the great satisfaction of the amputee.

While such a case as that described may be rare, the success obtained is indeed gratifying.

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# $1,000,000 Contribution to World Rehabilitation Fund

To help offset the loss of 300 used but serviceable artificial limbs and braces destined for underdeveloped countries, the Smith Kline & French Foundation has made a grant of $1,000.00 to the World Rehabilitation Fund, Inc. The 300 artificial limbs and braces, collected as a community project by the United Cerebral Palsy Association of Philadelphia and Vicinity, were destroyed in a fire at the Goodwill Industries warehouse.

The supplies had been collected by the Goodwill Industries from fire stations where they had been left by contributors and were awaiting transfer to the CARE warehouse for overseas shipment.

Howard A. Rusk, M.D., President, World Rehabilitation Fund, Inc., said "We are most grateful to the Smith Kline & French Foundation for this spontaneous gesture to help offset the losses resulting from the fire."

Thus far, 16,000 used by serviceable artificial limbs and braces have been collected by the World Rehabilitation Fund and other cooperating agencies for shipment to 23 nations.

Persons wishing to contribute used braces and limbs to the continuing drive can contact Mr. Hugh Pendexter, Jr., United Cerebral Palsy Association of Philadelphia and Vicinity, 66 North Juniper Street, Philadelphia 7, Pa. (LOcust 8-3580).

# Development Toward A Controllable Orthotic System For Restoring Useful Arm and Hand Actions

By THORKILD J. ENGEN, C.O.*
Houston, Texas

### *INTRODUCTION*

Cumulatively over recent years an increasing number of patients are surviving with extensive paralysis which includes loss of hand and arm movements in both upper extremities. This situation occurs in persons with high cervical cord lesions (C-5, C-6) who have survived traumatic injury with quadriplegia, as well as in persons with severe poliomyelitis residuals, those with central nervous system degeneration, disorders of the spinal motor system, and persons with myopathies. Among these, a large number are wheel chair bound for life, and they present diverse patterns of bilateral muscular weaknesses and paralysis of the upper extremities. These patients are a unique challenge to the combined efforts of physicians, orthotists, and other specialties to restore useful functions through application of suitable assistive mechanical devices. The fact that this challenge exists and that efforts to meet it are delinquent was recognized and described in the report of the 1962 *Conference on Orthotics Research and Development* issued by the National Academy of Sciences.[1] Upper extremity orthotics requires intensive development through multiple research and varied study approaches, if we are to meet eventually the great variety of needs encountered among these types of patients.

This report presents information on the most recent developments pertaining to a simple yet extensively useful upper extremity orthotic system, which resulted from a three-year research project carried out in the Department of Orthotics at the Texas Institute for Rehabilitation and Research and the Baylor University College of Medicine. A principal objective in developing this system is to restore hand and arm actions to wheel chair bound quadriplegic patients, and others of comparable handicap, having essentially flaccid paralysis in various patterns and degrees. Advantage is taken of the wheel chair as a frame of support for the external mechanisms, thereby minimizing the number of devices attached directly to the patient. A simplified pneumatic system subject to control by the patient was developed. This approach not only has definite cosmetic appeal, but also gives the patient a feeling of dignity and existence through his direct participation both in the control of the source of power and in being a consciously active part of the orthotic system.

### *BASIC OBJECTIVES*

The developments to be described cannot be viewed as consisting solely in the mechanism. Equally important is the point of view taken by the orthotist in determining the direction of the developments and in evaluating the motional components that accomplish the desired and useful total

* Director of the Orthotic Department, Texas Institute for Rehabilitation and Research, Houston, Texas, and Clinical Instructor in Orthotics, Department of Rehabilitation, Baylor University College of Medicine.

** This project was originally initiated under auspices of a Polio Respiratory Center Grant-in-Aid from the National Foundation. From 1960 to the present this work has been supported in major part under a Research Grant from the Vocational Rehabilitation Administration No. RD 542 to Baylor University College of Medicine.

actions that are serviceable to the patient. These latter factors will be discussed first, because they are an integral part of the research achievement and gave direction to the course taken in evolving new mechanisms.

At the outset, one must be aware of the great diversity in varieties and degrees of bilateral involvment of the upper extremity muscle systems presented by patients with cervical cord lesions, for example. Consequently, requirements for restoration of useful actions differ markedly between individual patients. Each patient to be considered for this orthotic system must be carefully examined and analyzed kinesiologically to determine patterns of function that remain, the relative degrees of strength and usefulness of the principal muscles serving the desired integrated actions, and where the severe losses are located. The patient must be able to tolerate the sitting position at 80° to 90°. The presence of joint tightness and muscle spasm exclude a patient from being an acceptable candidate for this orthotic system until these conditions are relieved or minimized medically.

Several factors were formulated explicitly as basic criteria in the ultimate objectives for a practical achievement, and certainly these considerations are of foremost importance in all orthotic efforts. In respect to the mechanical design, both construction and operation should be held to the utmost simplicity that is consistent with achieving functional objectives. Durability of parts, accuracy of operation, and economies in costs are of equivalent importance. Our practical experience has shown repeatedly the futility of imposing upon a patient complicated mechanisms that make him a passive robot and do not serve proportionately useful purposes. Such mechanisms will not be used continuously or effectively if the patient can find privately any other way out, even when this choice may involve reduced function.

*PRACTICAL REQUIREMENTS*

Since our ultimate aim is to serve a fairly large patient population, many of whom cannot visit a rehabilitation center where expert services are available, components should be designed for mass production and modular fitting to the fullest extent. To attain patient acceptance and pride, cosmesis and comfort are important considerations always. To make the patient happy as well as alert, every design should permit maximum participation by the patient in controlling and producing the useful actions. Finally, a carefully planned program to orient the patient to the versatility of the orthotic system and to provide practical training as indicated in producing useful activities and having successful and gratifying experiences with the system are necessary to insure progress, satisfaction and continuous usage. All of these considerations served to guide the direction of the mechanical devlopments in the present orthotic system, and indeed will continue to be primary factors for inclusion in any future developments of this nature.

Because of these basic criteria for development objectives, critical analysis and early rejection were given to the general ideas underlying the concept of attempting to imitate the actual detailed *motional components* produced during usual activities of normal muscle systems. This approach leads to unduly complicated hardware and control mechanisms, and provides for many actual motions that can be eliminated without reducing useful services to the patient. The traditional law of diminishing returns applies here, since the gain in useful actions is not proportional to the increase in individual motion components and the parallel increase in complexity of the mechanisms. Consequently, the initial concept adopted for this research development was to determine an optimum number and kind of *useful actions*, and then study the simplest means of enabling the patient to ac-

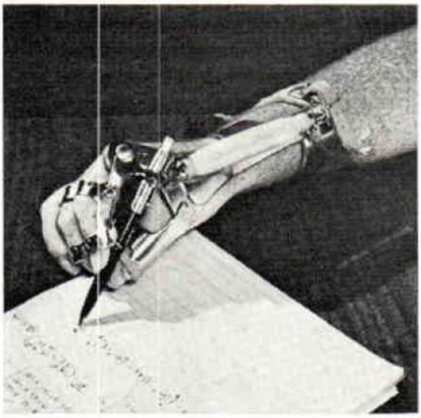

Figure 1—Powered hand orthosis providing finger prehension.

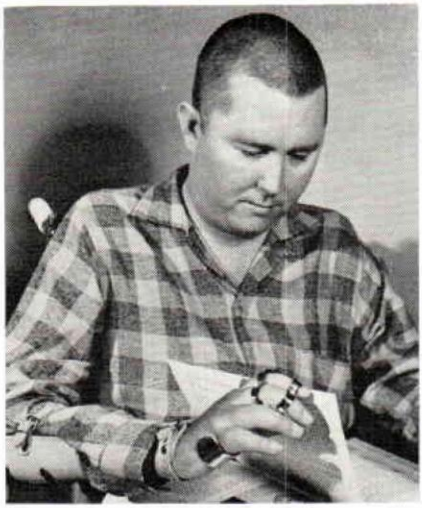

Figure 2—Powered system combining finger prehension—Elbow flexion and shoulder abduction.

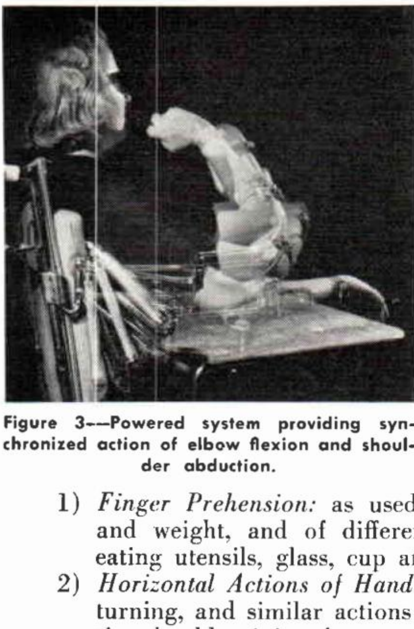

Figure 3—Powered system providing synchronized action of elbow flexion and shoulder abduction.

complish these actions. Three exceedingly useful and fundamental actions are described here, although for the future additional ones may be considered, when the real need for them becomes apparent.

The three principal actions considered to be most useful and which comprise the hand and arm actions that may be restored by the proper application of the present orthotic system are the following:

1) *Finger Prehension:* as used in grasping objects of moderate size and weight, and of different shapes, such as pencil, pen, paper, eating utensils, glass, cup and similar objects. (See Figure 1)
2) *Horizontal Actions of Hand and Forearm:* as used in writing, page turning, and similar actions not requiring major forceful actions at the shoulder joint that can be imparted by slight head and trunk position shifts.
3) *Synchronized Actions of Forearm and Upper Arm:* yielding smoothly phased and finely controlled combined motional components to produce natural and useful actions. The component motions produced include elbow flexion; partial supination and pronation of the forearm; shoulder flexion, vertical abduction, horizontal abduction, internal and external rotation. The useful actions include feeding, head and neck hygiene, applying makeup, brushing teeth, shaving, smoking, and similar actions. (See Figure 3)

In addition to these actions and unique to this system, motions may be arrested at any phase of their course providing thereby a fixed positioning for a useful purpose such as holding an object in a desirable location without expending energy.

## *DEVELOPMENT OF MECHANISM*

A rather unique approach was used in the final stages of arriving at the essential principles underlying the mechanical components of this orthotic system. During this research project, there were forty-one different designs or combinations of components tried out in a sequential effort to evolve an approach that is really practical and useful to the patients. During each stage some progress was in evidence, but the major advance occurred at about experiment No. 38, when an entirely new idea evolved. From this, the present system was developed rapidly. Nevertheless, all of the preceding experience was contributory.

The procedure which helped most in arriving at the concept employed in this orthotic system was as follows: A normal subject was placed in a wheel chair and mechanical components were made and applied to one of his upper extremities. These devices were attached to the wheel chair for support. The subject was required to perform numerous natural actions of the upper extremity without being opposed by the mechanical system. Changes were made from time to time until the mechanical system corresponded with the antomical structures and the multiple joint systems, so that gradually the normal motions and the mechanical system were smoothly synchronized.

Following this, a patient with a flaccid upper extremity and approximately the same size as the normal subject was placed in the same equipment and chair. Our next step was to apply power to the system so the desired actions of the extremity would result in a manner equivalent to those of the normal subject. The McKibben Muscle Substitute was attached to the mechanical device using as much as possible the pattern of origin and insertion points of normal muscle structure. In early experiments, the biceps principle was used to bring about flexion of the elbow joint, but the power actuator was later relocated along the forearm copying the action of the M. Brachio-radialis. This arrangement simplified the entire design, because mechanical support was no longer needed on the upper arm for a power attachment. In addition, it permitted the important abduction function of the shoulder joint, independent of or combined with elbow flexion. As a consequence of this arrangement, the patient's upper extremity has to function as an essential mechanical link in this system.

Three types of integrated forces are used to activate the orthotic system.

$CO_2$ Actuators    Spring Forces    Gravity Forces

For the purpose of simplicity, the components necessary in the power system are divided into three groups and briefly discussed.

1) Power Actuator    2) Energy    3) Controls

## *POWER ACTUATOR*

The power actuator we have chosen to activate the orthotic components is the McKibben Muscle Substitute. The function of this device has been well described in several previous publications.[2]

During our experience with this actuator, we have found it useful in our latest adaptations to modify the size of the artificial muscle according to the work it is to perform. This is because the energy and power necessary to provide adequate finger prehension is much less than the power needed, for instance, in shoulder abduction. Furthermore, incorporation of two helical woven sleevings in one muscle unit was found to increase the durability with little or no sacrifice of performance. The end fittings and method of attachment to the mechanical system are modified and sealed in plastic according to the function it is to perform. (See Figure 4)

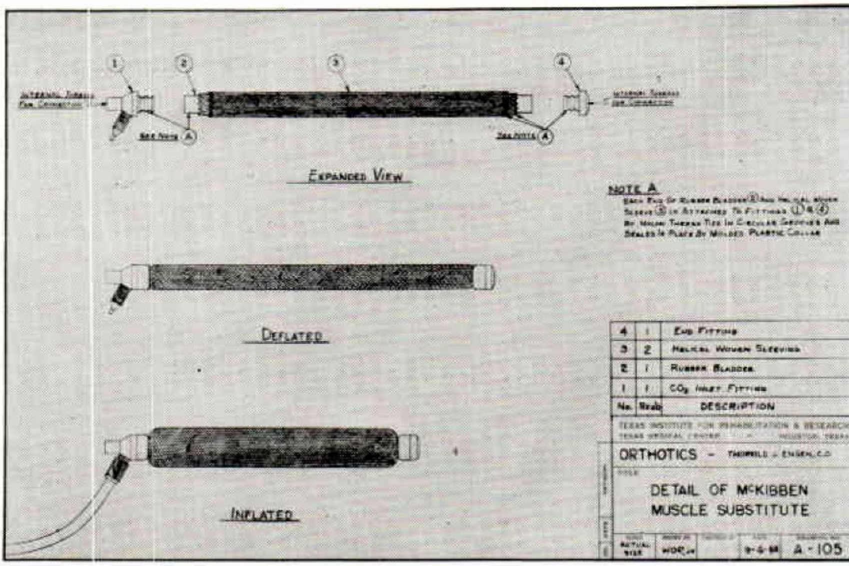


**Figure 4—Modified McKibben Muscle Substitute.**

*ENERGY SOURCE*

Carbon dioxide has proven to be practical as a power source for the above described actuator primarily because it imposes no hazard to the patient, it is generally available, and not as expensive as other energy sources. Large tanks of $CO_2$ with an inside siphon tube can be rented from various supply companies for the purpose of refilling smaller containers.[3] Small throwaway cartridges used in making carbonated water have shown potential usage as an energy source for a self contained powered finger prehension orthosis.

*CONTROL SYSTEM*

The success of useful actions obtained through means of powered orthotic systems adapted to the patient largely depends on the simplicity and efficiency of the control system. Furthermore, it is desirable that the patient be in control of the system and not the system in control of the patient. The rate and extent of response should be proportional to the controlling action.

A new principle was utilized in developing a simple valve for this control system. This consists of a flexible silastic rubber tubing*, and a spring loaded arm capable of depressing or pinching a cross section of the silastic tube sufficiently to stop or permit the flow of gas under pressure.[4] As a permanent enclosure, the valve mechanism is imbedded in a plastic casing made from polyester resin. The functions of the valve can be studied in detail in Figure 5, which shows a double action push button valve; in Figure 6, a double action control stick valve; and finally in Figure 7, a single action push button valve.

The type of control valve selected for an individual patient is determined by the control site available. Depending on particular circumstances, it is at times necessary to separate the control for inflation and deflation of the same power actuator. In such instances, single valve units are used.

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* Medical Silastic® 372—tubing .045" x .105".

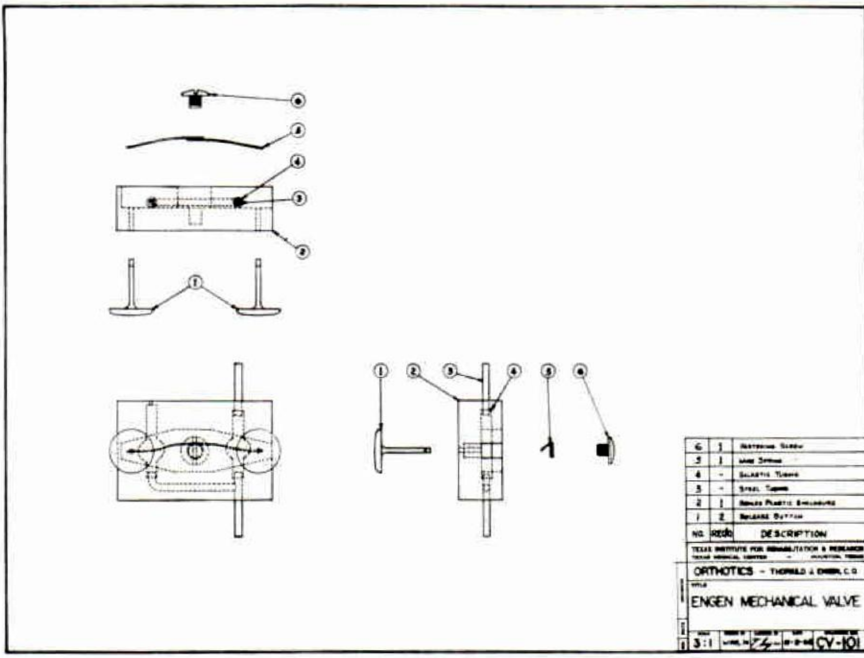


**Figure 5—Double action push button valve.**

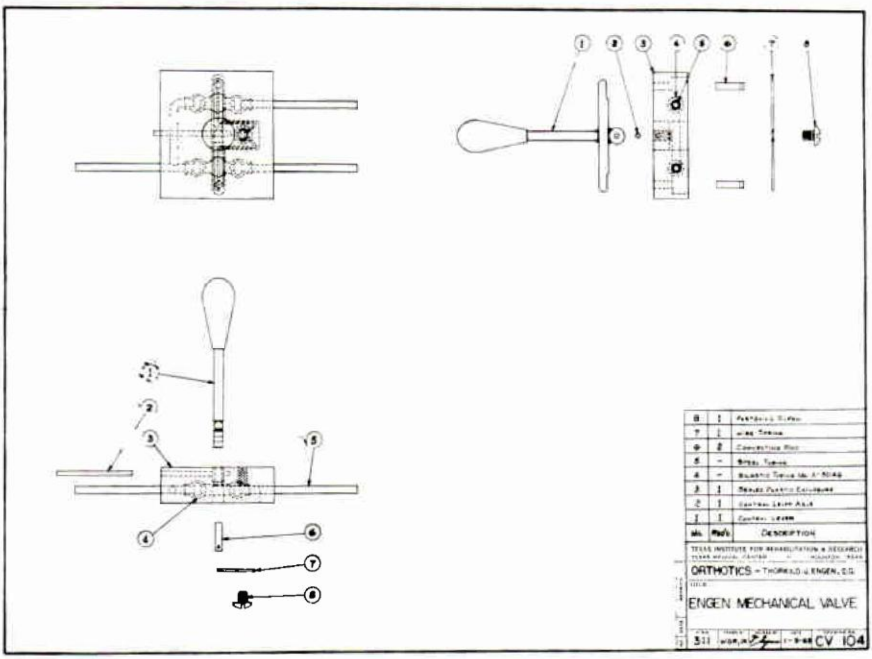


**Figure 6—Double action control stick valve.**

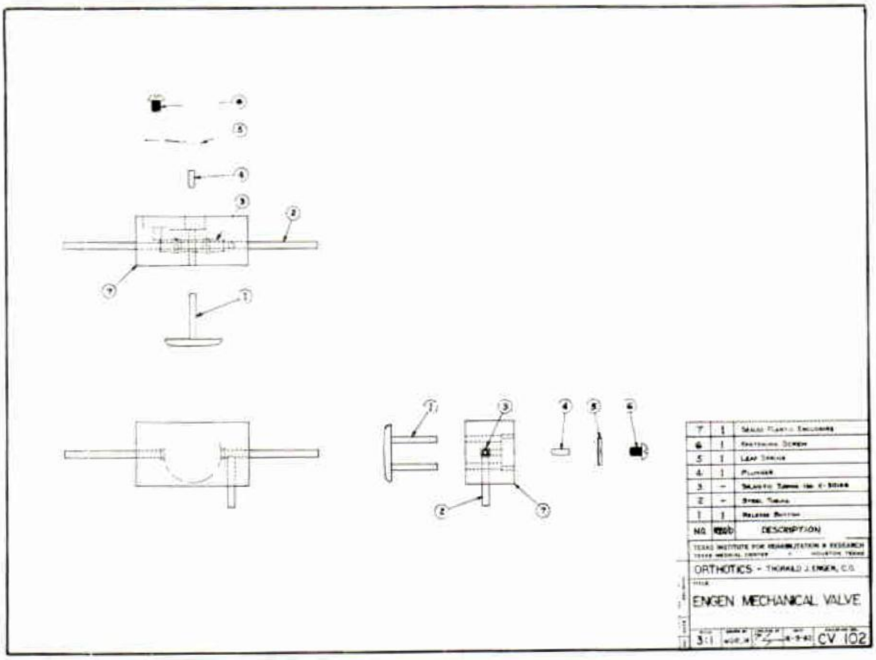

Figure 7—Single action push button valve.

## *IMPORTANT FEATURES OF THE CONTROL VALVE*

1) A line pressure of 80 psi can be controlled by mechanical linkage of a force of less than one ounce.
2) Admission and release of gas to the actuator can be gradated by the patient to perform a rapid response, and either a fast or a slow action may be provided according to the motion desired.
3) It is leak proof because the flow of gas is controlled from the reservoir to the actuator without internal mechanical interruption of the system.
4) The double valve weighs 9 grams, and the single valve weighs 5 grams. The physical size is comparable to a man's wrist watch.
5) The cooling effect associated with the flow of carbon dioxide does not adversely affect the operation of the system. The valve and its related components also tolerate great variations in temperatures.
6) The design of the valve will also allow it to be used to regulate the flow of any gas or liquid not corrosive to silastic.
7) The noise associated with the escaping gas from the deflating actuator is minimized effectively by a small cotton muffler attached at the exit of the deflation tube.

In evaluation tests, several valve units incorporated in this orthotic system have been in use by patients for six months without experiencing problems in the control system. The unusual physical characteristics of the silastic rubber tube, including inertness, corrosion resistance, and fatigue resistance, are considered to be the primary factors for its successful operation.

Other control modes including electronic and electro-mechanical devices have been developed and evaluated for particular applications and are reported elsewhere.[5 & 6]

## ORTHOTIC COMPONENTS

### A. *Finger Prehension Orthosis*

A basic aluminum hand orthosis with volar support is hinged together at the location of the proximal joint of the index finger with a unit stabilizing the semi-flexed phalangeal joints of the index and 2nd finger. A coil spring is incorporated in this joint for the purpose of dynamically assisting finger extension. One end of a power actuator is attached to a lever arm of the finger piece and the other is attached to the proximal part of the orthosis. The wrist is stabilized in a fixed neutral position. Upon contraction of the power actuator, the index and second fingers are moved toward the opposed stabilized thumb resulting in a chuck type prehension or pinch.

This type of powered device has been improved recently by incorporation of a friction joint at the wrist permitting passive prepositioning of the hand. This function is useful in many activities. (See Figure 8) A modified plastic hand orthosis is used to support the hand.[7] The force of the power actuator is transmitted to the finger section by a cable passing through a teflon lined coupling at the wrist joint allowing this movement to take place.

### B. *Extremity Abduction Unit*

A system utilizing the vector parallelogram principle was designed to achieve the objective of abducting the extremity independently of elbow flexion. (See Figure 9)

This four-joint parallelogram system has the following functions:

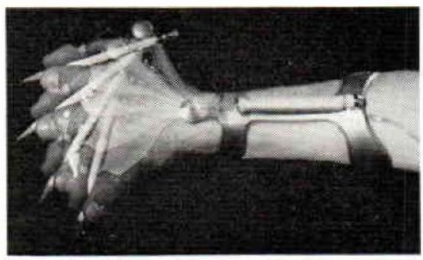

Figure 8—Powered finger prehension orthosis allowing passive prepositioning of hand.

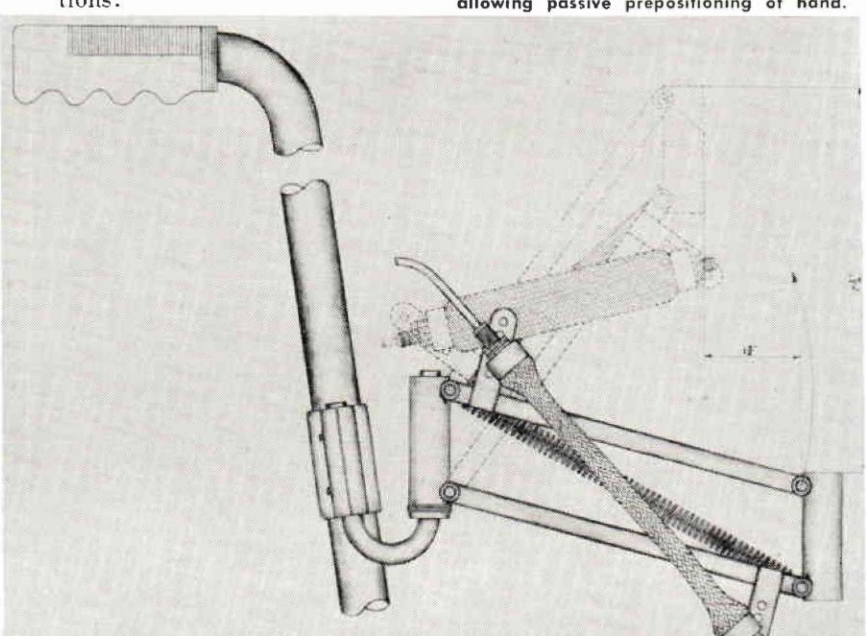

Figure 9—Extremity abduction unit.

1. To allow horizontal movements of the extremity.
2. To provide vertical movements of the extremity.
3. To act as a swivel arm and to support the elbow flexion unit in perpendicular alignment regardless of its elevated position.

Coil springs are incorporated in the unit to counteract the force of gravity on the extremity and permit the power actuator to provide its active force to elevate the extremity. Provision is made to adjust the force and position of the coil spring and actuator in relationship to the multiple-joint axis system of the vector unit.

C. *Elbow Flexion Unit*

This device is designed to flex the elbow with its fulcrum point located on the medial side of the elbow and corresponding to the axis of the epicondyles. The unit is linked together with the abduction device by means of a swivel arm with a fulcrum point corresponding to the location of the olecranon. This permits inward and outward horizontal movements of the forearm. (See Figures 10 and 11)

A telescopic tube and rod connected to the flexion units acts as an attachment for the hand support, and also allows voluntary supination and pronation. If desired, the hand can be prepositioned and fixed there by means of a set screw. One end of the power actuator originates on the radial side of the wrist and the other is secured slightly above the fulcrum of the elbow thus bringing about elbow flexion.

In the initial tryouts it was found necessary to incorporate a spring which would initiate extension of the forearm when the elbow was fully flexed. Also, when the power actuator was deflated, the forearm needed cushioning during the last phase of extension. One coil spring located inside at the end of the telescopic unit and linked to the elbow joint, proved adequate for both functions.

The shoulder abductor and elbow flexor components are made from stainless steel. Teflon, needle thrust and roller bearings are incorporated in the joints for the purpose of producing low frictional resistance.

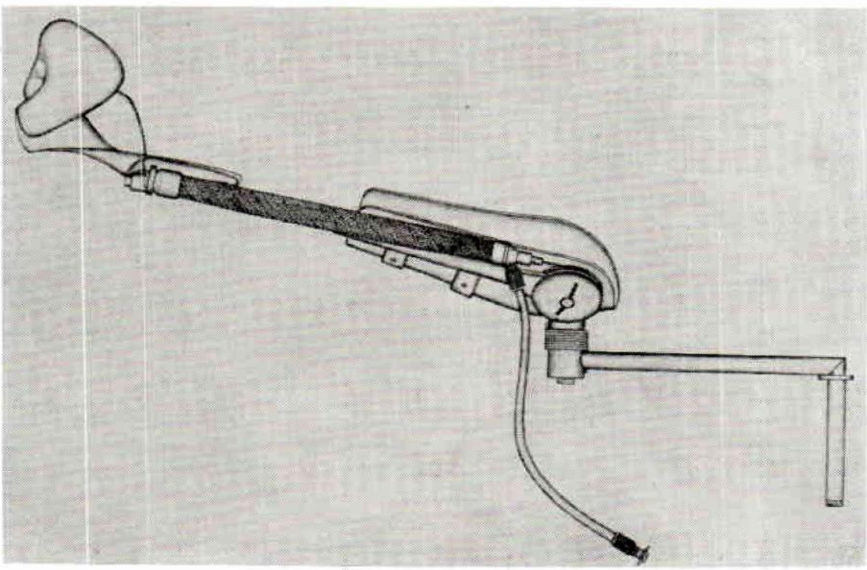

Figure 10—Elbow flexion unit.

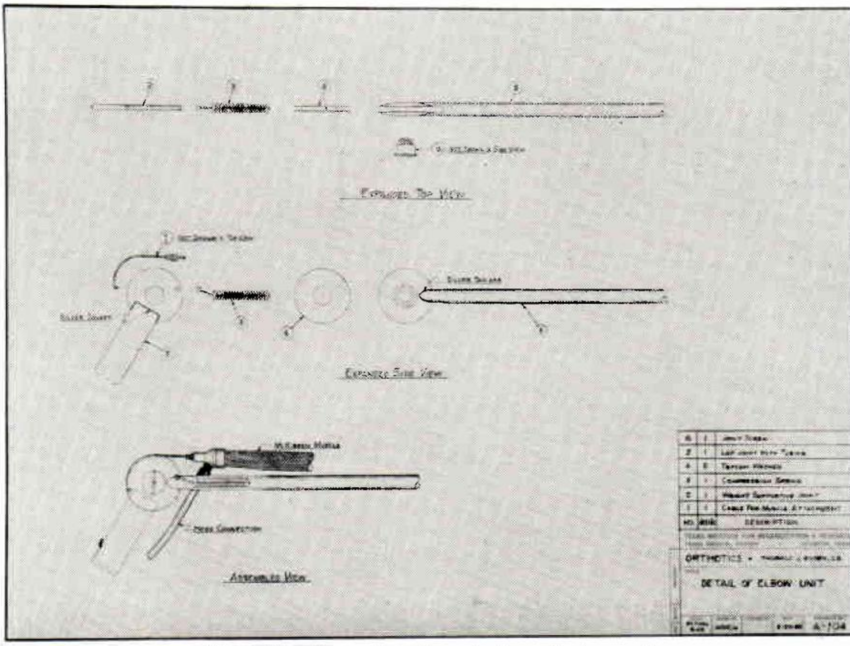


Figure 11—Expanded view of elbow flexion unit.

A moulded elbow and forearm trough made of laminated polyester resin is attached to the unit. A cutout is located at the position of the olecranon. This permits firm seating of the elbow and prevents the forearm from sliding when the elbow is fully flexed. This is very important because of the critical location of the fulcrum points of the unit, which must correspond closely with those of the extremity. The forearm is stabilized in the trough with a leather strap.

During the past eight months, ten powered orthotic systems have been applied on patients with various etiology. Evaluation of these including new adaptation are continuously being followed and evaluated.

*CASE STUDIES OF PATIENTS*

The following illustrations show three different types of orthotic applications on patients.

*CASE #1:* Figure 12, B. B., White, Male, Age 26.

*Diagnosis:* Cord lesion at C-4 and 5 level due to a trampoline accident, December 30, 1957.

This patient has almost normal function of both upper extremities with the exception of paralyzed hands.

After an evaluation for external power, application, an orthosis for the right hand was designed and applied providing index and long finger prehension against the opposed stabilized thumb. On the left side of the lapboard, a double action control unit activated by a rocker bar was mounted and controlled by the left forearm. This arrangement gave the patient a positive control site, which he learned to operate effectively in a very short time.

The $CO_2$ container, valve unit, and tubes were mounted on the under surface of the lapboard (see Figure 13). This permitted the patient to used the equipment while in bed, or during transportation by car, etc.

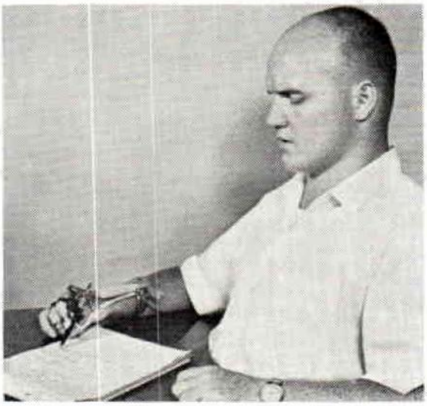

Figure 12—Powered finger prehension orthosis adapted to patient.

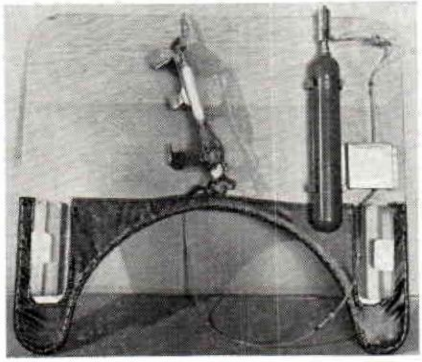

Figure 13—$CO_2$ container and valve box mounted on the under surface.

*Before Application*

1) Typing and writing with special made devices.
2) Feeding accomplished with eating utensils attached to hand orthosis.

After a short training period, the following summary from the occupational therapy report revealed the scope of his extended activities.

*After Application*

1) Shaving with a safety razor and handling all aspects of the activity after equipment is placed on his lapboard including shaving cream, wash rag, and after-shave lotion.
2) Feeding, including cutting thin slices of meat by using a rocking knife. Also, he can handle his drink, salt, and pepper, etc.
3) Brushing teeth (swivel). This includes handling tooth paste independently.
4) Telephone. This includes dialing.
5) Playing cards. He can handle cards with addition of card holder.
6) Typing and writing—increased in speed and tolerance.

Recently it was learned that this patient has decided to continue his education. He has been accepted at the university he attended prior to his accident. His goal is to become a patent lawyer.

*CASE #2:* Figure 14, L.E.P., White Female, Age 26

*Diagnosis:* Poliomyelitis. Onset, September 28, 1951.

This patient has minimal residual function of the right hand including radial wrist extensors, opponents of the thumb and scattered intrinsics throughout the fingers. This muscle picture enables her to grasp objects in a gross manner. Only weak wrist flexor and supination function was present in the left extremity.

Due to the total absence of function about the elbow and shoulder region in both arms, it was decided after the initial evaluation to apply power assistance to the right extremity to restore elbow flexion and shoulder abduction. The slight movement of function in the left wrist was found adequate to activate the two double control valves mounted on the left side of the lapboard. The $CO_2$ container was mounted on the under surface and polyvinyl tubes connect the power supply, valves, and power actuator. Snap disconnects are incorporated in the tubes so the individual components can be easily separated.

The following summary of functional activities prior to and after application was submitted by the Occupational Therapy Department.

*Before Application*

1) Turning pages with suspension sling applied to the right arm. This was not accomplished smoothly or with ease and required a great deal of positioning.
2) Smoking was possible if someone put cigarette in holder and positioned her arm in a flexed position.
3) Typing—minimal and could be accomplished only with right suspension sling attached.
4) Writing was restricted in range, shaky and her work tolerance very low.

*After Application*

1) Turning pages in a magazine, book and newspaper accomplished coordinately.
2) Smoking. Can put cigarette in holder but cannot light it safely.
3) Writing with slightly built up pencil and raised surface for as long as three hours with brief rest periods.
4) Feeding—independent with adapted fork, plate guard and lazy susan rotating disk. She is feeding herself three meals a day.
5) Makeup—can apply powder, rouge, eye makeup, and lipstick. She has a mirror that sits on her lapboard and a makeup holder for all cosmetics.
6) Typing accomplished with ease. Can insert paper, fold letter and insert in envelope.

*Avocational Interests*

Activities we have explored: (All these accomplished after setup.)

a. Mosiacs
b. Hook rug
d. Ceramics
e. Bongo drums
c. Leather lacing

At present this patient is consulting a vocational counselor for the possibilities of getting a job she would be capable of handling.

**Figure 14—System providing elbow flexion and shoulder abduction for patient.**

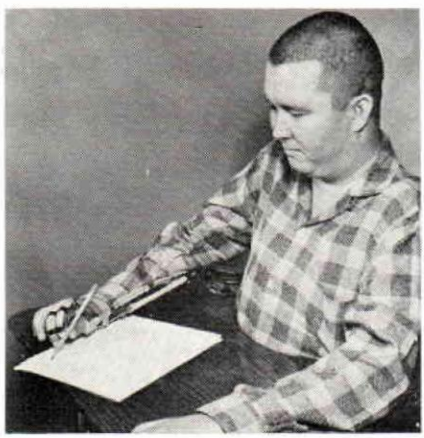

**Figure 15—Complete powered system providing finger prehension—Elbow flexion—Shoulder abduction.**

*CASE #3:* Figure 15, J.G.R., White Male, Age 27

*Diagnosis:* Poliomyelitis. Onset, August 28, 1956.

This patient is essentially flaccid throughout the upper extremities with the exception of trace and poor muscle movements in the shoulder girdle group. The only residual muscle function present in the lower extremities is located in the left leg, a fair + M. Peroneus longus and M. Peroneus brevis and good flexors and extensors of the foot.

Externally powered equipment providing finger prehension, elbow flexion and shoulder abduction on the right was adapted to this patient. Six valves were mounted under the left foot pedal of his wheel chair. Holes in the foot pedal exposed each control button and by a foot plate arrangement these were activated by inward and outward movements of the patient's foot.

Due to his personal business obligations, he did not receive formal training in the use of his equipment; however, upon his discharge, he was able to turn pages and use an adding machine of most importance to him as director of a book and magazine selling business. At a later date, he will be scheduled for a follow-up training program.

## *GENERAL CONSIDERATIONS*

This system, with the exception of the powered finger prehension orthosis, cannot function without being rigidly supported by, for example, a wheel chair. Its functional success depends entirely on the precise alignment with the anatomical structure of the upper extremity.

The power actuators as used in the described orthotic system are only adequate for light functional activities.

As the application of this system increases, a detailed engineering analysis must be initiated, including stress analysis, durability and fatigue tests and many other related studies.

## *SUMMARY*

Progress toward the development of a simplified and controllable orthotic system for restoring useful hand and arm action is described. This system, at the present time, is intended to serve practical needs of a particular class of patients, namely, those who are wheel chair bound and have marked muscular deficiency of the upper extremities. The system as a whole has been shown through practical experience with quadriplegics to restore with minimal training actions of immediate importance in daily activities, such as feeding, writing, manipulating books, attending to head and neck hygiene, and numerous others of similar nature.

Several new mechanical components which contribute to the function of this system are described also. These include a vector parallelogram elevator mechanism, a spring loaded elbow axis joint, a wrist friction joint, and a double and single action pinch-tube valve. The unique feature of this system is the manner in which these mechanical components are combined to produce synchronized and smoothly phased motions of the upper extremity segments.

Case studies on three typical patients of the type to whom this system is especially useful are given. Detailed comparisons provided by occupational therapists are included, revealing marked degrees of improvement in typical activities due to application of this orthotic system.

## *ACKNOWLEDGEMENT*

The author expresses his appreciation to the numerous members of the medical staff at the Texas Institute for Rehabilitation and Research whose continuous encouragement stimulated progress throughout this research effort. Also, valuable contributions have been made to the development and sequential improvement of this orthotic system through the coordinated efforts of all members of the staff in the Orthotics Department.

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# CLINICAL PROSTHETICS AND ORTHOTICS COURSE FOR PHYSICIANS AND THERAPISTS OFFERED BY UCLA

The University of California, Los Angeles, Prosthetics Education Program has announced a new course for physicians and therapists which will be presented in the 1963-64 academic year. The course will last two weeks, and will cover the major fields of upper and lower extremity prosthetics, upper and lower extremity orthotics, and spinal orthotics.

This new course is designed to provide a thorough refresher on the basic principles of these fields, plus new material on all of the newest techniques and devices. Those who have taken previous courses at UCLA will find ample information on all the latest advances in prosthetics, such as the total contact plastic socket, hydraulically controlled prosthetic units, the patellar tendon bearing below knee prosthesis, the new functional long leg brace, and the use of porous laminates for prosthetic sockets.

The two-week session will include an all day field trip to Rancho Los Amigos Respiratory Center for special presentations on devices for the so-called "totally disabled." Completion of the two-week course will be the equivalent of attendance at all of the courses in prosthetics and orthotics presently offered at UCLA for physicians and therapists.

This new comprehensive course has been designed and is being presented in answer to requests from the Veterans Administration, from various medical societies and from facilities of several of the nation's larger teaching institutions. Four presentations of the course are offered: October 14 to 25 and December 2 to 13, 1963, and February 10 to 21 and April 6 to 17, 1964. Inquiries concerning the courses should be addressed to: Prosthetics-Orthotics Education Program, UCLA Medical Center, Los Angeles 24, Calif.

# NEW REGIONAL DIRECTORS OF AOPA

## MOONEY HEADS REGION I

Howard Mooney, C.P., of Lowell, Massachusetts, is the new Regional President of Region I. Members from the six New England states and the Dominion of Canada, unanimously elected him at the meeting at Cambridge, Massachusetts, May 4. Mr. Mooney is Business Manager of Boston Artificial Limb Company, Inc.

Serving with him as Regional Officers will be John Glancy, C.O, as Vice-President and Joseph Aveni, C.P., Secretary-Treasurer, both of Boston.

## DANKMEYER CHOSEN BY REGION III

Charles H. Dankmeyer, C.P.O., of Baltimore was elected Regional President of Region III at the meeting in Pittsburgh, April 26-28. Serving with Mr. Dankmeyer will be Karl Barghausen of Pittsburgh, Vice-President, and Leonard Svetz of Pittsburgh as Secretary-Treasurer. The meeting at Pittsburgh was a joint one with the Pennsylvania Orthopedic-Prosthetic Society, with Alfons Glaubitz, of Elizabethtown, Pennsylvania, serving as Program Chairman.

**At Meeting of Region I—H. R. Lehneis confers with Dr. Sidney Fishman, Director of New York University's Orthotics and Prosthetics Education program.**

**Louis Pulizzi, Past Director of Region III, with Basil Peters, George Kowatic and Joel Kalas at the Region's Meeting at Pittsburgh.**

## BOHNENKAMP TO HEAD REGION VII

AOPA Region VII elected Donald Bohnenkamp, C.P.O. of Omaha, as President of the Region for a two-year term 1963-65. As Regional President he will assume the duties and post of the Director of the Region on AOPA's National Board at the New Orleans Assembly.

Serving with him will be Chester Nelson of Minneapolis as Vice-President. Mrs. Betty Hanicke was re-elected Secretary-Treasurer.

The election climaxed a fine meeting at the Town House Motel in Omaha, Nebraska, May 17-19. National AOPA was represented by President-Elect Robert Gruman and Executive Director, Les Smith.

The Region voted to hold the 1964 meeting in Minnesota, preferably at one of the resort areas near Minneapolis.

## LEROY NOBLE CHOSEN BY AOPA REGION IX

Region IX, covering Southern California, Southern Nevada, and the state of Arizona, met at the Cockatoo Inn, in Hawthorne, California, March 24 and 25. In the concluding Business Session the following officers were elected for a two-year term 1963-1965:

Regional President, LeRoy Noble, President of the Universal Orthopedic Appliance Company, Whittier, California (as Regional President, Mr. Noble will also take office as National Director for Region IX at the New Orleans Assembly this coming November.)

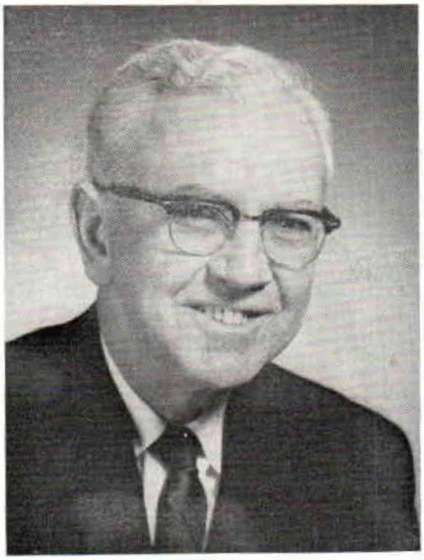
Vice - President, Richard Fadely, President of Modern Prosthetics Appliances of Santa Monica, California.

Secretary - Treasurer, L. Benson Marsh, Director of Prosthetics at Sierra Engineering Company.

## REGION X PICKS FRANK MOOS

Frank Moos, Vice-President of Miller Orthopedic Appliances of San Jose, California, is the new member of the AOPA Board of Directors from Region X. He was elected Regional President and Director at the meeting held at Palo Alto, California, March 31.

He succeeds Mr. Herbert Hart, who resigned as Regional Director in order to devote more time to his duties as Vice President of AOPA.

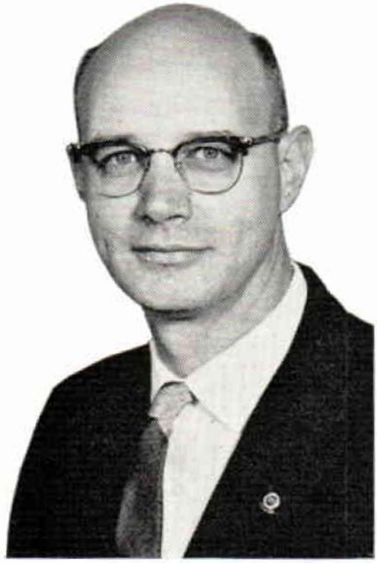


## CROWLEY HEADS REGION V

Bart J. Crowley was unanimously elected Director of AOPA Region V at the meeting in Grand Rapids, Michigan. Mr. Crowley, a veteran orthotist, is President of the Akron Orthopedic Brace Company of Akron, Ohio, and a former President of the Ohio Orthopedic Association. He and Mrs. Crowley were in charge of the arrangements for the 1962 Regional Meeting.

Serving with Mr. Crowley will be Cletus E. Iler of Saginaw as Vice-President of the Region, and Robert Fannin of the Columbus Orthopedic Appliance Company as Secretary-Treasurer.

## PRESIDENT FILLAUER REPORTS ON AOPA'S NEW CAREER OPPORTUNITIES PAMPHLET



The American Orthotics and Prosthetics Association has recently published a career booklet which we feel may be both interesting and useful to the many orthopaedic surgeons, physicians, and rehabilitation officials who are readers of the *Journal.*

Members of the medical profession and rehabilitation workers are well aware of the ever increasing need for additional trained and educated orthotists and prosthetists, and may wish to aid in the recruitment of able and honorable individuals to such a career. I would like to take this opportunity to call attention to the usefulness of the new career pamphlet in such recruitment.

"Career Opportunities for Orthotists and Prosthetists" is a brief, 1200 word outline of the personal qualifications, education, and training necessary for such a career. It also includes a brief summary of the work and responsibilities of the limb and brace fitter, plus information on the Association, the Certification program, and the opportunities and prospects in sight for young men who are concerned with this aspect of the rehabilitation of the disabled.

The career booklet was designed for use by vocational and guidance counselors in Junior Colleges and high schools. In addition, it can save the time of the busy physician in giving patients, as well as prospective prosthetists, a quick, concise description of the work of the orthotist and prosthetist.

Copies of "Career Opportunities for Orthotists and Prosthetists" may be obtained without charge from:

The American Orthotics and Prosthetics Association
Suite 130, 919 18th Street, N.W.
Wahington 6, D. C.

Sincerely,

CARLTON FILLAUER

# BOOK REVIEWS

*MESSEN, MASSNEHMEN, ABFORMEN AM UND FUR DEN MENSCHSLICHEN KORPER. Measure, Measurements, Molds of and for the Human Body. By F. Pueschel, Technischer Verlag Herbert Cram, Berlin, 1962. Reviewed by Hans R. Lehneis.*

This book can be highly recommended as a worthwhile addition to the reference library of any prosthetist. Along with complete coverage of the subject matter it contains some new and interesting information and is readable and well illustrated.

Prosthetic and orthotic measuring techniques, both conventional and new, for everything from arch supports to neck collars, is the major attraction of the volume. Of particular interest is a description of a new silicon base impression material used frequently by the author in place of alginates for taking facial or hand impressions for cosmetic restorations. The material is reportedly as flexible as alginates and gives as accurate an impression, but since the material does not shrink, its shape remains constant once an impression has been taken.

Conventional methods of fabricating lower extremity prostheses are carefully outlined, but in addition some unique methods are discussed in detail. For example, one such method utilizes a lead strip shaped to the above-knee stump at various levels, helping to determine the size and shape of the horizontal patterns. In a like fashion patterns are made of the frontal and sagittal planes of the stump.

A photographic method is also outlined based on the theory that re-establishment of body symmetry is the primary objective of prosthetic restoration. A photograph of the amputee's sound leg and torso is projected to life size measurements and used to arrive at the static alignment of the prosthesis.

Among upper extremity measuring techniques, the Hepp-Kuhn method for short below-elbow stumps is discussed, in which the olecranon and humeral epicondyles are encased thus which anterior and posterior wing ex-eliminating metal hinges. For above-elbows, a procedure is presented in tensions in the proximal area are used to stabilize the socket on the stump.

With no less thoroughness, measurement techniques are provided for positioning and sizing prosthetic ear and nose restorations. Illustrations of the proportional relationships of the nose and ear to the head by geometric division in the frontal and sagittal planes help the reader to understand the material. A classification chart of 33 finger and nail shapes contributes much to a chapter on partial finger and hand amputations.

These sections on measurement would be enough to justify the book, but adding to its inclusiveness is an excellent introduction covering both general and surface anatomy and illustrated with charts of the skeleton, the musculature, and the central nervous and circulatory system. Another introductory chapter is an exposition on the proportional relationship of the human body segments to each other and their ratio to head length.

There are supplementary chapters concerned with shoes and measuring devices; surgical supports, trusses, etc. In addition a thorough treatment of the measurements for clothing and related items is presented. This subject may appear to be of little value, but considering the prosthetists or orthotists relationship with the patient, this material can be of value when directing the patient to sources of related assistance that he may need.

This reviewer unqualifiedly believes that this book deserves a claim for completeness in the subject treated.

*INJURY AND RECOVERY IN THE COURSE OF EMPLOYMENT. By Earl F. Cheit. John Wiley & Sons, New York and London. 377 pages. $11.95. Reviewed by Joseph C. Aveni, C.P.*

This book can best be called a "reference manual" since it covers just about all the facts that one may wish to indulge in.

It is a basic yet thorough study of the many complicated systems making up today's Workmans Compensation Acts.

As a reference manual, it not only cites case histories, gives comparisons, suggests solutions, but also challenges the reader to solve the problem.

Its numerous charts and references point out the fantastic amount of research that must have gone into compiling this book.

As a text book for students preparing for a career in the "Legal Aspects Of Workman's Compensation," Vocational Rehabilitation, Industrial Accident Commissions or Rehabilitation, it has many basic though highly technical possibilities.

The first eight or so chapters classify as "study" material — the last three can be considered as "reading" material. By this I mean that the first eight or so chapters can, in my opinion, be clearly understood only if one is willing to "study them". The last three chapters are probably best described as a compilation of many facts and suggestions in "reading form."

Finally and conclusively, the Author convinces the reader of the need for "changes in the Law, the need for better administrative forces, and the need for more accurate evaluations of physical incapacities as a means of equitably providing Workman's Compensation."

*"SPORTS MEDICINE", edited by J. G.P. Williams. Published Baltimore, The Williams and Wilkins Company, 1962, $12.00. 420 pages, illustrations.*

Dr. Williams, the author, is the Registrar of the National Spinal Injuries Centre, at Stoke Mandeville Hospital in Great Britain. He has written an extremely interesting and worthwhile book. Of special interest to the Orthotist and Prosthetist will be Chapter 19 on "Sport and the Disabled." This will make interesting reading also to any young paralytic or amputee.

*"Injuries of the Knee Joint" by I. S. Smillie, F.R.C.S. (ed.) F.R.F.P.S Third edition published in the United States by the Williams and Wilkins Company of Baltimore, 1962, 536 pages including colored plates; price $17.00.*

The author is lecturer in charge of the Department of Orthopedic Surgery at the famous University of St. Andrews, Scotland. This comprehensive manual is of primary interest to Orthopedic Surgeons, but will be excellent background reading for any Orthotist.

## NEW BOOKS

*PRINCIPLES OF BONE REMODELING*, by Donald H. Enlow, Ph.D., Associate Professor of Anatomy, The University of Michigan Medical School.

Published by Charles C. Thomas, 301 East Lawrence Avenue, Springfield, Illinois. The price is $6.75. The Orthopaedic Surgeon and the Dentist as well as the persons interested in the history of medicine and anatomy will find this book interesting and helpful reading.

*THE HOROWITZ LECTURES, 1961, by Robert L. Bennett, M.D., Rehabilitation, Monograph XIX, The Institute of Physical Medicine & Rehabilitation, New York University Medical Center, 1962.* 39 pages. $1.00. Reviewed by LeRoy Wm. Nattress, Jr.

Orthetics in Physical Medicine

Beginning with the acknowledgement of the fact that orthetics is now spelled with an "o" not an "e", Dr. Bennett proceeds to give a brief, knowledgeable overview of the field of bracing. Dr. Bennett cites three uses of bracing: (1) in the control or prevention of deformity, (2) in the correction of deformity, and (3) in the recovery of function. His discussion of the control of deformity is particularly well stated and illustrated.

In describing the ideal brace, Dr. Bennett, with tongue in cheek, stated "this device should cost nothing, be invisible, have no weight and dissolve when it is no longer needed!" This is truly a remarkable goal for which to strive.

On a more serious note, Dr. Bennett maintains that the responsibility for proper barcing lies with the physician. "The experienced orthotist can be of the greatest help to the physician . . . Progress will take place only when the physician and orthotist complement each other's skill . . . Most orthotists are master craftsmen, but they put forth their best efforts when their products are appreciated and properly utilized." To this we should add a hearty, Amen!

Dr. Bennett closes the lecture with a word of admonishment and caution. "Unfortunately, even devices of proven value are not known, or appreciated by a large majority of physicians. Unless the physician realizes the value of these devices when properly prescribed, fitted, and used, the field will not develop as it must if we are to care adequately for the physically disabled."

"The goal must never be to create a mechanical man. At some point there is a limit to man's acceptance of the degree of automation that can be built into a device that he must now wear. The future still lies in the prevention of needless deformity and in the recovery of necessary function through the most effective use of the patient's own neuromuscular and musculoskeletal systems."

## BOOKS RECEIVED

*Selective Bibliography of Orthopaedic Surgery*, including a Cumulative Index of Instructional Course Lectures, St. Louis, The C. V. Mosby Company, 1962; 79 pages; $2.90.

This Bibliography has been prepared by the Committee on Teaching Aids of the American Academy of Orthopaedic Surgeons: Doctors J. Hamilton Allan, Ernst Dehne, Francis J. Cox, Garrett Pipkin, and Carroll B. Larson, Chairman. It will be a useful tool in the library.

*Disc Lesions and Other Intervertebral Derangements*, by E. J. Crisp, M.D. Edinburgh, E. & S. Livingstone, Ltd., 1960. Distributed in U.S.A. through the Williams and Wilkins Co., Baltimore.

*V.A.P.C. Total Contact A.K. Technique*, UCLA Teaching Manual, by Miles H. Anderson, Ed.D., John J. Bray, C.P.O., and Donald F. Colwell, C.P. Published by UCLA Prosthetics-Orthotics Education Program, 1963. 52 pages, mimeographed. Illustrated.

This edition of the manual has been extensively revised in view of added experience gained in recent classes, and supersedes the November 1962 edition. The earlier edition is now obsolete and should be discarded.

*Upper Extremity Orthotics in Rehabilitation*, by Rose M. Elliott, O.T.R. and Randolph N. Witt, C.O. Published by the Texas Rehabilitation Center of the Gonzales Warm Springs Foundation. Price $1.00. 15 pages, mimeographed. Illustrated.

Descriptions, specifications, and fitting instructions for thirteen upper extremity splints, assists, and feeders.

## *To The Ladies:*

# FROM AOPA'S AUXILIARY

**Mrs. Elinor Bohnenkamp**
President

**Mrs. Esther Pava**
Vice President

**Mrs. Ted W. Smith**
Secretary-Treasurer

**Mrs. Lorraine Scheck**
Past President

DEAR AUXILIARY MEMBERS:

With school almost over for another year as this is written, I know you all are in the midst of vacation plans. For those of you in locations which have not held their district meetings, we hope your plans include attendance at these informative conventions.

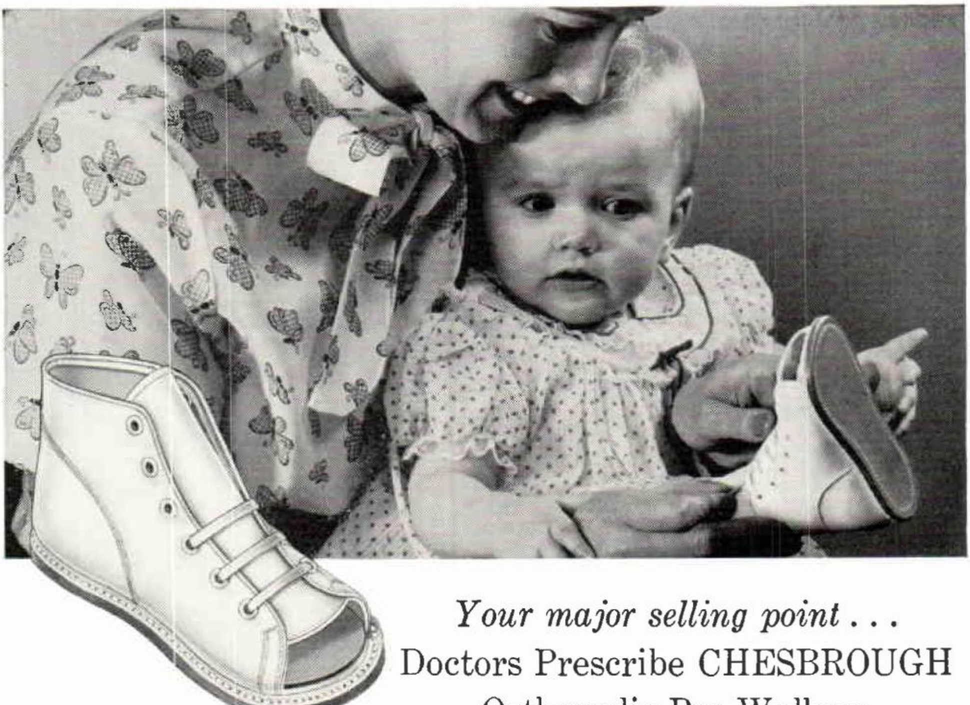
All reports indicate good attendance and interesting prgrams, as well as the "boost" we all get from a change of scenery and the sociability of our meetings.

Plans are progressing for the National Convention in New Orleans, November 2-6. Now is the time to commence planning to attend. Our women's activities seem to be more fascinating each year, and New Orleans has so much to offer.

As you read this, your Auxiliary President and Secretary will be in Europe with the AOPA Technical Mission. We will have the pleaure of meeting the wives of foreign orthotists and prosthetists. They may have ideas and activities of interest to our members.

Until September, when we'll be here with more news of New Orleans, I'll say "adieu."

ELINOR BOHNENKAMP, *President*



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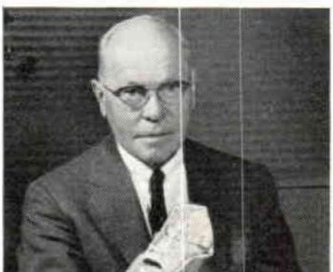

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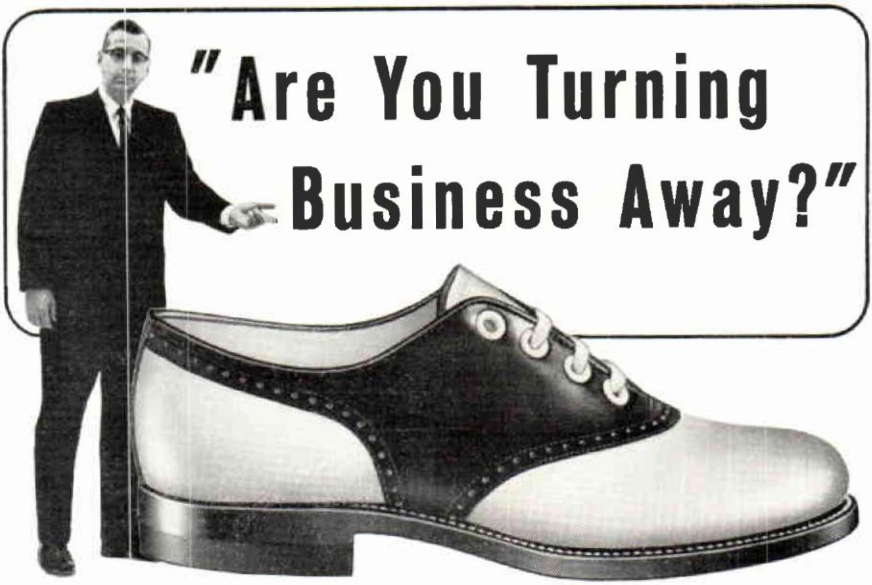


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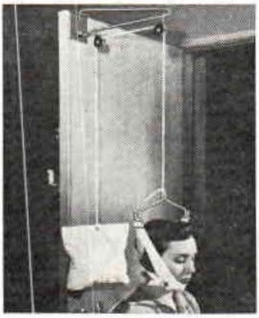

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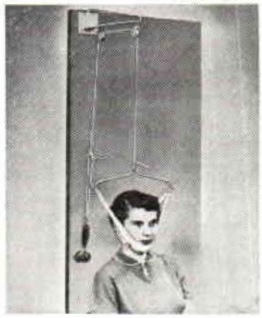

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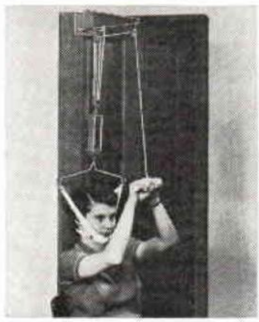
OD-7



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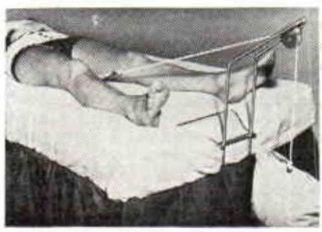

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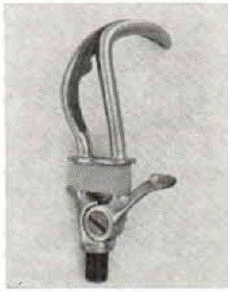
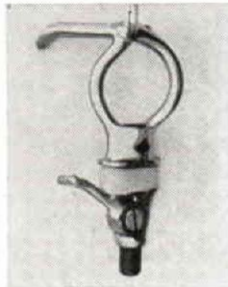

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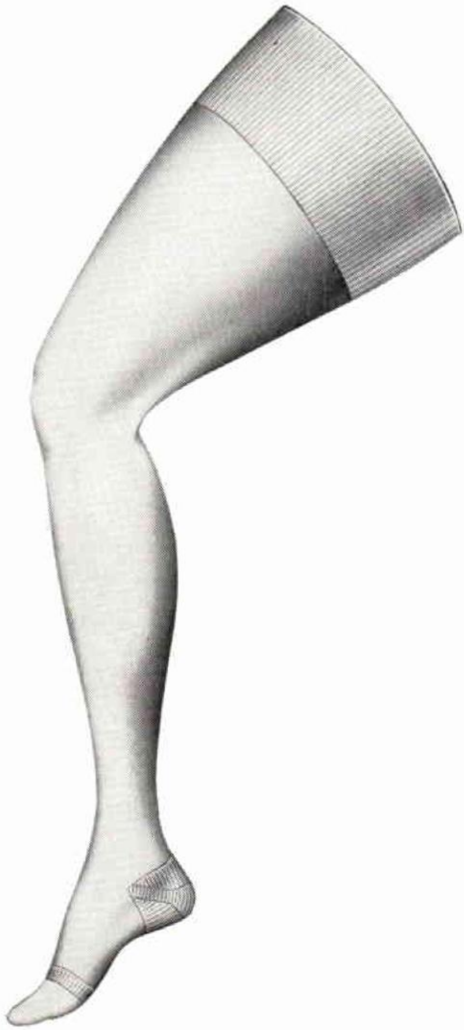

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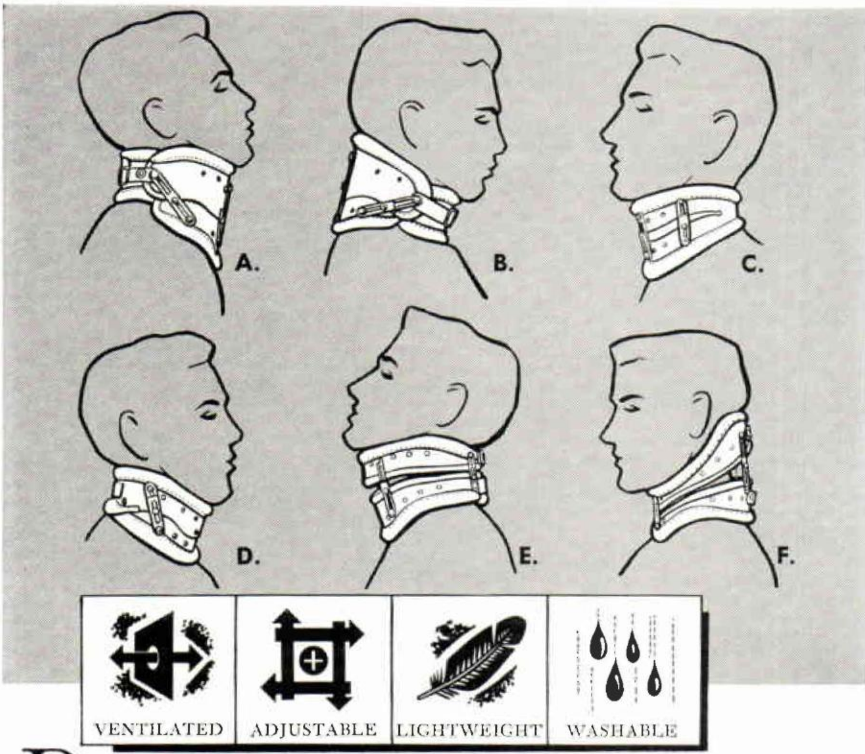
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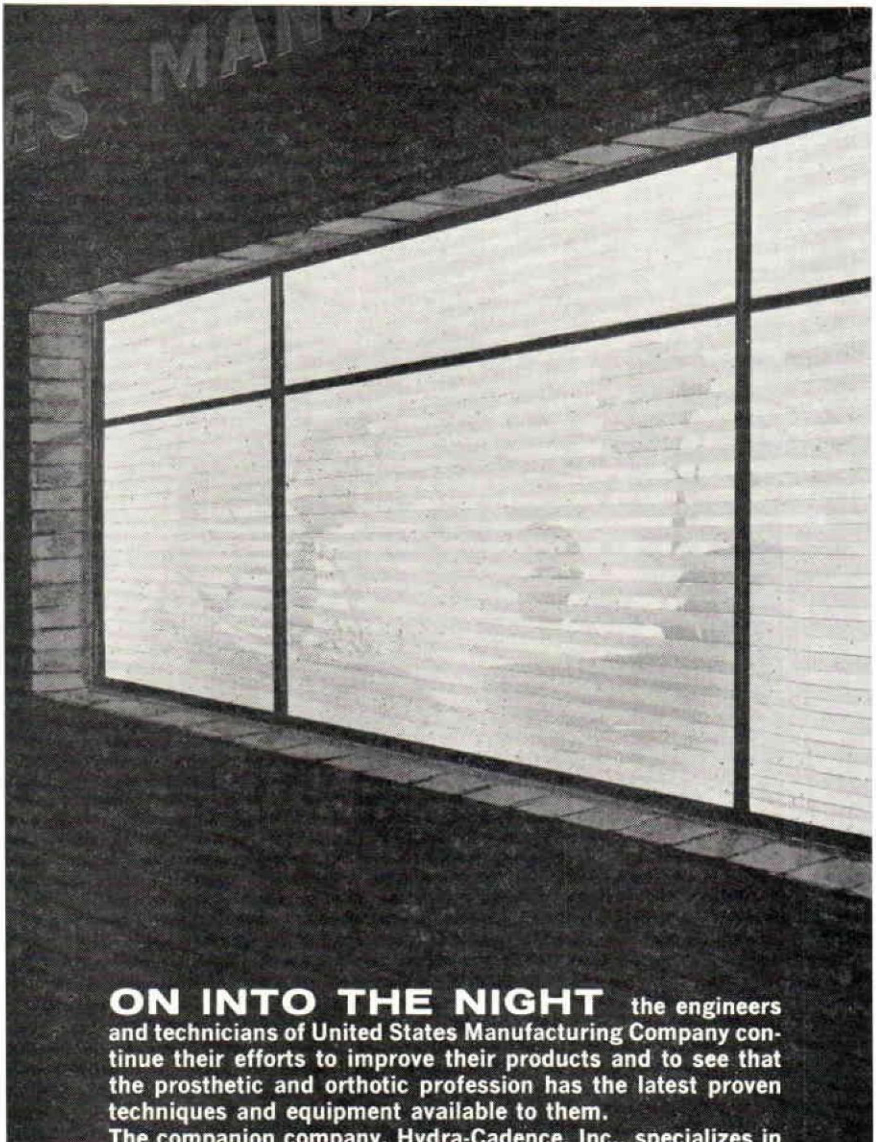
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