100 cases have been managed by the Seattle group, using the immediate postsurgical prosthetic fitting technique.

Project personnel continued to devote considerable time on educational efforts for clinicians interested in the technique.

SENSORY AIDS

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Fabrication of Obstacle Detectors for the Blind

Bionic Instruments, Inc., Bala Cynwyd, Pennsylvania
Thomas A. Benham, J. Malvern Benjamin, Jr.
D. Ridgeley Bolgiano, and E. Donnell Meeks, Jr.

Professor T. A. Benham presented a paper at the June 1966 research conference in London held under the auspices of St. Dunstan's. A review of the conference including some notes on the work at Bionic Instruments, Inc., appears elsewhere in this issue.

Construction was completed in December 1966 of the "3-look" electronic cane mentioned in earlier issues of the Bulletin. This latest version, designated Model C–3, has been built to specifications which call for the upward-looking beam to detect potential hazards in the head-and-shoulders path less than 7 ft. high and at a range of about 7 ft. from the user's hand. The obstacle detecting beam which probes ahead is designed to provide a signal from objects in its path out to 10 ft. A knurled control wheel in the handle allows the user to vary the outer detection limit from 10 ft. inward to 3 ft. The downward-looking terrain-discontinuity beam is adjusted to detect dropoffs in terrain of 30 deg. or more, or vertical drops of 2 ft. or more, the indications being given at least 4 ft. away from the discontinuity.

The Model C–3 cane uses three gallium arsenide laser light sources manufactured by the General Electric Company. Developments permitting true semiconductor-laser operation at room temperatures have made for advantages in equipment size and battery endurance. The light-source optics are fitted into small tubular housings pointing in the desired directions for the three probing ray-pencils. The ray direction for the obstacle detecting beam is adjustable by the control wheel. The two nacelle-like structures on the Model C–2 cane, illustrated on page 201 of BPR 10–4 Fall 1965, are now replaced by small tubular light projectors and one receive-nacelle somewhat lower on the cane shaft. Photodiodes specially

manufactured by the Philco Corporation are used as the light sensitive elements in the receive-nacelle. A rechargeable nickel-cadmium battery housed in the cane handle should provide a typical day's use without recharging. Provisions for wireless transmission of auditory output indications of the three information channels to a receiver mounted in an eyeglass temple will be included at a later date. A cane user and/or a mobility trainer could thus have warning signals delivered near the ears without the encumbrance of wire connections.

The mechanical dynamics of the cane have been kept as similar as possible to the dynamics of an ordinary typhlocane. The weight, however, will be greater, but hopefully not over two pounds.

Spelled-Speech for Automatic Readers Usable by the Blind
Metfessel Laboratories, Inc., Los Angeles, California
Milton Metfessel, Ph. D., and Constance Lovell, Ph. D.

This contract with Metfessel Laboratories, Inc., originally scheduled for termination June 30, 1966, has been renewed for an additional year without further funds. The time is required for completion of a final report, preparation of an illustrative tape recording, and disposition of government-owned property used during the period the experimental research was done.

Professor Metfessel has indicated that he plans to have the report and tape completed early in 1967. The report or an abstract may appear in a later issue of this Bulletin. Plans have already been completed regarding disposition of the equipment used during the project.

Research on Audible Outputs of Reading Machines for the Blind
Haskins Laboratories, Inc., New York, N. Y.
Franklin S. Cooper, Ph. D., and Jane Gaitenby Newman

Various aspects of the work on this project have been reported in some detail at recent meetings here and abroad. Dr. Cooper and Miss Gaitenby (now Mrs. Newman) spoke and presented some demonstration tapes at the VA-arranged Sixth Technical Conference on Reading Machines for the Blind, January 1966. A summary will be found on pages 18 and 19 of BPR 10–5 Spring 1966.

Drs. Cooper and Studdert-Kennedy addressed St. Dunstan's International Conference in June 1966. Proceedings will be published by the British sponsor, and some brief notes appear elsewhere in this issue of the Bulletin in Mr. Freiberger's summary paper.

Research work on speech continues at Haskins Laboratories on a number of fronts, as is reported from time to time in journals of the field and in Haskins' own Status Reports on Speech Research. Machine generation

of fairly natural-sounding readily intelligible speech, capable of being listened to for periods sufficiently long to be considered worthwhile, continues to be the aim of the work being done specifically for the Veterans Administration. Despite the earlier beliefs of some, and the intuitive feelings of others, such speech has to date not proved easy to come by. Progress, however, is being made both in understanding the problems and in sketching out designs for the high-performance, audible output system being sought at Haskins.

Output Characteristics and Construction of an Interim Word-Reading Machine

Haskins Laboratories, Inc., New York, N. Y.
Franklin S. Cooper, Ph. D., and Paul Brubaker

This contract is currently in process of being terminated. A final report will be completed early in 1967. As was pointed out in earlier issues of the Bulletin, the concept of stringing prerecorded words together using the hardware first contemplated for this fixed-price contract in its 1956–57 planning stages now seems an obsolete approach. Knowledge gained during the active years of this project, and some of the equipment developed, will be applied to the other continuing research contract at Haskins mentioned in the note just preceding this one.

The Development and Evaluation of a Personal Reading Machine for the Blind

Mauch Laboratories, Inc., Dayton, Ohio
Hans A. Mauch and Glendon C. Smith

The Visotoner reading device for the blind developed under this contract was demonstrated by a VA staff member from Hines, Illinois, at the 15th Annual Meeting of the President's Committee on Employment of the Handicapped. Mr. Smith, senior engineer on the project, presented a talk on his work before the St. Dunstan's conference which is summarized elsewhere in this issue. He demonstrated the Visotactor B, the Visotoner, and the Colineator at this conference.

The contractor has received all of the parts required for the construction of 6 Visotoners, 4 Visotactors B, and 10 accompanying Colineators. The assembly of these units was well underway by Fall 1966.

Work continues on evaluation of the Visotactor B and the Multi-column Visotactor. This evaluation procedure put the piezoelectric bimorph stimulators through rather rigorous tests. Several changes in the techniques of using the piezoelectric bimorphs were developed as a result of this work. Current versions of the instruments are more reliable than their earlier counterparts.

A complete personal recognition reading machine for the blind, the principal and most ambitious goal of the work under this contract, has been built and operated in a laboratory model. Much was learned from this feasibility-demonstrating experience. To bring the unit closer to the desired goal—a semi-portable device to be kept in the home or office, usable by and useful to some segment of the blind population—it was apparent improvements in several areas were necessary. Current work on the design and development of Recognition Prototype II is aimed at achieving such improvements. It is hoped that the new model will have a higher reading speed, a lower error rate, an improved multi-font capability, a greater tolerance to misalignment, and a better output of the spelled-speech variety. Progress is being made in each of these areas through new designs and techniques by Mauch Laboratories and the employment in the system of a Cognitronics Corporation photographic film audio memory drum "Speechmaker" unit with special sound tracks of slightly modified Metfessel "spelled-speech."

Determination of Performance Attainable with the Battelle Optophone
American Center for Research in Blindness and Rehabilitation, Newton, Maassachusetts
Leo H. Riley, M.D., and Ann Harrington

The original concept of training blind people in the use of the optophone by having them come to the Center for their instruction proved relatively unworkable with the subjects and the conditions set up by this contractor. Current emphasis has shifted to home use of the equipment with considerable self-teaching and only occasional visits to the homes by the instructor. It is still too early to report on progress under this plan.

Evaluation of Ultrasonic Aid for the Blind
American Center for Research in Blindness and Rehabilitation, Newton, Massachusetts
Leo H. Riley, M.D., and Gunther Weil, Ph. D.

Dr. Riley participated in the June 1966 research conference held in London, England, under the auspices of St. Dunstan's. A summary paper on this meeting and a rather complete report on the work and findings at ACRIBAR concerning the ultrasonic aid designed by Dr. Leslie Kay and built by Ultra Electronics, Ltd. will be found in other sections of this issue of the Bulletin.

As Dr. Kay points out from time-to-time, and as the scientific leadership at ACRIBAR is well aware, the full potentials of a device such as the ultrasonic aid may not emerge during a formal, controlled evaluation which perforce allows only limited time for extended real-life use of the device. The contractor is currently gathering data to enhance our knowl-

edge of the longer-time effects relating to use of this aid as a mobility device for blind people.

Development of Test Procedures for Evaluation of Binaural Hearing Aids
Northwestern University, Evanston, Illinois
Raymond Carhart, Ph. D. and Wayne Olson, Ph. D.

This contractor continued his studies of the communicative efficiency of hearing impaired persons when receiving speech through present day hearing aids. Previous efforts along these lines have involved comparisons of the relative efficiencies of monaural versus binaural hearing aids and have indicated that the addition of a second hearing aid only slightly increases the communicative efficiency of the user over what he could achieve with a favorably oriented single instrument. That is, the person's performance when listening to speech originating on the side of his single hearing aid will be improved only to a small degree with a second instrument affixed to the opposite side. However, if the speech to be attended to comes from a source on the side away from the individual's monaural hearing aid, he will be at a serious disadvantage in the presence of competing messages. In such an instance, a second instrument on the other ear would now place that hearing aid in a favorable position so the listener would not be seriously affected by the origin of the signal he wishes to hear. The factor responsible for the marked deterioration in ability to understand speech originating on the side away from the hearing aid (or good ear in the case of unilateral deafness) is the head shadow effect which is now understood more fully on the basis of work completed under this contract. The above statements apply, of course, to listening situations in which other conversation or noise is present in addition to the speech of interest to the listener. A major conclusion derived from the work to date is that the primary advantage of a binaural hearing aid over a monaural instrument is that the binaural system increases the probability that the hearing aid user will always have one of the two instruments favorably oriented with respect to the acoustic stimulus to which he wishes to give his attention.

Another finding of much interest is the degree to which present day hearing aids (monaural or binaural) considerably reduce the speech discrimination ability of the wearer. Experience has shown that hearing impaired persons and even normal hearing persons experience a sharp reduction in communicative efficiency when receiving speech materials in the presence of speech or noise competition through a hearing aid with a restricted frequency range and marked harmonic distortion. These same persons are adversely affected to a lesser degree when tested under identical conditions, but with a different instrument having a restricted frequency range but minimal harmonic distortion. Finally, relatively good performance is observed when these listeners receive the speech materials in

the presence of the same competition, but through an instrument with a wider frequency range and moderate harmonic distortion. Even so, the performance in the last instance does not equal that attained by the subjects when a high fidelity system is employed for the listening in competition to speech materials.

Four general hypotheses shaping in part the current research activities are reported to be:

1. Speech discrimination ability in quiet will not be affected by restricted band widths (500–2000 Hz.), but the understanding for speech will be seriously affected under such conditions in the presence of competition.
2. The understanding of speech in the presence of competing signals will be better with a broad band pass (500–4000 Hz.) than with a narrow band pass (500–2000 Hz.).
3. Speech discrimination scores obtained while using a flat frequency response characteristic or a slightly rising frequency response pattern (3 db or 6 db per octave) will be better than discrimination scores achieved with a frequency response which slopes upward to the high frequencies more sharply (9 db per octave). The above statement will hold true regardless of the audiometric configuration of the hearing impairment.
4. Harmonic distortion values of 20 percent or less will not seriously affect speech discrimination in noise or other competing signals but distortion increased by decade percentage increments above 20 percent will systematically reduce the undersanding of speech when presented in the presence of competing signals.

Additional details of this work may be found in papers presented by project personnel at the Convention of the American Speech and Hearing Association (November 1965), Acoustical Society of America (June 1966), and American Academy of Ophthalmology and Otolaryngology (October 1966). Reference copies of the limited edition of the annual report for Fiscal Year 1966 may be consulted in selected libraries.

Electroacoustic Characteristics of Hearing Aids

Houston Speech and Hearing Center, Houston, Texas
James Jerger, Ph. D.

The continuing purposes of this study are to develop more satisfactory methods for measuring the performance of hearing aids psychoacoustically, and to apply these methods to the evaluation of the critical electroacoustic parameters of hearing aids. The research should provide the empirical background data on which the Veterans Administration could base a hearing aid procurement program with emphasis on physical tests sufficiently related to psychoacoustic measures to serve as selection criteria.

Previous research on this project has yielded three important conclusions. First, substantial and consistent performance differences can be observed among hearing aids having different physical characteristics. Second, hard-of-hearing listeners and normal-hearing listeners perform in essentially the same manner. The different physical characteristics of an aid are at least as important to a normal listener as they are to a hard-of-hearing person. Third, performance differences are primarily related to the degree of harmonic distortion in the output signal.

Dr. Jerger and his associates have recently published three papers in the *Journal of Speech and Hearing Research* based on work supported under this project, sometimes jointly with other federal agencies:

"Hearing-Aid Performance and Hearing-Aid Selection," Vol. 9, No. 1, pp. 136–149, March 1966.

"Comparison of Some Speech Intelligibility Tests in the Evaluation of Hearing Aid Performance," Vol. 9, No. 2, pp. 253–258.

"Performance—Intensity Characteristics of Synthetic Sentences," Vol. 9, No. 2, pp. 305–312.

The Effects of Distortion on Hearing Aid Performance

Auditory Research Laboratory, VA Hospital, Washington, D. C.
Roger N. Kasten, Ph. D., and Stephen H. Lotterman, Ph. D.

Current work on this project has involved an examination of the acoustic gain and non-linear distortion in hearing aids as related to the characteristics of the loudness control used in the aid. This control, similar to the volume control or gain control on much audio or radio equipment, is usually a subminiature potentiometer designed with an electrically "tapered" element. The non-linear tapers used are generally chosen to allow the equipment user the most convenience in adjusting the device to the desired level.

With many of the aids studied in the project, the acoustic gain frequently reached its essential maximum before the control was advanced to its maximum limit. In other words, the reserve in gain one might expect in the instrument associated with positions of the control beyond its usual operating point just does not exist.

Measurements of non-linear distortion showed that this parameter increased as the loudness control was advanced to normal levels, and continued to increase with further movement of the control *after maximum acoustic gain was achieved.* The danger thus exists that a user, hoping to improve his signal, may keep advancing his control into the region where further acoustic gain is nil, but where damaging non-linear distortion continues to increase.