HIGHLIGHTS OF VA CONTRACTUAL RESEARCH PROGRAM

PROSTHETICS

John O. Esslinger, M.D.
Birmingham, Michigan

A brief progress report on research aimed at attaching a prosthesis to the skeletal system is being prepared for possible presentation at an orthopedic research meeting next winter. The General Motors Research Laboratories are cooperating in the preparation of fused Vitallium screening.

Long-range animal experiments continued aimed at passage of a prosthesis through the skin and direct attachment to the bone. Such attachment would permit better control and more natural activity than present external sockets. Useful by-products may be a method for improving end-weight bearing of ordinary prostheses and methods to pass electrodes or tubes through the skin. Some expansion might accelerate solution of the very difficult biological and engineering problems.

Gilmatic, Northridge, California
Gilbert M. Motis

After preliminary bench and cycling tests, three improved models of a mechanical wrist rotation unit controlled from body harness are being built for test, probably by NYU, UCLA, and VA, on above-elbow amputees and a below-elbow case with stump too short to use the flexible elbow hinges and screwdriver-like socket which were developed years ago by the Prosthetics Research Program to provide voluntary pronation and supination for below-elbow amputees with longer stumps. A hollow central portion will allow axial control.

An improved electrically driven mechanism for a rotating wrist has been built for bench tests. Power requirements, inertia, and various types of locks will be studied. Several designs of special momentary-contact switches (intended to conserve battery life for any of several uses of electric power) have been built for test.

Electrically operated elbow locks (based on adaptations of commercial versions) have been designed. Three copies are being built for test. Many parts of the commercial lock are used, thereby reducing cost.

Preliminary designs and models of other mechanisms for upper-extremity prostheses are in the laboratory stage.

Mauch Laboratories, Inc., Dayton, Ohio
H. A. Mauch

The Mauch Swing-Control System, Model B, was accepted on VA contracts April 1, 1965, after some years of development, evaluation, and extensive clinical application studies resulting in very favorable conclusions (see BPR 10-1 Spring 1964). A few minor improvements were made in recent months, in a system demonstrating outstanding durability.

Preliminary models have been made of metal-lined plastic foam shanks. These not only reduce weight compared with wood but allow the fitting of shorter and more slender amputees without cosmetic compromises or losing the anterior-posterior adjustment of the lower end of the cylinder to adjust knee angle at maximum extension.

Further improvements have been made in the hydraulic ankle. Lateral motion of the forefoot is possible with low friction while weight is on the heel if part of the ball of the foot encounters an irregularity, but the forefoot becomes frictionally locked in the new position as soon as the load line passes through the ball of the foot. This principle, invented by Dr. Ulrich Henschke and Mr. Mauch, seems to provide greater stability than older spring-resisted lateral motion mechanisms. Currently, a design has also been conceived to allow transverse rotation about the longitudinal axis of the shank (as long advocated by the University of California) yet to increase the amputee's perception of stability.

Work continued on a voluntary stance and swing control, based on stump control of the socket position.

National Academy of Sciences-National Research Council
Washington, D.C.

The Committee on Prosthetics Research and Development organized an invitational Conference on the Control of External Power in Prosthetics and Orthotics, held at Airlie Foundation, Warrenton, Virginia, April 8-10, 1965. Participants included research workers in prosthetics from the United States and abroad plus a few experts in remotely operated special equipment. There was an intensive review of body control sites, transducers, sensory feedback, signal processing, actuators, and clinical application problems. A number of models of externally-powered devices were available for study. The proceedings will be published by CPRD, edited from authors' manuscripts and a stenographic transcript of discussions. The conference was jointly sponsored by the Vocational Rehabilitation Administration and the Veterans Administration.

The new Subcommittee on Sensory Aids held an organizational meeting on March 31, 1965.

The Committee on Prosthetics and Orthotics Education has distributed thousands of copies of four pamphlets on prosthetics to appropriate audiences. Films and slides have been distributed, especially to medical and paramedical schools. A film on locomotion (BPR 10-2) has been completed by UCLA, and Northwestern University is preparing the script for narration of its film on upper-extremity harnessing. An up-to-date roster of prosthetics clinic teams, compiled with the assistance of the American Orthotics and Prosthetics Association, has assisted in dissemination of information.

New York University, New York
Renato Contini

After analysis of deficiencies in several pressure transducers to measure pressure between an amputation stump and the surrounding socket, NYU designed a strain gage bridge mounted on two parallel cantilever beams. Pressure is transmitted to one of the beams by a Teflon plunger flush with the inner wall of the socket. Static and dynamic bench tests were made in comparison with an expensive commercial gage, and trials on an amputee were compared with German studies. A brief preliminary report was made, and a more complete report is in preparation.

NYU proposes to concentrate its attention in the next fiscal year on the important question of pressures in sockets during use. An attempt will be made to define the effects of socket fitting methods and of alignment.

Northwestern University, Chicago, Illinois
Clinton L. Compere, M.D.

The Northwestern single-axis knee unit, with programmed disk-friction, after successful evaluation is now commercially available. It was placed on VA contract April 1, 1965.

Six units of the polycentric knee have been distributed to other centers for evaluation. The function (exceptional stability at full extension and programmed friction during swing phase) receives high acceptance. Although an ingenious kinematic design makes the unit function much like a single-axis unit at large knee flexion angles and hence overcomes much of the cosmetic problem typically encountered with other polycentric joints, width of the knee remains an objection.

Considerable progress has been made in improving sockets. A suspension system for preparing a cast of a stump under partial weight-bearing condition has been further improved, so the plaster model of the stump requires less modification before preparation of the socket. Approximately 50 amputees are wearing hard sockets of the PTB type made from casts taken

with the NU suspension technique. Further work on shop tools is under way. Preliminary work has also been done on above-knee stumps using a combination of the University of California quadrilateral brim and a modified NU suspension system. Other applications to Syme stumps and to upper-extremity stumps are being investigated.

Sockets combining rigid supporting areas and flexible portions overlying movable soft tissue, particularly active muscles, continue to show promise. The original socket of this type is still in use after two and a half years.

The first model of the electric coordinated-motion arm for eating completed 22 months of field testing with continued high acceptance. A report on a bathing device for a bilateral above-elbow amputee has been submitted for publication. The project staff continued to serve actively as lecturers at the NU prosthetics education program and at regional meetings of the American Orthotics and Prosthetics Association.

University of California at Los Angeles
Biotechnology Laboratory
John Lyman, Ph.D.

The project completed a technical report on evaluation of the Heidelberg pneumatic prosthesis, and is finishing a comparable report on the French electric hand (originally developed in Vaduz, Liechtenstein). Other reports summarizing engineering and performance evaluation of the Northwestern University electrically driven elbow and the needs-analysis studies (described in BPR 10-2) have been submitted for final editing within the university.

An experimental muscle hernia was surgically created in the pectoralis muscle of an amputee volunteer, and he was trained to bulge the muscle through the fascial defect under the skin to operate a deflection transducer. Initially, he was allowed to watch an indicating spot on an oscilloscope providing a measure of the deflection. The goal is to teach the amputee to bulge the muscle voluntarily to any desired amount, eventually only with proprioceptive feedback.

University of California at San Francisco and Berkeley
Charles W. Radcliffe

A report was completed on a revised below-knee socket with flexible liner below the tibial tubercle and a surrounding air chamber to support the distal soft tissue. A pilot course in this technique was held for Bay Area prosthetists. A conference at San Francisco is being planned for July, 1965, to consider the several new methods for fitting below-knee prostheses developed by various laboratories.

A manual on the UC-BL pneumatic swing control unit for above-knee prostheses is in press. Twenty prototype models have been delivered to permit independent testing, with wooden shanks and knees. Meanwhile progress is being made on a pylon-type prosthesis which may eventually also be tested with the pneumatic system. A similar design for a knee-disarticulation prosthesis is also being tested by one subject.

Revised pivot locations of the polycentric above-knee prosthesis have been developed from both graphical and computer studies. The goal was to retain full stump control during stance phase yet improve cosmetic appearance.

A new method of designing mechanisms to operate in three dimensions has been devised, arising from biomechanical studies of the hip joint and consideration of prosthetic and orthotic hip joints. This method may prove a substantial contribution to kinematic theory. Further work is continuing on the adjustable exoskeletal framework, or adjustable brace, for the entire lower extremity, to extend prior work at the ankle.

Considerable work was done on rotations of the spine during walking, flexion, and lateral bending. Muscular activity of the back, shoulder girdle, and arms during level walking also was studied. The implications for walking after loss of body symmetry (e.g., unilateral above-knee amputation) may eventually be related to complaints of low-back pain.

Veterans Administration Hospital, Seattle, Washington
Ernest M. Burgess, M.D.

Drs. Burgess and Romano and Mr. Traub visited Dr. Weiss in Poland, as well as a number of other European centers en route, to discuss immediate post-operative fitting. In recent months, approximately a case a week has been amputated and fitted immediately. Indications and methods for fitting are rapidly becoming clearer. The stumps in recent cases compared with conventional care, heal unusually fast, postoperative pain and discomfort are markedly reduced, and training proceeds very rapidly. A preliminary report was prepared in March, and a more thorough report is anticipated next autumn. A new prosthetics laboratory was opened in April.

The *ad hoc* committee appointed by the Committee on Prosthetics Research and Development met May 20, 1965, to review progress at a number of locations, based on reports gathered by Dr. Golbranson of the Navy Prosthetic Research Laboratory, using a standardized reporting format reviewed at an earlier meeting in January.

SENSORY AIDS

Fabrication of Obstacle Detectors for the Blind

Bionic Instruments, Inc., Bala Cynwyd, Pennsylvania
J. Malvern Benjamin, Jr.

The miniature hand-held non-ranging obstacle detector, described and pictured on pages 157-158 of BPR 10-2 Fall 1964, has been completed and successfully operated. It has served its purpose of providing this contractor with first-hand experience in the construction of operable, highly miniaturized optical detection systems. Also, it is small enough to fit within the cane shaft which is currently considered the best mounting position for such units.

Work is near completion on a cane-configured electronic aid for the blind. This unit comprises three beams for probing space in front of the user. One beam "looks" forward and upwards. When the cane is held approximately at a 30 deg. angle with the vertical (chosen as a representative carrying angle) the beam will detect overhanging objects approximately 6 feet high and 6 feet ahead.

A second beam projects straight ahead to serve as an obstacle detector. The receiving photodiode for this system is movable in image space with a user operated thumbwheel. This feature allows the user to control the outer range limit at which the unit picks up objects. It is thus adaptable to environments of varying degrees of clutter, and to the desires of a particular traveler. A new method employing null detection reduces the effects of apparent change in range caused by object texture variations.

The third beam points downward to a point on the ground 5-6 feet ahead to detect edges, drop-offs, and holes in the terrain.

At present, one stimulator will signal a response activation from any of the three beams. A pair of interrogation switches allow the user to tell which function(s) caused the stimulator operation. Further study and analysis are required prior to considering the installation of a more convenient "readout" system.

The Contractor also hopes in the near future, to make a few relatively simple modifications to an existing Model G-5 Obstacle Detector to provide it with an acoustic output which will convey ranging information by the pitch of the tone heard when an obstacle is present.

Research on Human Perception of Objects by Use of Pulsed Sound

Lockheed-California Co., Burbank, California
William W. Sutherland and John E. Parnell

Psychoacoustic data are being obtained with a number of blindfolded subjects regarding their capabilities to detect aurally the presence of an

object using several types of sounds. The following signal types are used for comparison by the subjects: (1) complex d.c. pulse, i.e., a click-like sound, (2) bursts of white noise, (3) continuous white noise, (4) discrete audio frequency tones. Equal optimum repetition rates are used with the gated white noise and the broadband d.c. pulse. The level of signal output is controlled by the experimenter and is used as the measure of subject threshold. The subjects orient the source paraboloid horn for maximum object echo return, and a standard audiometric technique is used to establish the signal level required for detection of the object.

Test results indicate that the continuous and gated white noise appear to be more effective for the detection task than the rectangular pulses. These results have been obtained in a quiet background. Tests will also be made in a noisy environment. The investigators feel that a pulsed signal will prove more effective in a noisy environment than the continuous white noise; although such noise was found to be effective in an anechoic environment.

Equipment has been assembled for producing a frequency modulated sound in the audible spectrum analogous to that of a bat. Comparisons of this frequency modulated pulse and the optimum broadband pulse in both a direct and remote binaural listening situation will be made.

Spelled-Speech for Automatic Readers Usable by the Blind

Metfessel Laboratories, Inc., Los Angeles, California
Milton Metfessel, Ph.D.

Work on the spelled-speech project has continued in five general areas:

1. *Alphabet development with the compatible spelled-speech approach.* In view of the varying playback conditions to be expected in home use of an automatic reader, it is important that the alphabet installed in the reader be capable of generating acceptable spelled-speech in a wide range of playback situations. A major undertaking has been alphabet development directed toward achieving letter sounds free from the playback restrictions of the alphabets previously constructed. Such letters (in addition to meeting previously used requirements with respect to intelligibility, rate coalescence, and melody) need to belong to the same universe of sounds, so that they do not contain minute and subtle differences that will be differentially affected by variations in playback conditions. The compatible spelled-speech approach to alphabet construction, introduced by Professor Metfessel in 1964, includes: (1) procedures for facilitating the production of letters that meet these requirements, and (2) procedures for checking the acceptability of letters.

Previous investigators have concluded that it was not feasible to synthesize natural-sounding speech by splicing together phonemes recorded on tape. However, results at this Laboratory with these procedures—in addi-

tion to their roles as objective tests of the acceptability of alphabet letter sounds—indicate that this conclusion was premature. Synthesis of speech from a single set of phonemes is beyond the scope of this project; but the findings suggest that the general procedures devised for alphabet development applied to working with phonemes offer promising leads to the solution of this problem. Furthermore, with respect to synthesis of speech by manipulation of non-vocal sound parameters, Metfessel Laboratories feel that the characteristics needed for producing natural-sounding speech must first be determined by work with phonemes actually spoken.

2. *Research with blind subjects.* In the fall of 1964, eight blind persons came to the Laboratories for a session designed primarily to provide information on whether the controls of the teaching machine were suitable for use by persons without sight. The eight participants were of varying age (college age through middle fifties), educational background, and length of time without sight. All had had some experience with braille. After initial instruction and demonstration, each manipulated the controls of the teaching machine model as he participated in an introductory training session in spelled-speech. Results revealed that these blind persons: (1) had no difficulty in working with the controls of the instrument; (2) showed rapid learning of the spelled-speech materials (and, incidentally were enthusiastic about the possibility of a reader with such output); and (3) responded generally in very similar fashion to that of sighted subjects used previously (confirming the idea that much preliminary work can be done effectively with sighted persons).

3. *Training series to explore the value of slower within-word rate in initial training.* Five of the Starks training tapes were duplicated at a reduced speed. These were used in a training series with eight sighted subjects. All used the slow tape in the first session and were given a choice of staying with the slow tapes or moving to a faster within-word rate in subsequent sessions. Four used the slow tapes throughout. They evidenced less difficulty with the material than had been the case with slow learners in previous series. By the final session, all the others had requested faster speed. They had no trouble in making the change and made good scores on the final tape. This exploratory study suggested that a set of longer alphabet sounds would be valuable for use in training slow learners.

4. *Modification of the Educo teaching machine* to make completely separate the playing of the training material and the recording of the training session.

5. *Study of initial rate of understanding material presented with auditory code of spelled-speech.* This study was designed to provide information on the baseline for training in spelled-speech. Sentences were prepared using the compatible spelled-speech alphabet which has been most exten-

sively checked. They were presented to 87 sighted subjects, at rates varying from 10 to 15 words per minute. Analysis of the results indicated that, by the end of the hour, the subjects were handling speeds of 10, 12, and 15 words per minute with only an occasional error. Training to understand material in the auditory code of spelled-speech clearly can start at a point reached with other codes only after weeks or months of training. Furthermore, tryout of different procedures for presenting materials in this study has suggested a new method for advancing trainees from slower to faster speeds in gradual steps with maximal reinforcement and minimal frustration at each step.

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

The principal aim of this work is the development of an audible output means for a high-performance reading machine for the blind. For high performance, the acoustic output must be speech of reasonably good quality. This implies a library installation, comparatively expensive machines, and distribution of recorded magnetic tapes. Machine and labor costs will, however, be offset in large part by high-speed production of the tapes.

There are three major problems to be solved in making a reading center of this kind available to the blind:

1. Development of suitable machinery for generating speech from input information about the sequences of letters on the printed page. This includes the task undertaken in the current contract and extends it somewhat to demonstration tests of an operating laboratory system. Teletypesetter tapes will be the input to this laboratory system.
2. Replacement of the teletypesetter tapes by a character recognition device capable of reading ordinary books, newspapers, and typescript. (Character recognition devices are coming into widespread use in business applications, though typical devices now read only a single typeface.)
3. Incorporation of the complete machine into a library environment and a demonstration test of its usefulness in providing "voice recordings" to blind users.

It seems that the best type of synthesized audible output for a reading machine for the blind will be what has been called *re-formed speech* since the individual words are from stored instructions based on real speech. Next best would be *compiled speech,* put together from voice recordings of single spoken words. The principal advantages of re-formed over compiled speech are that the former can have the intonation and duration of the words adjusted to give a more natural flow of rapid speech. There is the

further advantage that standard digital equipment, which is rapidly becoming available at moderate prices, meets all the instrumental requirements except for the final (comparatively simple) analog synthesizer. Compiled speech, while simpler in principle, would require large and expensive special purpose memories. (The Word Reading Machine constructed under a parallel VA contract is intended only for exploratory tests and would be too slow for use in a library installation.)

Preparations for making re-formed speech. Preparations include the design and construction of a formant-type synthesizer, its use with the Digital Spectrum Manipulator and the computer and disk file. Good progress has been made in the synthesizer. Most of the sound generating circuits and control circuits have been designed and built; moreover, attachment to the Digital Spectrum Manipulator seems straightforward. The formant generators have excellent characteristics and seem more than adequately stable.

Basic research on manipulating re-formed speech. A moderate amount of progress has been made on this task, too. One of the principal problems in manipulating the re-formed speech (as distinct from generating it in the first place) will be to control the relative durations of words (a) to improve phrasing and naturalness, and (b) to increase the overall speed if it turns out that this is what blind users prefer. A series of studies has been made on the rate at which varied speakers — judged to be medium, slow, and fast — produce their words and what parts of the speech utterance they manipulate in order to control the overall rate. The rates are affected not only by the individual style of the speaker but also by the grammatical structure of words, positions of words, number of words in the sentence, and the number and kinds of phonemes in syllables. For the same text, where many of these variables can be held constant, there are notable similarities between the performances of very rapid and very slow speakers. Slow speech is not, however, merely fast speech stretched uniformly in time. Some of the speech gestures and their resulting sounds are essentially invariant, so that all of the stretch must be taken up by other sounds and the intervening silences.

Output Characteristics and Construction of an Interim Word-Reading Machine

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

Regular evaluation tests by groups of blind listeners await completion of the Word-Reading Machine hardware and its control by the computer. Rapid progress is being made in putting the device into operation. The control functions for the WRM are to be exercised by the recently

acquired computer. This has had to await the inevitable shakedown of the computer itself and the training of staff in its use. Both of these have been largely accomplished. Connections between the WRM and the computer have been wired in, and programming the control functions will be comparatively straightforward. Transferring the recorded vocabulary from the cards on which it is now stored to the magnetic-tape Dictionary of the WRM has as yet to be completed and will be a laborious job.

It has not seemed either feasible or necessary to present the limited tests now available to blind subjects. At present, the sample outputs consist of relatively short passages of text, sentences of which have been laboriously compiled by manual wordcard retrieval and subsequent tape recordings. This method is too time consuming and error prone to be practical in extensive testing of the 7,000-plus word vocabulary, especially with handicapped subjects who are not immediately available to the laboratory location. There have, however, been numerous tests using sighted listeners. Their reactions have often been mild astonishment that the compiled speech is so comprehensible and inoffensive. Comparison with a demonstration at the IEEE meeting in March 1965 of the recorded word systems in use at the New York and American Stock Exchanges — in which systems a maximum of 125 words was stored — confirms the impression that the compiled speech recordings are highly satisfactory by that standard.

The Development and Evaluation of Optophone Devices for the Blind

Battelle Memorial Institute, Columbus, Ohio
Charles B. Shields

This contract is scheduled for termination at the close of Fiscal Year 1965. Ten Model D Optophones, several extra probes, and a 200-lesson training plan including taped and textual materials have been produced. Several groups have been trained by the developing contractor using his training program, and detailed results appear in a series of annual reports. During the last year of effort, most work has been in the area of photocell improvement.

A blind staff member at the Central Rehabilitation Section for Visually Impaired and Blinded Veterans, VA Hospital, Hines, Illinois, has also completed the Battelle training course locally, and reacts with enthusiasm to the device.

Training of a blind staff member of the VA NYRO continues on a volunteer basis, with the subject progressing similarly to the subjects trained at Battelle Memorial Institute. By April 1965, after completion of 60 lessons, nominally one hour each, plus some practice reading supplementary materials, the subject was able to read about 7 words per minute on the course's sixth reading test.

A more formalized evaluation of the VA-Battelle Optophone has commenced at ACRIBAR as reported elsewhere in these notes.

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

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

Work aimed at producing reading devices for the blind is going forward in several areas at Mauch Laboratories. Problems associated with procuring high quality, precision shaped, specialized photocell arrays in small quantities (for experimental use in prototype development) have led this Contractor into photocell research and development. A high vacuum evaporator has been successfully used to produce cadmium selenide photosensitive parts used for this project. These techniques are being mastered, and allow the Laboratories to produce a precision unit of controlled-quality CdSe laid down in an eight-cell linear array plus a thirteen cell recognition array, all in a half-inch circle. Multiple connecting leads, inter-cell insulation, and protective coatings further complicated this delicate work.

Design, construction, and testing of a large-size photocell array and the associated memory and recognition circuitry for the Mauch recognition reading machine continue. Initial work was done using photographic transparencies of the characters in fourteen different type faces, projecting images on the special array, five diameters larger than called for in the final design. Techniques were developed for logic circuit design to accommodate the multifont input involved. Current experiments use nine fonts from books, newspapers, and the typewriter.

The Colineator tracking aid, shown in Figure 4, page 140 of BPR 10-1 Spring 1964, has been improved through the addition of a line skew adjustment. By turning a small knurled wheel the user may now make a fine adjustment of the device so as to align his reading probe perfectly with a line of type. The transparent pressure platen or base of the instrument is now made of breakage-resistant "Plexiglas" rather than glass. Special non-skid coatings on both sides of this plate prevent slippage. The device may be used with single sheets and thin books on top, or thick books under the plate where a "through-the-glass" mode of operation is used.

Two additional Visotactor B prototypes have been completed. This unit, drawn across a line of print, produces a "single column" tactile "look," using eight stimulators, two to each of four fingertips of the right hand (see Figure 4, page 140, BPR 10-1, depicting a blind subject being trained in the use of the Visotactor). The optophone training texts developed at Battelle Memorial Institute are being used in this program. One two-hour

lesson per week is provided. A trainee reads the fifth test in the series at an average rate of four words per minute including line change time. This is about the same reading speed attained by an average optophone student at the same level in the training series. Current plans at the Laboratories call for consideration of the construction of a "multicolumn Visotactor" in which two or three columns of stimulators may be used to improve the tactile "image" delivered to the fingers.

A first prototype model "Visotoner" has been completed. Visotoner is Mauch Laboratories' name for miniaturized optophone which incorporates several unique design features first formulated for the Visotactors A and B. Like earlier optophones, the Visotoner contains a vertical column of narrow photocells to scan letters and the electronic circuits needed to generate a different audio frequency for each photocell while it is "seeing black."

The most notable feature of the Visotoner is its small size. Both the Visotoner and its rechargeable battery will easily fit into a coat pocket. The Visotoner and personal earphone weigh only 10 ounces. The nickel cadmium battery weighs 12 ounces and provides over three hours of Visotoner operation without requiring the user to locate a power outlet. The battery can be recharged hundreds of times. Due to battery operation, the Visotoner sound is free from hum and power line noise.

The Visotoner uses a variable magnification scheme which permits the user to select within the 330 deg. rotation of a single knob, the proper magnification for reading letters from 7 to 35 point size, a 5 to 1 range. The knob and the twelve clock positions (each 30 deg. of rotation) are marked by braille dots, enabling the user to set the probe for a familiar letter size without experimenting.

The photocell circuitry is such that fixed light values are used for triggering the tone generators. This feature, in conjunction with a single overall threshold adjustment, permits determination of reflectivity or gray scale values of an object. A blind person can, for instance, rapidly determine the green from the black side of a dollar bill, or he can use the probe to locate room lights or windows.

The Visotoner was designed to permit one hand operation to allow the other hand to position and hold the paper. Long guide rollers with excellent frictional characteristics help the probe stay on line. The user's thumb displaces the nearest roller axially facilitating changing from line to line. The Visotoner may also be used with the Colineator tracking device for long periods of reading.

The main improvement in the photocell array used in the Visotoner was produced by glass and metal encapsulation which fully protects the cells from the adverse effects of humidity. The improved stability makes individual threshold adjustments unnecessary.

The Visotoner electronic circuit was assembled in a "cordwood sand-

wich" which fits within the available space in the probe body. The circuit contains 38 silicon transistors, 63 resistors, 18 capacitors, and 12 diodes. Further reduction in size is possible but only with a considerable increase in the price of components. For this reason, readily available standard electronic components were used in the Visotoner. Because the electronics are located in the probe unit close to the photocell array, the cable from the probe to the battery and earphone is made from three very flexible wires twisted together in place of the stiff multiconductor shielded cable required if the circuit is located remotely. The battery connectors, earphone jack, and volume control are molded into a plug at the end of this cable.

This prototype Visotoner along with a Colineator tracking aid have been placed with the American Center for Research in Blindness and Rehabilitation [ACRIBAR], Newton, Massachusetts, for evaluation.

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

Three VA-Battelle Model "D" optophones and associated manual tracking aids have been placed with this Contractor to gather data in an impartial setting on performance attainable, usefulness, other capabilities, and limitations of these optophones. For a variety of reasons, the initial group of over six subjects has shrunk to only two. Performance has been similar to that achieved at Battelle Memorial Institute and at the VA Research and Development Division in New York. Sufficient progress in the 200-hour training course has not yet been made for insights, judgments, conclusions, or recommendations by the researchers. The two subjects averaged 4.8 words per minute and 3.1 words per minute respectively on Test 5 in the training series.

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

Ten of the ultrasonic aids for the blind designed by Professor Leslie Kay of Lanchester College of Technology and built in a pilot run of about 100 units by Ultra Electronics Limited, London, England, have been purchased by the VA for evaluation. ACRIBAR (see heading) has been selected as the evaluating agency for the VA.

The hand-held torch-like ultrasonic projector and receiver is about 7 in. long and weighs 10 oz. The separate battery is carried in a conventional

carrying case, slung over the shoulder. Inspiration for the unit was derived from the knowledge that certain blind bats "see" through use of a swept-frequency ultrasonic sonar-like biosystem. The Ultra units sweep 90 to 45 kc per second with a repetition rate of about 5 sweeps per second on short range (0-7 feet), and 2 sweeps per second on the long range (0-20 feet). Sound energy returned by reflection from objects in the "torch's" field is combined with energy in the unit to produce audible tones whose pitch gives an indication of range, and whose audio quality differs for different types of reflecting bodies. Lower pitch indicates a closer object, higher one, farther away.

The contractor is currently engaged in preparing his detailed project plans and in selecting his field of blind participating subjects.

Electroacoustic Characteristics of Hearing Aids

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

A sentence-intelligibility test as well as several other traditional measures of speech intelligibility were used to evaluate listener performance with three hearing aids differing substantially in physical characteristics. Results showed that only the sentence-intelligibility test data revealed meaningful differences among the aids. The rank ordering of aids was essentially equivalent for all the listeners, independent of the type or degree of their hearing loss. These results suggest weakness in the practice of individual hearing aid selection when based on differences in speech-intelligibility test scores. Details of this work may be found in:

Jerger, James, Speaks, Charles, and Malmquist, Carolyn, "Hearing Aid Performance and Hearing Aid Selection," Technical Report No. 5, Research Institute of the Houston Speech & Hearing Center, VA Contract V1005M-1239, 14 pp plus 9 Figs., May 1965.

Development of Test Procedures for Evaluation of Binaural Hearing Aids

Northwestern University, Evanston, Illinois
Raymond Carhart, Ph.D.

A replication of an experiment similar to that conducted in Sweden by Nordlund and Fritzell was done, but using English speech materials and subjects wearing hearing aids. Three major conclusions were drawn from this experiment. First, binaural superiority for aided speech discrimination does exist, but the magnitude of this superiority is such that one must conclude that the level of an individual's aided binaural efficiency is primarily determined by the listening efficiency which was achieved via the most advantageously positioned monaural hearing aid. Therefore, for most persons, the binaural hearing aid will be superior to a monaural

one mainly to the extent that it increases the probability that the auditor can monitor his acoustic surroundings via an advantageously positioned hearing aid. Second, the listening efficiency obtained by the wearer will be sharply decreased in the presence of extraneous background noise. This reduction in communicative efficiency is much greater than would be predicted on the basis of testing his performance with the hearing aid in quiet surroundings. Third, the experimental results indicated that the marked binaural superiority observed by Nordlund and Fritzell in a relatively difficult listening condition was not maintained under conditions simulating aided listening in a less taxing acoustic environment.

An improved version of the N. U. Auditory Test has also been developed. It has the same basic format as the earlier test in that speech discrimination materials (primary signal) as spoken by one talker are presented against a background of short sentences and questions (secondary signals) spoken by a a second talker.

The Effects of Distortion on Hearing-Aid Performance

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The distortion affecting hearing aid performance comprises intermodulation, harmonic, and transient distortion. Current investigations are pursuing the effects and interactions involving these distortions and their influences on the subjective evaluation of a hearing aid. Dissatisfied with customary measures of a wearer's performance with an aid, new measures are being sought by these investigators. The aim of the work is to provide additional selection criteria to be used when judging hearing aids as applied in VA audiological rehabilitation activities.