CONTROL AND COMMUNICATION DEVICES FOR THE SEVERELY DISABLED

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INTRODUCTION

Normal people have communicated and interacted with one another since mankind first began to evolve on this planet. Man's method of communication may be unique in the animal kingdom and studies in this area are much in vogue in laboratories all over the civilized world.

The functional loss of four limbs, compounded by the loss of the ability to speak, tragically closes the door to a life that was once limited only by the imagination. We are striving to reopen this door through research, development, and evaluation efforts. Devices are being developed that may help to replace some of the capabilities enjoyed by veterans prior to their injury or illness.

Through development we try to harness residual physical activities that can consistently and positively be demonstrated by patients. Such activity may be the gross movement of an arm, the head, a foot, or simply the blowing into or sipping from a straw. These activities may initiate a command to an electronic or electromechanical device, which in turn may be used to operate a variety of electrical appliances. Common appliances that have already been controlled in this fashion include lamps, radios, television sets, electric beds, and nurse calls (Fig. 1).

I. ENVIRONMENTAL CONTROL SYSTEMS

A. VAPC Hospital Model Enviromental Control System

The VAPC Hospital Model Environmental Control System (Fig. 2) is composed of an Actuator unit, a Monitor unit, and a Power and Control Section.

The Actuator incorporates two air switches interconnected through a single tube. It is sensitive to both positive and negative pressures

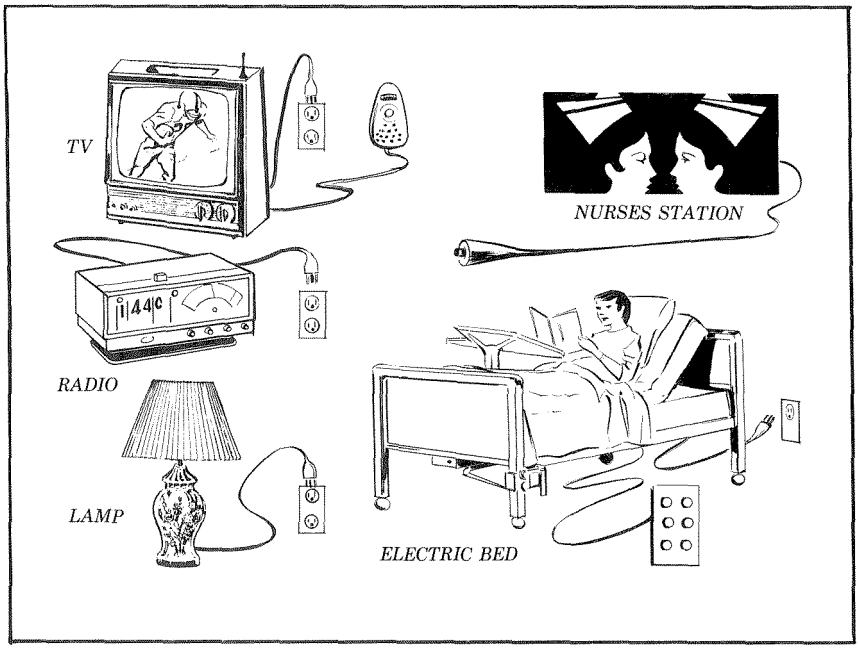

FIGURE 1. — Appliances that a typical non-handicapped patient may use.

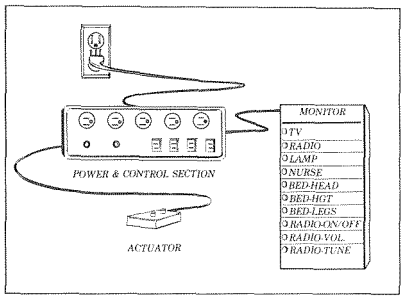

FIGURE 2. — A controller now used by paralyzed persons.

developed in the mouth. Two pushbutton switches in the Actuator may be operated by a hospital attendant or a patient who has adequate finger motion.

The Monitor indicates the appliance or control the patient is using at a particular moment. The Monitor is electrically connected to the Power and Control Section.

The Power and Control Section (Controller) houses the logic and power-transmission components. This section provides three types of electrical outlets that allow up to twelve different appliances or devices to be connected. Four conventional grounded 110V a.c. receptables, six low-volt-

age signal outlets, and two jacks which provide switching functions are available. Conventional electrical appliances can be operated by simply plugging them into the 110V a.c. receptables. With the main power switch on, the patient can control a plugged-in appliance by applying or removing full power to the receptacle associated with the particular appliance. For safety reasons the low-voltage outlets are used to control remote relays which in turn operate air conditioners, fans, electric beds, and other appliances that are not close to the Power and Control Section of the Environmental Control System. A major advantage of this arrangement is that 110V power is not transmitted over long distances through extension cords, thereby reducing fire and electrial-shock hazards.

The switching jacks are employed as an alternative to a pushbutton switch for the hospital nurse call, and to operate special televisions with motorized tuners.

Optional accessories are special interfaces to control the Simmons Electric Bed, and an emergency alarm.

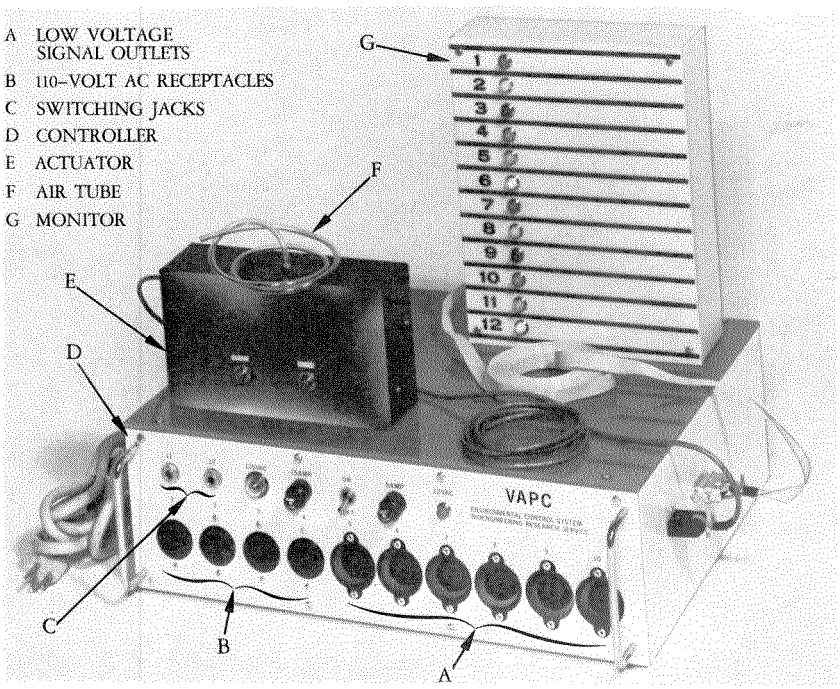

FIGURE 3. — VAPC Environmental Control.

By depressing the SELECT pushbutton on the Actuator or by sucking on the air tube, the user can make the VAPC Environmental control

sequence through 12 appliance-access channels (Fig. 3). Each time the patient sucks on the air tube or depresses the SELECT push-button, the environmental control "steps" to the following channel. When the desired channel is reached (as viewed on the Monitor), it may be activated or deactivated by blowing into the air tube or by pressing the ON-OFF pushbutton switch. Appliances remain in either the ON state or the OFF state while other channels are selected.

This control system may be placed either adjacent to the patient's bed or on a mobile cart with other appliances. Prescriptions for patients and the final location of appliances and the Controller are determined by the professional staff and by patients.

The VAPC Hospital Model Environmental Control may be utilized in the home for limited applications. The use of a telephone or intercom, for example, is precluded because the system lacks the proper switching outlets and emergency power.

B. VAPC Home Model Enviornmental Control System

Development of the VAPC Home Model Environmental Control (Fig 4) overcame some of the limitations for home use of the original system.

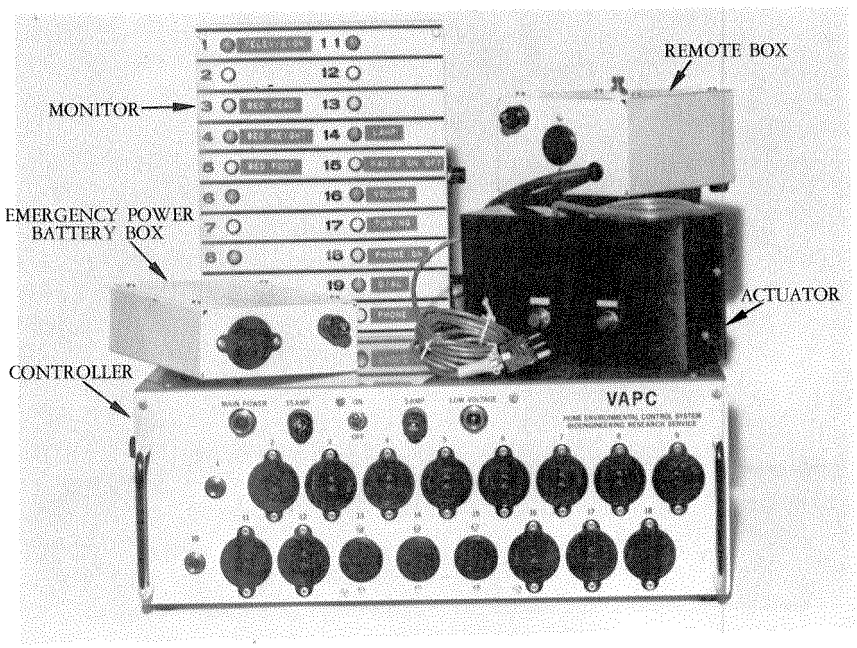

FIGURE 4. — Commercial VAPC Home Environmental Control.

The commercial VAPC Home Environmental Control is similar to the VAPC Hospital Model Environmental Control in many respects; this home-type system is essentially a larger (20 channel) version of the hospital unit. It consists of five basic sections: Actuator, Controller, Peripherals, Monitor, and Remote Box. It also includes an optional emergency-power battery box.

The Actuator is the same as that used in the hospital system. The Monitor, although larger, is similar to the hospital type. The Power and Control Section (Controller), with 20-channel capacity, is simply a larger version of the hospital type. The Remote Box allows other individuals living with the patient to operate appliances.

The Home Environmental Control System operates several other devices in addition to the appliances used with the hospital system. Specially adapted appliances for use with the home system include an automatic-dialing telephone, an intercom, and remote 115V a.c. power outlets. Currently being evaluated, but not yet available for general issue, are specially adapted area-surveillance systems, door openers, curtain openers, and similar devices. An emergency battery power supply, which is automatically activated during home power failures, is also available as an optional part of the system.

The VAPC Home Environmental Control System is available from General Teleoperators, Downey, California. There are certain specially adapted peripheral appliances that must be ordered with the system. Other appliances that simply plug into the Controller can be procured from other sources.

C. VAPC Remote Station Environmental Control

The state-of-the-art in environmental control systems has advanced with the recent development of the VAPC Remote Station Environmental Control. Figure 5 shows how the Actuator, Monitor, and Control Section are mounted on a powered wheelchair. Appliances to be controlled are connected to the receivers illustrated in Figure 6. One type of receiver controls 110V a.c. applicances; the other operates adapted appliances, such as a telephone or intercom.

Actuators for hard-wired environmental controls have traditionally been placed in fixed locations that require their users to be at fixed locations when operating appliances. Also, controlled appliances are traditionally wired to the Power and Control Section together with the Monitor, requiring most of the appliances to be in one room. But because the VAPC Remote Station Environmental Control uses a radio-frequency control link, the patient can be mobile, and can control appliances located in various rooms in his home.

The VAPC Remote Station Environmental Control is not yet commercially available.

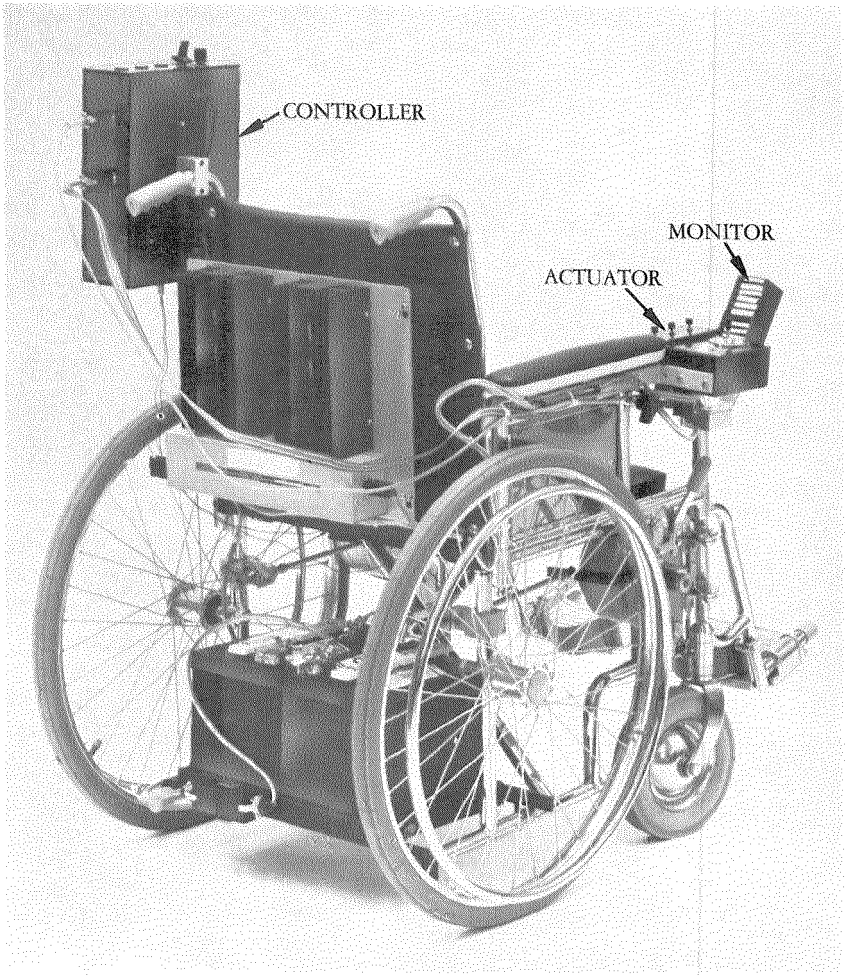

FIGURE 5.—VAPC Remote Station Environmental Control actuator, monitor and control section mounted on a wheelchair.

D. Scope Voice-Operated Typewriter and Environmental Control

Functionally paralyzed patients who are able to vocalize may find potential value in the Voice-Operated Typewriter and Environmental Control System (VOTECS) developed for VAPC by Scope Electronics, Inc. (Fig. 7). The system consists of six interconnected sections or units which permit voice activation of an environmental control system and electric typewriter. A 16-character buffer display is used to assist the operator during the training phase and also doubles as a text editor prior to typing.

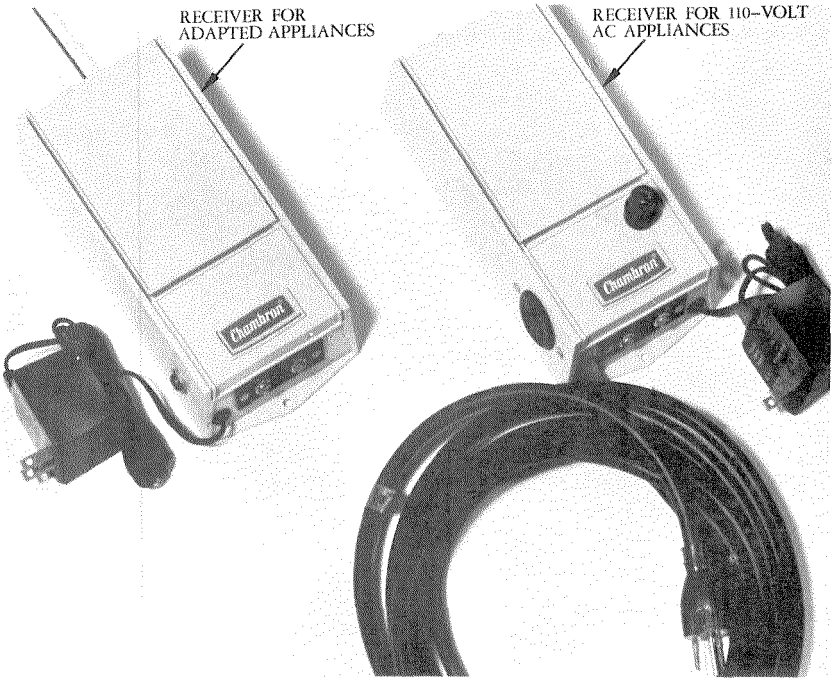

FIGURE 6. — VAPC Remote Station Environmental Control receivers.

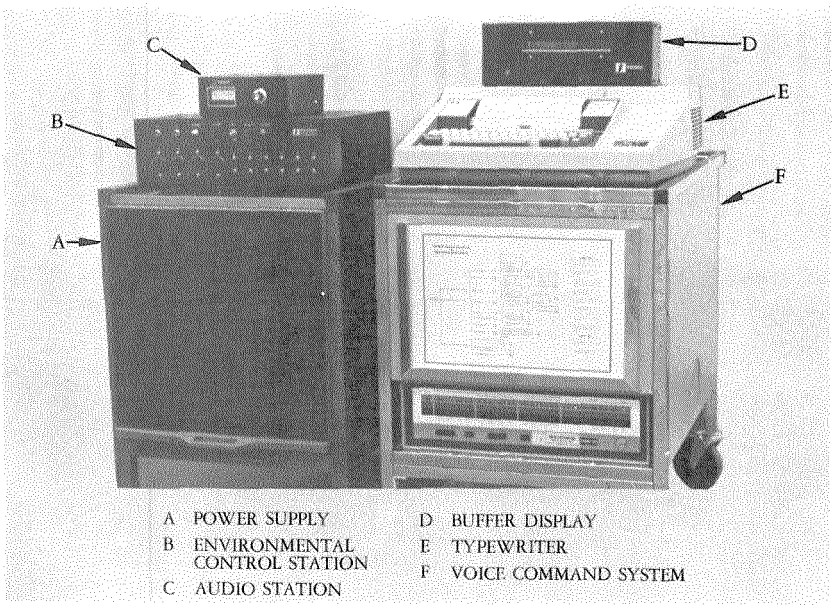

FIGURE 7. — Voice-Operated Typewriter and Environmental Control (VOTECS).

The six sections or units and their respective functions are as follows.

Voice Command System: Provides a training mode to accept the user's vocabulary. A command is typed on the typewriter via the control station and displayed on the buffer display.

Power Supply: Provides suitable electric power to operate the environmental control station, audio station, and buffer display.

Environmental Control Station: This section was designed to be a solid state counterpart of the VAPC Hospital Model Environmental Control which will accept the existing interfaced appliances. The environmental control station accepts signals from the voice command system; it is, in this respect, analogous to the typical breath or pushbutton actuator. The signals activate the various outlets in the environmental control station, directly eliminating channel-sequencing.

Typewriter: This section is the primary output of the VOTECS. All ordinary typing is controlled via the voice-command system and there is provision for typing out a limited number of frequently used words with a single voice command.

Buffer Display: This section facilitates training procedures and permits text editing for typing purposes. It also provides visual feedback to the operator for each spoken word.

Audio Station: This section is the conveyor for the user's spoken commands to the system. It incorporates an audio amplifier and a VU Meter for setting the amplifier level. At present, the system uses a directional and noise-cancelling microphone: ultimately it will incorporate an omnidirectional and wireless microphone. We anticipate that the wireless microphone will permit operation of the VOTECS from distances of up to 1000 ft from the audio section.

The Voice-Operated Typewriter and Environmental Control are not yet commercially available.

II. COMMUNICATION DEVICES

Communication devices currently under evaluation by the VA Prosthetics Center are either of the random access or the scanning type. Each has two subclasses: those that present gross messages and those that provide alphanumeric messages.

A random-access communicator is a device that will print out or display a character, message, or illustration without sequencing through other characters, messages, or illustrations. Scanning communicators operate in sequential modes.

Gross message communicators use phrases, sentences, or illustrations to communicate ideas or needs. Alphanumeric message communicators use individual characters of the alphabet and the digits 0 through 9. Alphanumeric messages may or may not include punctuation symbols.

Portability, how many motions per message, types of input switches,

available accessories, reliability, and service are also of concern in evaluating or comparing communicators.

A. VAPC Communicator

The VAPC Communicator is a scanning gross-message communicator (Fig. 8).

A grease pencil or a tape label machine can be used to place 11 messages on the Message Unit. To select the desired message, the patient sequentially scans the display lamps until the lamp associated with the desired message is illuminated. Sequencing speed can be adjusted by rotating the knob on the left side of the Message Unit.

The unit is portable; it contains rechargeable nickel-cadmium batteries and a charger with a timer to charge the batteries for a predetermined time. Actuators for the device include an adjustable pneumatic switch, a sensitive microswitch, and a magnetic switch.

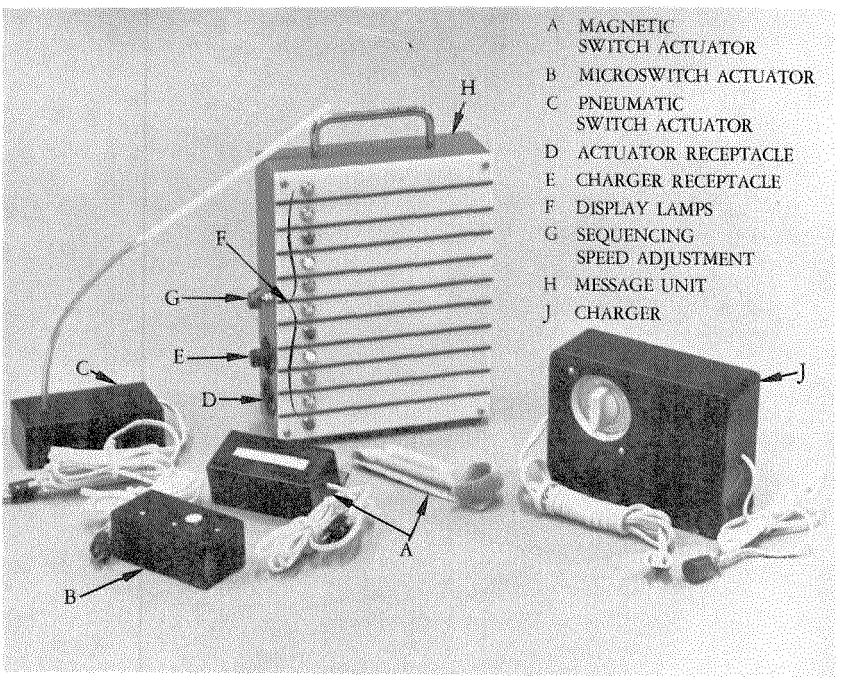

FIGURE 8. – VAPC Communicator (defined as a Scanning Gross Message Communicator).

B. PortaPrinter

The PortaPrinter (Fig. 9) can be considered a scanning alphanumeric communicator. The numerals from 0 through 9 and mathematical symbols are displayed on the small square to the right of the main message board.

Messages are printed out in "hard" copy. A scanning-speed dial allows the scanning rate to be adjusted. The device may be operated in either one of three microswitch modes.

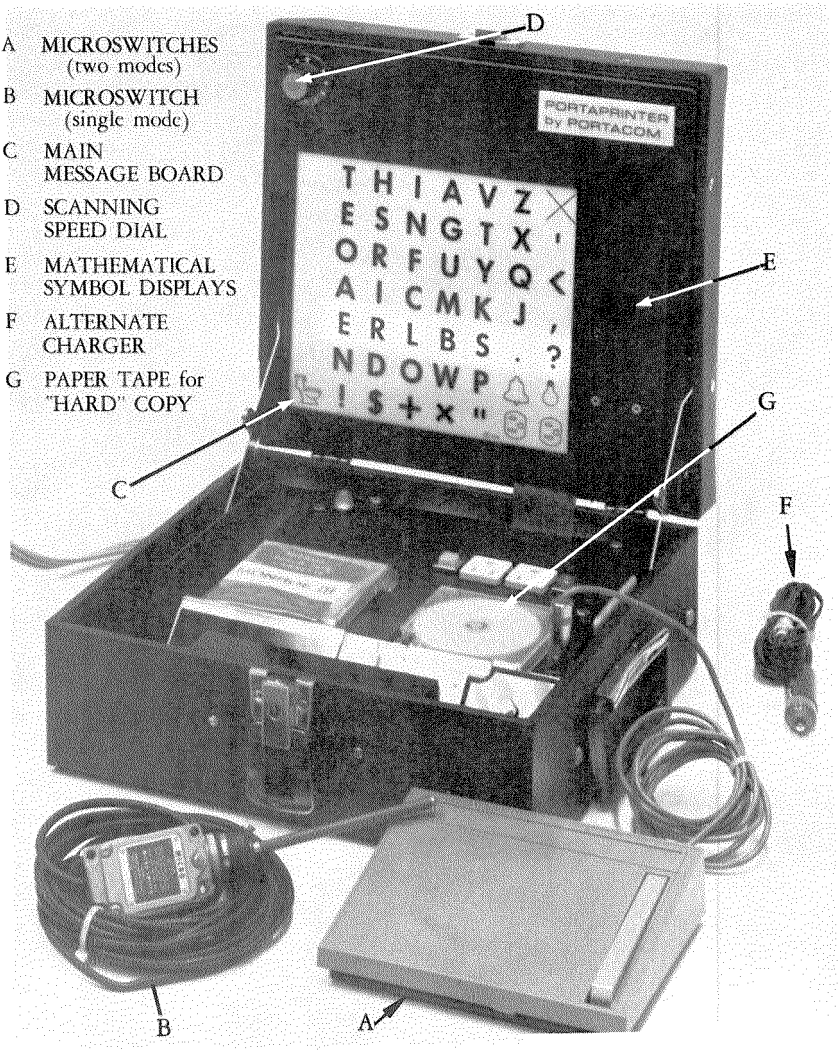

FIGURE 9.—PortaPrinter (defined as a Scanning Alphanumeric Communicator).

The message board displays all the letters in the alphabet, and the letters T, I, A, E, S, N, O, and R are repeated (Fig. 9). The manufacturer claims this repetition provides faster access to these commonly used letters and results in faster message speeds.

Selection of letters is achieved by first scanning down the rows and then across the columns until the desired letter or symbol is illuminated. Three distinct operations are required to print out a letter.

This device is currently undergoing evaluation at two hospitals.

C. Tufts Interactive Communicator

The Tufts Interactive Communicator (Fig. 10) is a scanning alphanumeric communicator. The bottom row allows the user to print out some short words or suffixes directly. Access to the letters or characters is similar to that of the PortaPrinter, but this device is not considered portable since it requires 110 V ac power. It has a scanning-speed dial. A "hard" copy is continuously printed in addition to a 32-character buffer display.

One unit is now undergoing evaluation at a hospital; two others will be deployed for evaluation shortly.

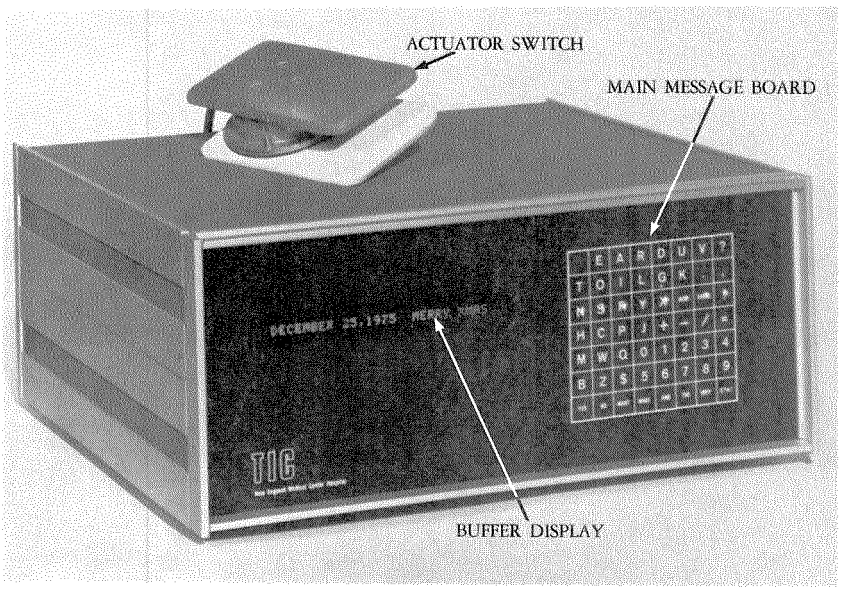

FIGURE 10.—Tufts Interactive Communicator (defined as a Scanning Alphanumeric Communicator).

D. Strip Printer

The Strip Printer (Fig. 11) is a scanning alphanumeric communicator similar in operation to the two units described above. It is portable and may be operated by tongue, pneumatic, or microswitch actuators. An environmental control, similar to the VAPC Hospital Model Environmental Control, can also be operated with this device.

Three Strip Printers will be evaluated in as many hospitals.

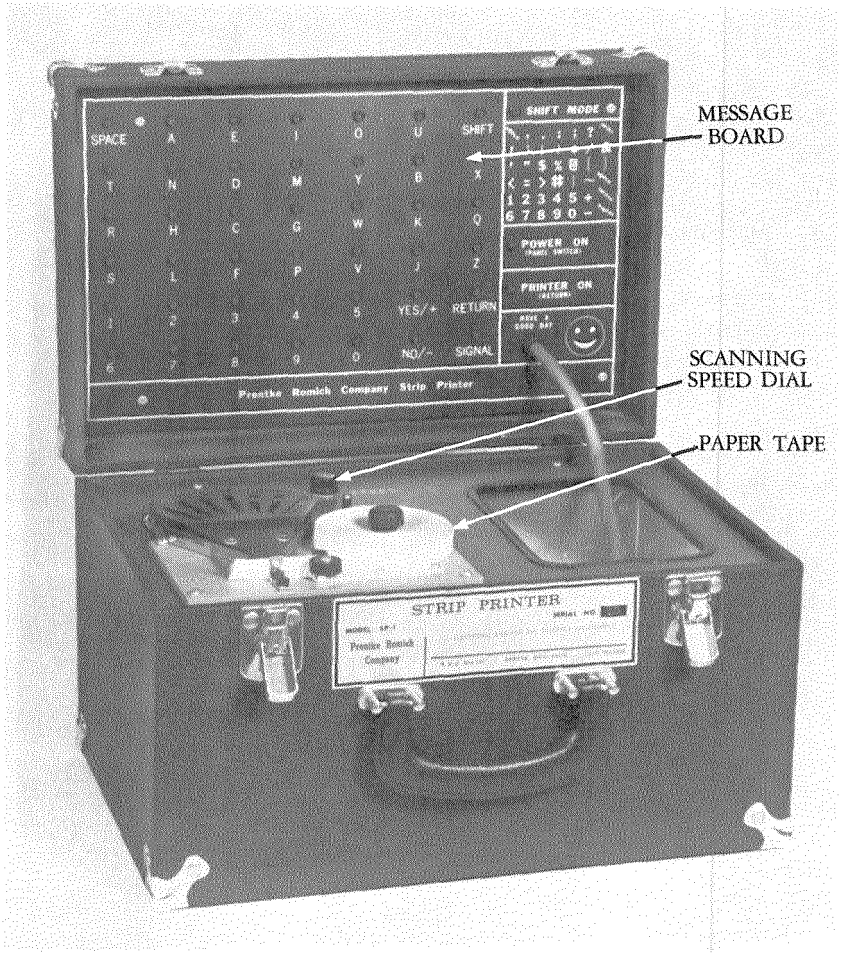

FIGURE 11.—Strip Printer (defined as a Scanning Alphanumeric Communicator).

E. Possum Typewriter

The Possum Typewriter is a random-access alphanumeric communicator (Fig. 12). It provides an alternate means for operating an electric typewriter, other than using the fingers, mouthstick, or other conventional aids. It permits operation of a typewriter through pneumatic or microswitch control via a coded input not unlike Morse Code. Each typewriter key has its own code and at the end of each coded signal a character is typed or some other operation occurs, such as backspace or carriage return.

This typewriter is being evaluated at three hospitals.

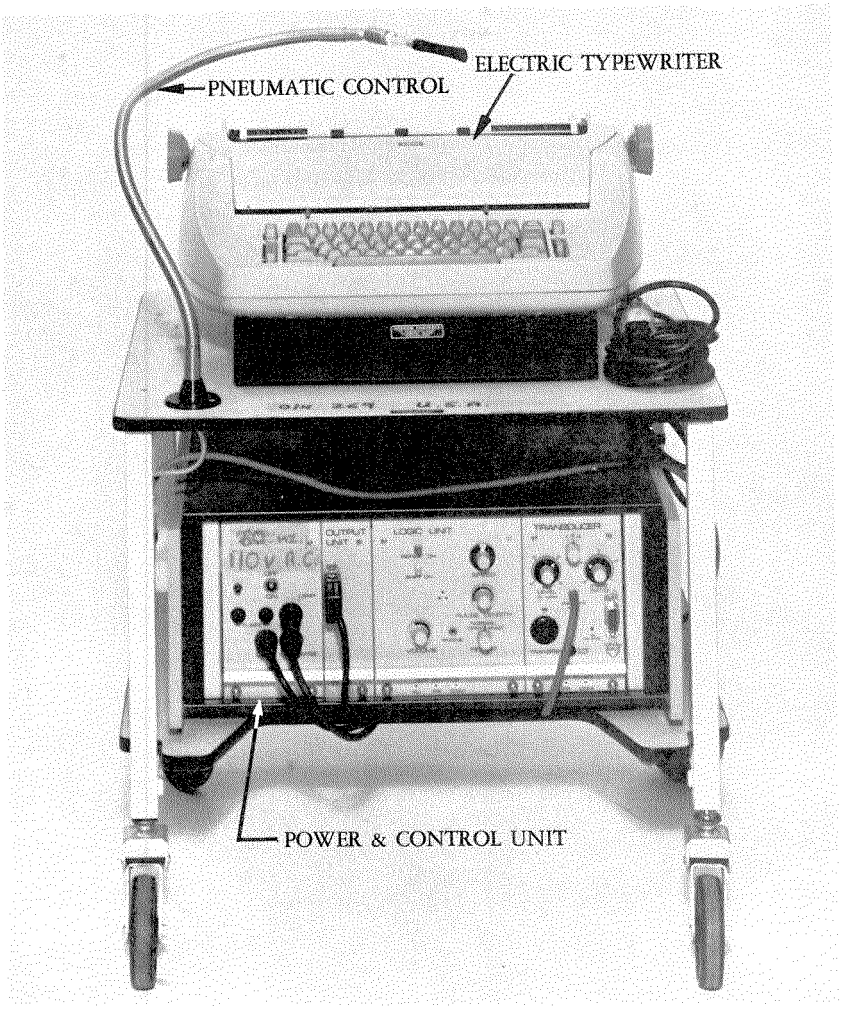

FIGURE 12. – Possum Typewriter (defined as a Random Access Alphanumeric Communicator).

CONCLUSION

The list of commercially available environmental controls and communication devices is growing rapidly. These systems represent the initial technological thrust developed by engineers to aid the physical rehabilitation community.

ACKNOWLEDGMENT

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