REPORTED ABROAD [a]

PHONO-ACOUSTIC CONTROL OF ORTHOPEDIC AIDS [b]
(Results of Research Sponsored by the Federal Ministry of Health, Germany)

Dr. G. G. Kuhn, S. Burger, and P. Gammer

Research Laboratory
Orthopedic University Clinic
Muenster, Germany

The use of control by muscle-action current has in the last years achieved encouraging results in several countries. Unfortunately, in these externally powered prostheses, control is possible only to the extent of the availability of proper muscles or muscle groups from which action potentials can be derived.

In spite of their highly developed controllability these prostheses, too, possess the same weaknesses as the present externally powered prostheses: They can only be controlled by auxiliary muscles.

In general, man is inclined—especially the interested layman—to overrate the extent of technical development, particularly in connection with externally powered prostheses. The essential difficulty is thereby often overlooked; it is—as it has always been—the adaptation of the prosthesis to the stump. Therefore, the real great task of orthopedic technique is to obtain a combination between technique and patient in such a way that the latter dominates.

As certain work material or technical construction parts have their own rules with regard to their processing and usability, so do externally powered constructions have equal demands on control.

Orthopedic technicians have always attempted to utilize all innovations in the field of technique. Acoustics is one branch of technique the possibilities of which until now have not been applied to prosthetic constructions. In utilizing auxiliary musculature for control purposes the patient is often overtaxed and considers the prosthesis a burden.

---

[a] Based chiefly on translations by Dr. Gabriel Rosenkranz, Medical Consultant to the VA Prosthetics Center.

[b] Translated from the October 1965 issue of Orthopadie-Technik and reprinted with permission.

At this point we direct our attention to the use of the ear and eyebrow musculature for control purposes (steering purposes).

To what extent acoustics can be considered as a physiological regulator is clearly demonstrated by the secretary when she works from dictation on her typewriter or by taking shorthand. She is "controlled" through the acoustic commands of the dictating person. To what degree of perfection this "control" can be developed, does not call for further explanation.

In the area of acoustics many experiences in various fields are available. To name only a few, we have speech instruction, audiometry, and singing instruction. The technique has produced special microphones that eliminate strong outside noises, and inconspicuous microphones that can be worn as a wrist watch or a fountain pen.

The first step in our experiments was the selection of a wheelchair. We equipped it with a phono-acoustic command apparatus of our own design. This apparatus makes it possible, by means of the voice over a larynx microphone, to control the wheelchair by turning it on, starting it to move, and moving it fast, slow, forward, or backward while controlling the steerage.

The first results were so encouraging that we decided to use this control method for further tasks in the orthopedic technique.

For artificial arms for bilateral amelias where the necessary control means are still lacking, new interesting possibilities are looming. Even the use of a typewriter with the aid of the voice becomes a distinct possibility. Thus, a silver lining is envisioned even for the severest disabled.

Description of the Wheelchair

Figure 1 shows an experimental model for children and juveniles. The frame is of tubular steel; measurements are as follows: wheel stand, 670 mm.; distance between wheels, 500 mm.

Two 20 × ½ in. wheels are arranged in front on a separate axis. Two 200 × 50 mm. casters, singularly placed, serve as passive steerage (Fig. 2).

Propulsion is achieved by two direct current 12-volt, 180 watt motors (Fig. 3). Each motor can be switched on forward or backward independently. The power source is a 12-volt lead storage battery with reinforced plates. The motor power is transmitted by means of polyamid friction rollers against the front wheels (Fig. 4).

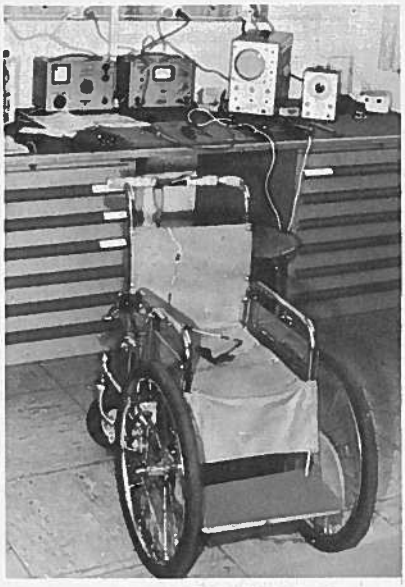

FIGURE 1

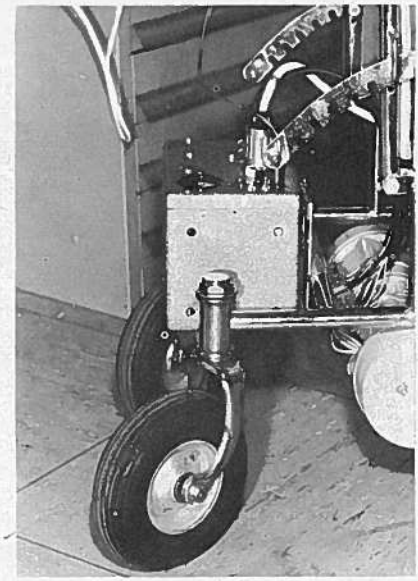

FIGURE 2.—Arrangement of rear wheels.

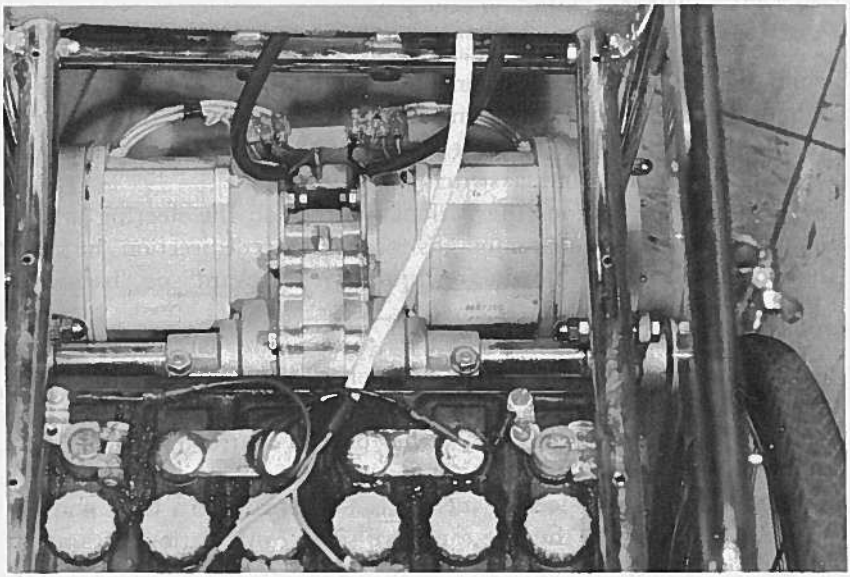

FIGURE 3.—Shown are motors with gearing mechanism and batteries.

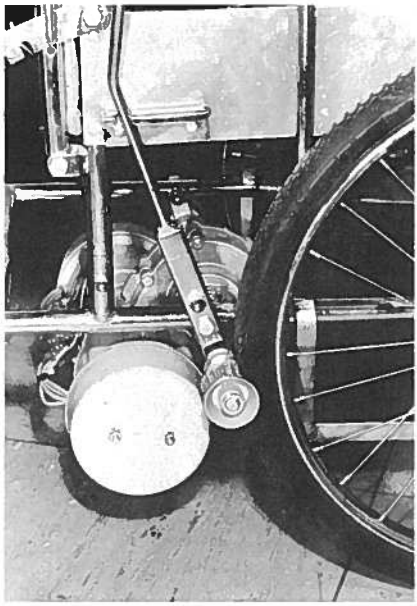

FIGURE 4.—A friction roller in position.

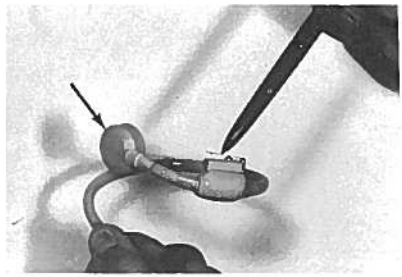

FIGURE 5.—Larynx microphone (arrow) with on-off switch.

Description of the Steering Mechanism

The steering of the wheelchair consists of a fully transistorized command-giving system. The command-giver consists of a larynx microphone (Fig. 5, arrow) with an on-off switching mechanism (Fig. 5, indicated by ball point pen). It also consists of an NF amplifier unit, frequency channels, and a switch relay (Fig. 6).

Through chin motions the patient switches on the steering mechanism. By means of sound commands for the desired direction, he directs the wheelchair to go "slowly" or "quickly," "forward" or "backward," "left" or "right."

The steering sound is transmitted through the larynx microphone to the amplifier. The frequency channel, which is connected with the amplifier, is tuned to an accurate tone frequency and, when in harmony with the steering tone, switches on the control relay for "movement" and "direction" (Fig. 7). When the patient arrives at a destination, he turns off the steering mechanism by means of a light nod with his chin (Fig. 8), and thus he can have some conversation without the system picking up any command from his conversation.

With practice and proper use of the larynx microphone, extraneous noises and the associated unintentional steering disturbances are avoided.

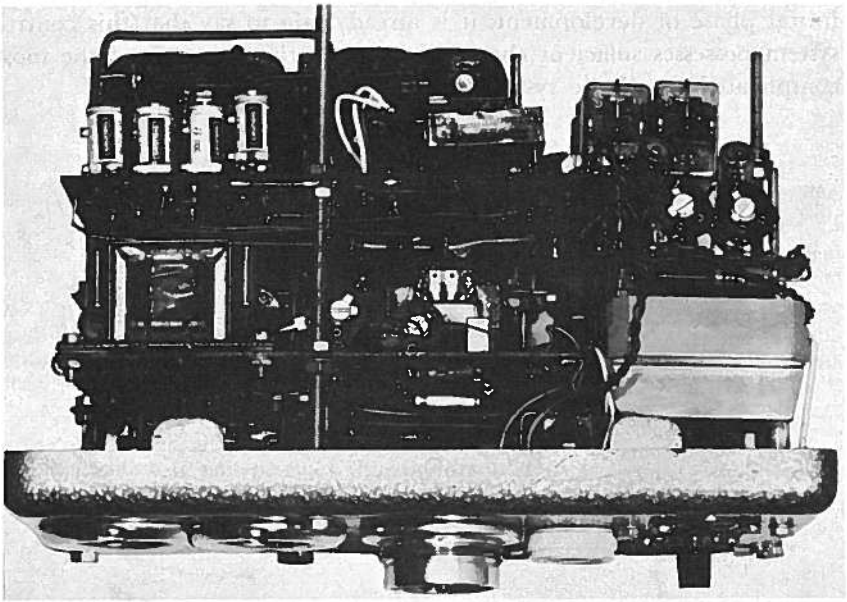

FIGURE 6.—Top view of steering mechanism.

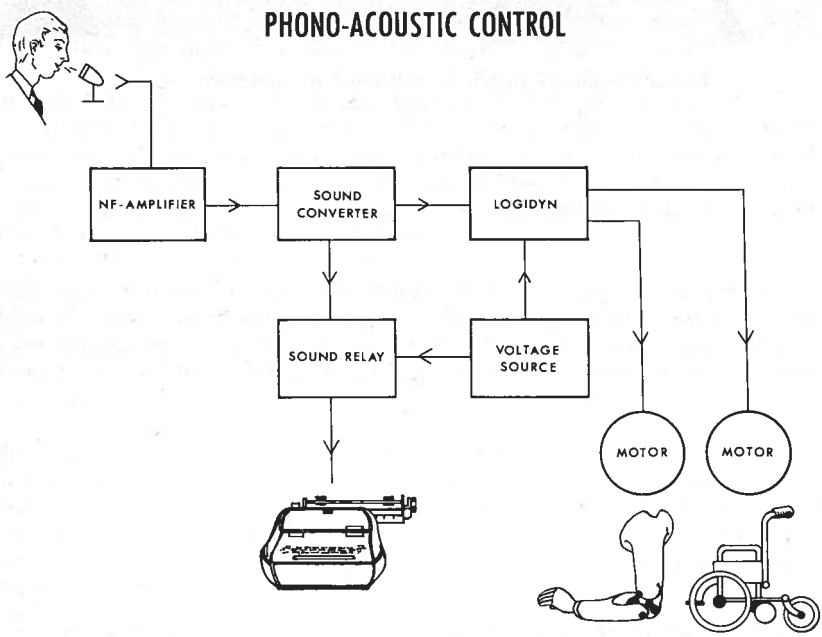

FIGURE 7.—Schematic of the phono-acoustic control.

Although we are aware that the phono-acoustic control is still in an initial phase of development, it is already safe to say that this control system possesses sufficient channels to satisfy the demands of the most complicated prosthetic systems.

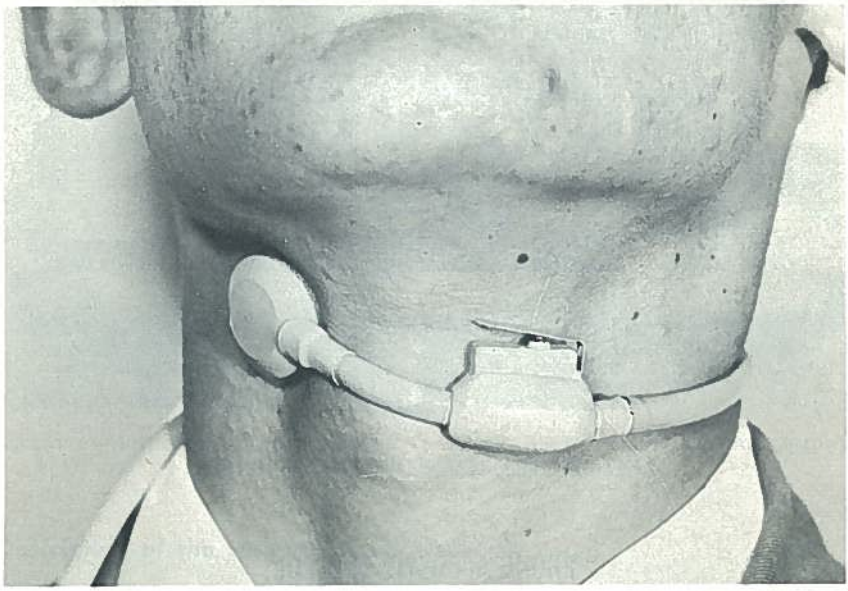

FIGURE 8.—On-off switch is controlled by movement of chin.