CHAPTER 14

TULANE UNIVERSITY

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The Bearchair

Designers: Charles Keller III, George S. Liu, Juan H. Sanchez
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INTRODUCTION

The prevention of several conditions, such as scoliosis and kyphosis, is critical to a child with cerebral palsy. The Bearchair precludes these, along with many other conditions including hip dislocation, knee contractures, and pelvic obliquity.

The chair is designed for children with cerebral palsy between the ages of 5 and 8, and it features an adjustable seat and therapeutic accessories (seat cushions, headrest, pommel, side support, armrests, harness), and a passive motion exercise. With these, the chair provides postural support and exercise for the lower extremities.

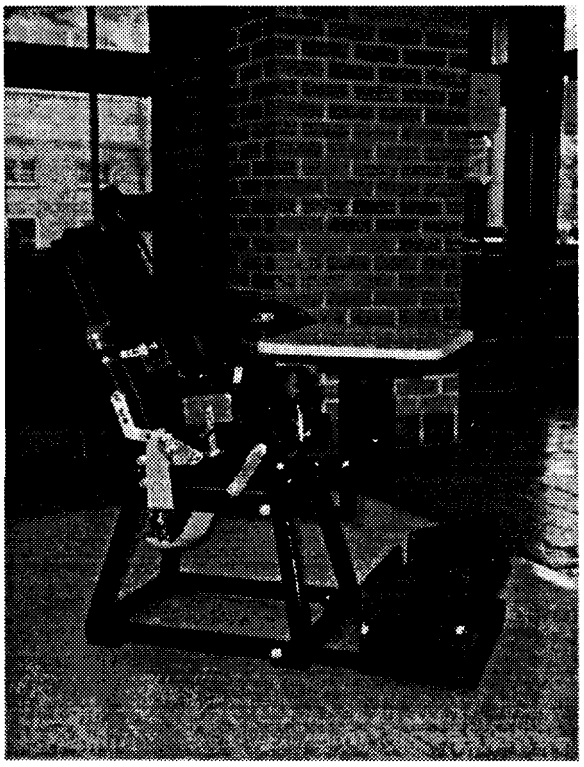

Fig. 1. The Bearchair (sideview)

SUMMARY OF IMPACT

The Bear-chair has been chosen for use at Children's Hospital in New Orleans, LA.

TECHNICAL DESCRIPTION

The main goal of our chair is to provide postural support and prevent the listed conditions in children with cerebral palsy. The criteria followed include:

anterior / posterior seat angulation
adjustable lumbar, thoracic, and head supports
sufficient belts and harnesses to insure safety
detachable tray
modularity for adaptability

The main components of the system include: the seat, accessories, base, play tray, and leg rest with passive motion device.

The seat consists of three slotted square frames that are connected by linkages through slots. (see figure 1) The bottom two frames make up the seat, and the top frame is the backrest. The frames are made of square steel tubing, with cushions of 1 inch thick foam covered with vinyl attached to 1/4" plywood. The slots in the frame allow adjustability for seat and hip angles. The seat angle is controlled by sliding the front linkage between the top seat frame and bottom seat frame forward along the slot in the lower seat frame. The hip angle is adjusted by tilting the back frame with respect to the upper seat frame. More features include adjustable seat depth and back height.

The accessories include: the headrest, pommel, side supports, armrests, and harness. The headrest is adjustable to allow for different head positions to improve functionality of the head and neck muscles. The pommel maintains abduction of the thighs, and is adjustable in abduction angle, depth, and height. The side supports keep the patient in the correct upright position. The armrests provide comfort for the arms, and rotate according to the back position.

The harness provides thoracic support and keeps the child from sliding forward.

The base provides support for the main seating component and a point of attachment for the play tray and leg rest/passive motion device. A simple box frame is used with the bottom base being larger than the top base to provide a low center of gravity. The frame is made out of 1 1/4" square section steel tubing. Rubber rests at each comer along the bottom to prevent sliding and absorb shock.

The play tray provides enjoyment during therapeutic seating and use of the upper extremities. It consists of a piece of particle board covered with washable vinyl. The play table is adjustable both vertically and horizontally.

The leg rest consists of a wooden frame that supports a platform that the feet rest on. The angle of the platform is adjustable, the platform also may be moved in or out to account for leg length. The passive motion device consists of a bicycle pedal system driven by a 1/20 horsepower motor by a 36:1 gear system. The client can control the motor that causes the pedals to rotate by a double pole throw switch that is attached to a 6 volt battery. The entire system rests on a platform that can be attached to the leg rest frame. The entire chair cost $200 to manufacture.

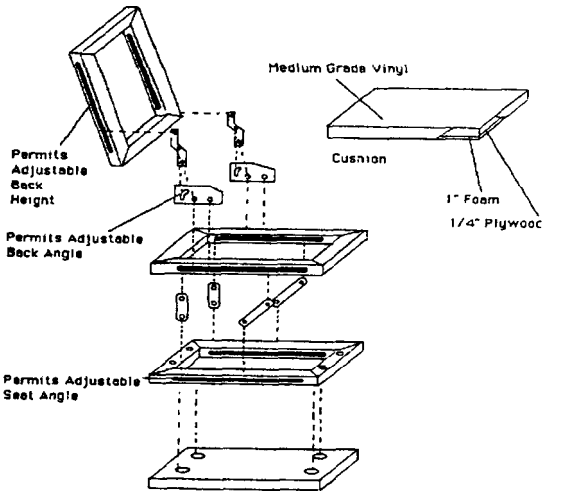

Fig. 2. Main Seating Component

The Tulane Hirider Chair

A Therapeutic Chair Equipped with Passive Standing
for Children with Cerebral Palsy
Designers: Jason Gee; Peggy Carlow;
Max Rangel; Susie Shimamoto
Supervising Professor: Ronald C. Anderson, Ph.D.
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INTRODUCTION

The daily task of sitting can produce many problems for children with cerebral palsy. These include: pelvic obliquity and other deformities and pressure sores. Currently, there are many chairs that provide postural support in a comfortable seating arrangement.

The Hirider Chair provides therapy for these problems in addition to one other feature. The Hirider lifts the child from a sitting to a standing position. The chair permits the child to be positioned at sitting and standing positions, as well as at any position between these two extremes.

Passive standing as a daily activity provides essential weight bearing for the cerebral palsied child's bones. This promotes bone growth and helps to prevent osteoporosis. Muscle contractures and spasms are reduced with regular stretching of the muscles by passive standing. Standing also reduces the occurrence of bowel and bladder infections, kidney stones, and pressure sores.

SUMMARY OF IMPACT

The Tulane Hirider Chair has been chosen for use at Children's Hospital in New Orleans.

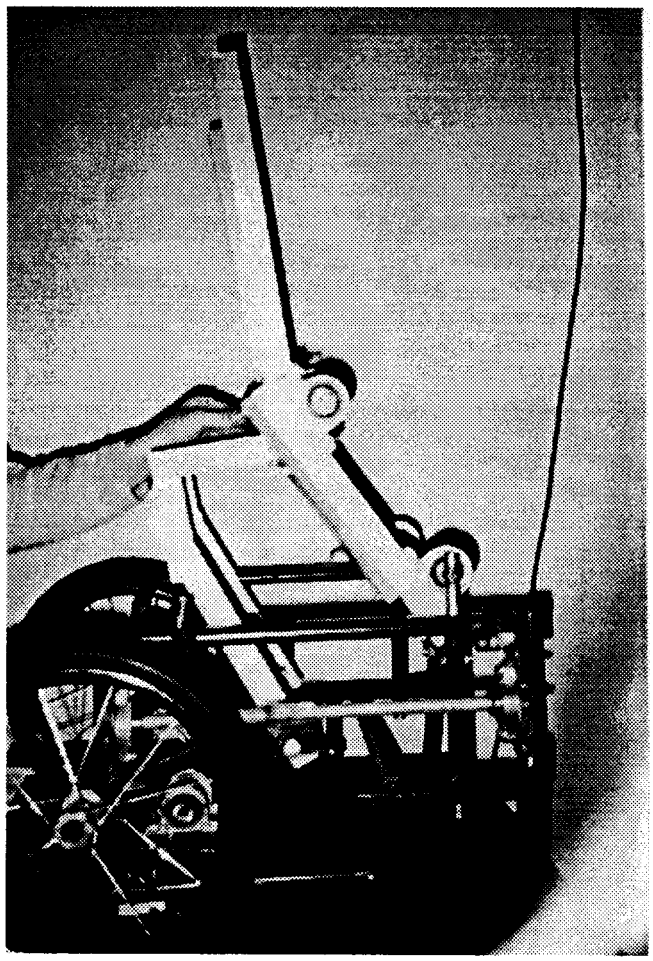

Fig. 1. The Tulane Hirider Chair (sideview)

TECHNICAL DESCRIPTION

In designing the Hirider, we adhered to the following criteria:

adjustability for growth
proper postural support
ease of positioning
portability
safety
functional mobility
economic feasibility
ease of maintenance

This chair consists of a stationary steel outer frame base and an inner frame that houses the seat and the back. These frames are made from used "Jaguar" wheelchair frames. The inner frame moves from sitting to standing position and is lifted by a Linak model 30.2 linear actuator, driven by a 12 volt battery, and controlled by an eight position joystick. It is attached to the back of the inner frame and is equipped with a brake to prevent slippage of the mechanism during the standing mode.

The inner frame is a four bar linkage system composed of 1 1/4" square aluminum 1/8" wall tubing. This linkage s essential for maintaining a vertical back orientation as the chair moves from sitting to standing position. The linkage member located under the seat on each side of the chair connects the back member to a 3/4" nut that turns on a 3/4" threaded rod. The threaded rods are rotated by two power screwdrivers, this rotation causes the nut to move forward or backward depending on the direction of rotation. The link follows the nut and moves the back support forward or backward relative to the seat. As a result of this motion, the back-to-seat angle may be adjusted.

The knee joints, where the inner frame is connected to the outer frame, each consist of a 1/2" bore standard mount ball bearing pillow block. The hip joints each consist of two pillow blocks, in which one is attached to the back and one is attached to the seat.

Other features of the chair include: adjustable footrests and legrests to allow for different knee and ankle lengths and exchangeable seating cushions which may be secured with Velcro strips. Restraining equipment includes a bar across the lower trunk area and an "H-strap". Other optional equipment may be added, such as additional restraints, a head positioner, and passive motion devices.

The cost of the Hirider chair is approximately five hundred dollars.

The P.P. Seating System

Designers: Antonio *Flores; Michael Hew; Daniel Larson;*
Marta L. Villaraga
Supervising Professor: Ronald C. Anderson, Ph.D.
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INTRODUCTION

The ability of children with cerebral palsy to support themselves in an upright position is critical to their future development. A seating device that provides such support with adequate comfort and that achieves the following would be beneficial for their therapy:

- development of normal postural tone
- improvement of the skills necessary for daily activities
- prevention of the development of contractures and deformities

The P.P. Seating System provides correct postural support in a comfortable upright position for a child with cerebral palsy. The entire seating system consists of 23 tubular frame components and 10 cushions that facilitate the comfortable positioning of the child. Features of the system include:

- detachable components depending on the client's requirement
- a play table that promotes functional activity of the upper extremities
- angled seating between the seat and back, range of motion from 75 degrees to 105 degrees, allowing 21 combinations
- size adaptable parts for any child between the ages of 3 and 10
- passive motion exercises, with three different ranges: 15, 30, 45 degrees for the knee joint

These various features of our system offer many therapeutic advantages mainly by providing an upright position during daily activities.

SUMMARY OF IMPACT

Judges chose the P.P. Seating System as the winning chair in a design competition held among senior design projects at Tulane University. The chair has been chosen for use at Children's Hospital.

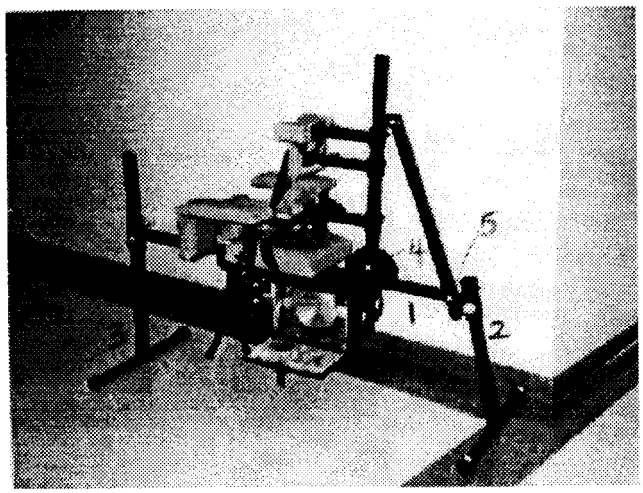

Fig. 1. P.P. Seating System (sideview)
1. Main Frame
2. Back Ground Support
3. front Ground Support
4. Back Column Hinge
5. Angled Back Bar Hinge

TECHNICAL DESCRIPTION

The three main goals in designing the P.P. Seating System were: size adjustability, modularity, and the promotion of correct posture for children with cerebral palsy.

The seating system consists of five main components: the main frame, the back support and its accessories, the front components (pommel/kneepad setup, the play table, and the armrests), the foot support and passive motion mechanism, and the patient-chair interface.

The chair is approximately 31 inches long, 17 inches wide and 35 inches high. The main frame is made out of square steel tubing and is composed of a long frame and a cross frame welded together. Two ground supports are fixed at each end. One of these supports is perpendicular with the main frame, and the other can be adjusted to allow the entire frame to tilt at 5, 10, or 15 degrees with respect to the ground.

The back column is attached to the main frame and is supported by an angled bar that has seven different attachments with the frame. These allow the back column to be positioned at seven different angles with respect to the frame. Three components slide on the column, the lumbar and side supports, the shoulder support, and the neck support. Each of these can be adjusted vertically and extended in or out via a sliding mechanism.

The front components consist of the pommel/knee pad setup that attaches to the main frame. This component also may serve as the front support for the play table. The armrests are width and height adjustable, and the table can be attached by replacing the armrests with interchangeable side brackets.

The length of the foot platform is adjustable, and this platform can be rigidly locked in a given position or it can be actuated as part of the passive motion mechanism to provide motion to the lower legs. This motion can be set for three different ranges of extension relative to their normal 90 degree orientation to the upper legs. The speed and range of this motion is controlled either at the control panel on the seating system or externally.

The patient-chair interfaces are made of foam and placed on wooden bases and are attached to the support frame via steel plates. All cushioning is covered by hospital approved material.

The cost of this chair was $481.85 excluding research and development and labor costs.

Spinal Extension Chair For Use In Cases of Myelomenigocele

Designers: Ronald Mosrie, Marta Villaraga
Therapist: Geralyn Griffin, LOTR, Children's Hospital
Supervising Professor: Ronald C. Anderson, Ph.D.
Department of Biomedical Engineering
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INTRODUCTION

Myelomenigocele is a spinal formation defect whereby the neural arches of the vertebra do not close properly. This can result in the protrusion or damage of the spinal cord, leading to severe neurologic problems. While this affliction can be catastrophic, in many instances it is possible to rehabilitate an affected child and return some degree of ambulatory freedom. Much of the therapy necessary to accomplish this is in postural exercise, where the extensor muscles of the lower spine and upper leg are required to maintain position. One way in which postural exercise can be achieved is to have the child sit with an anteriorly rotated pelvis. This position forces the spine into extension, and can be achieved with a seat that is tilted forward. The purpose of this project was to design and build such a chair so that the client can get the needed exercise during ordinary daily activities.

SUMMARY OF IMPACT

After an initial trial at Children's Hospital, the chair was returned to the Department of Biomedical Engineering for second generation design changes to account for the growth of the patient. The chair is now in possession of the patient who uses it daily both at home and at school, and she really enjoys the chair.

TECHNICAL DESCRIPTION

The chair was adjusted for the growth of the child. The seat consists of a broad foam-filled cushion tilted forward approximately 10 degrees. The chair back is intended to provide broad thoracolumbar support in an upright, lordotic position. Two encircling steel brackets, welded to the chassis, have foam-filled pads attached on either side to give adjunct lateral support. The chair back and seat are mounted on a welded chassis and attached to a base with casters so it can be easily moved from room to room. Steel brackets are welded to the chassis to which a clear acrylic tray can be clamped to provide a playing surface for the child during the time spent in the chair. Slotted steel uprights are welded to the chassis above the chair. This allows nylon straps to secure a plastic chest harness to prevent the client from falling forward as she tires. A modified automobile safety belt is included as well, to prevent the child from slipping out of the chair.

The approximate total cost of this chair was $200. We feel that this design is simple, easily manufactured, and above all, effective in providing postural therapy in a non-clinical environment.

The Bedside Server
A Bedside Table to Aid a Quadriplegic

Designer: Chad Coberly
Advisor: Ms. Carolyn Fiffere
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INTRODUCTION

Our client is a Quadriplegic with some motion of her left arm. She has a 10 inch reach and very limited strength. These restrict her access to objects placed on a bedside table.

The Bedside Server is an alteration of a standard nightstand with and added storage carousel in the cabinet. A sensitive switch activates a motor that turns the carousel to the desired position. This action makes objects such as books, writing instruments, and telephone directories easily accessible. The table also has a specific place for a tape recorder, tapes, a telephone, and a respirator. As a result of this space optimization, the client now has access to twice the number of objects previously available on a regular bedside table.

SUMMARY OF IMPACT

As of this writing, the table has been in use for 10 weeks and is working exceptionally well. The carousel greatly increases the space available to the client to store items within reach. Access to additional items is very convenient and timesaving for the client.

TECHNICAL DESCRIPTION

The Bedside Server was designed for a person with very limited mobility below the neck. Our client's specific needs were kept in mind for this particular design, but an adaptation of the table could be used by any disabled person.

The table was limited in size by strict dimensional measurements. The height of the table is divided into two levels, one 25 inches and the other 38 inches high (refer to figure). Length and width were restricted to 48"x22" due to the bed position. A specific place for fixed items within the reach of the client was also desired.

The product was to be simple and aesthetically pleasing. Other criteria, such as ease of cleaning and repairing were also considered. Several types of material storage modules were considered. These included such alternatives as bins on a movable vertical belt. Complex alternatives were rejected, and the mechanical and operational simplicity of a lazy susan was chosen.

The Bedside Server consists of a wood outer structure, similar to that of a normal nightstand, with two levels. The higher side of the table houses the carousel. The carousel is 21 inches in diameter and has six partitions. A 3/4 inch trim surrounds the entire turntable to keep items from falling out when it rotates. A 1/7 H.P., 120 volt AC motor powers the carousel, which is directly connected to the turntable. The motor is wired to a small 6 amp soft touch push button switch that is mounted over the carousel unit. This switch controls speed of rotation and prevents continual rotation. The right side of the cabinet has a tape holder which holds 15 tapes. The telephone and tape recorder sit on top of the cabinet, and the second shelf of the cabinet stores the respirator. A marine grade epoxy fastens the individual pieces together. The entire structure is painted with a pleasing brown semi-gloss.

The design is estimated to have a lifetime of at least five years, assuming proper use and care. The cost of the materials for the table totalled $95.

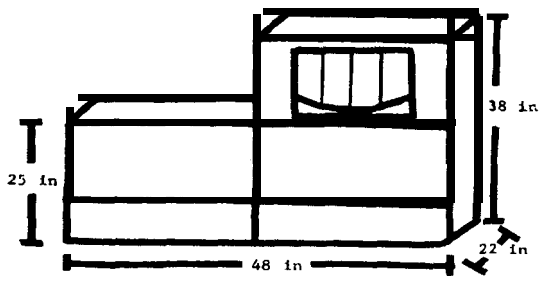

***Fig. 1. Bedside Server with outside* dimensions**

CAMPOD

Chair Arm Mounted Photographic Operation Device

Designer: Michael J. Voor
Supervising Professor: Dr. Ronald Anderson, Ph.D.
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INTRODUCTION

Photography can be difficult or impossible for a paraplegic person, even if that person has some arm movement. Lack of strength and dexterity makes it difficult to lift, aim, and steady a camera for quality photographs, as well as to change filters and film.

The CAMPOD makes photography much easier for these people. It attaches to the arm of the wheelchair and holds the camera in various positions. Springs counterbalance the camera weight and facilitate easy motion. Persons currently unable to enjoy photography should have little trouble taking quality photographs with the aid of this device.

SUMMARY OF IMPACT

The CAMPOD permits our client to use a camera independently.

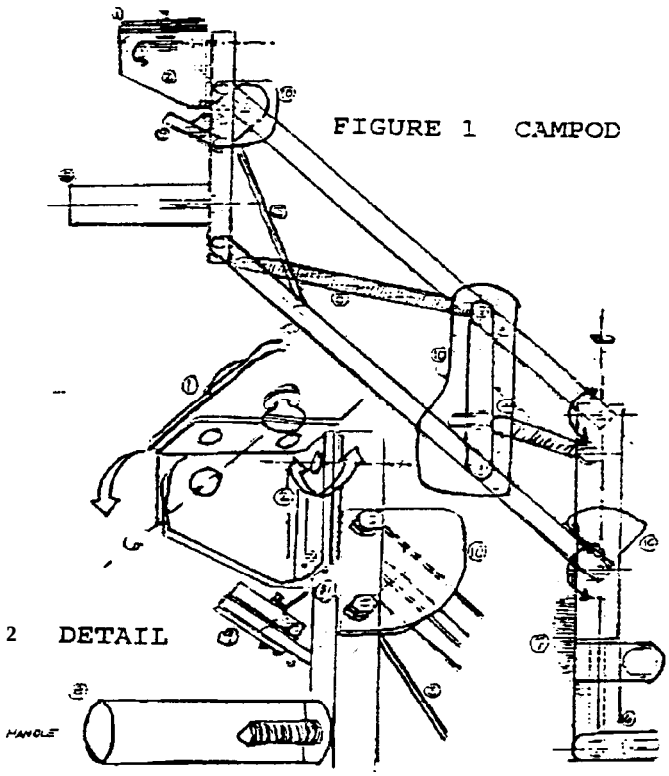

FIGURE 1 CAMPOD

1) CAMERA PLATFORM
2) SWIVEL BRACKET
3) SWIVEL CONTROL CORD
4) BISTABLE SUPPORT SPRING MECHANISM
5) LIFTING SPRING
6) MOUNTING BRACKET
7) ROTATION CONTROL SPRING
8) HANDLE
9) SWIVEL LOCK
10) SAFETY SHIELD

FIGURE 2 DETAIL

TECHNICAL DESCRIPTION

The CAMPOD's design permits controllable use of a camera for many disabled persons. The apparatus is easy to maneuver and hooks easily onto a wheelchair for easy accessibility.

A four bar mechanism allows for movement to either the "up" or the "down" position without change in orientation of the end piece. The camera is mounted on a small platform (1) that rotates in the frontal plane from either a horizontal or a vertical position. This platform and bracket (2) upon which it is mounted can swivel on a horizontal axis about +/-15 degrees. In the down position the freedom is greater (+/-90 degrees) to allow access to the film or the lens. This variance in freedom is accomplished by a cord (3) that runs from the bottom of the swiveling bracket through the upright arm and attaches to the lower of the horizontal arms. In the up position this cord is stretched tight and holds the bracket at a more upright angle. In the down position slack forms in the cord allowing the bracket's rotation to increase from +/-15 degrees to +/-90 degrees.

Two sliding springs (K-10 lb/in) on a fifth bar (4) provide the stability for this "up" or "down" position. Another spring (5) (K=2 lb/in) provides lifting support. The base is inserted by a rod into the mounting bracket (6) fixed to the arm of the chair. The entire mechanism can rotate in the horizontal plane toward or away for the user. A spring (7) fixes it to the mounting bracket and limits this rotation. The CAMPOD can be removed easily from the wheelchair by unhooking the spring and sliding the rod out of the mounting bracket.

The total cost of the CAMPOD, excluding labor costs was $20.

The Voice Activated Switch

Designer: Edgar W. Benavides
Supervisor: Bonnie Martin, MCD,CCC-SLP,Children's Hospital
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INTRODUCTION

Computer access is denied to those who cannot operate a keyboard. Some alternatives are available, but the usual switches present problems. Most require limb movements that quadriplegics lack. There are currently three types of switches designed for quadriplegics. They are:

The pneumatic switch(the puff and sip switch)
The pressure switch
The tongue switch

All suffer from susceptibility to false activation. The pneumatic switch is difficult to wash, and the tongue switch is slightly uncomfortable. The voice activated switch allows access to a computer with a simple vocalization.

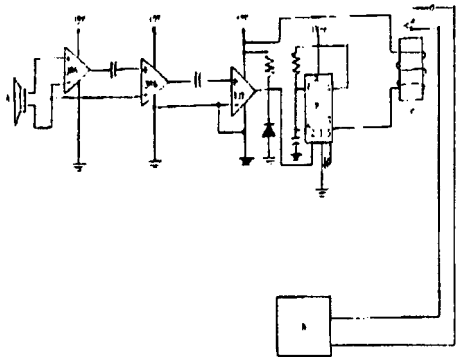

Fig. 1*. Schematic* ***of voice activated switch.***

The patient does not need to enunciate clearly, and it can be accessed by a faint whisper or a plosive exhalation. It is also more hygienic and easier to use than the switches mentioned above.

SUMMARY OF IMPACT

The voice activated switch was designed for use by a patient in the speech therapy department at Children's Hospital in New Orleans. Due to the critical condition of the patient the device has not been used.

TECHNICAL DESCRIPTION

Quadriplegics need an effective switch to activate the electronic communication devices. Children's Hospital uses two types of these devices: The Light Talker and the Adaptive Firmware Card. Both can be accessed by the same type of switch, and those currently in use were discussed above.

The voice activated switch consists of an 8 ohm magnetic speaker that receives the audio input of the patient. I chose the speaker over the microphone to avoid false activations caused by extraneous noise or breathing. Two audio amplifiers then amplify the signal received. This output is then sent to the input of a voltage comparator, which detects any signal not equal to zero volts and sends high output to the trigger of a 555 timer set up as a oneshot multivibrator. When this timer is triggered by the comparator it forces the output low for 0.5 seconds, which causes the SPDT relay to close. This relay activates either the Light Talker or the Adaptive Firmware Card.

A speaker clamp connects the speaker to the flexible gooseneck tubing that is mounted to the table or wheelchair by a C clamp.

The total cost of the materials in this device was $30.24. Two nine volt batteries are also needed. One for the voice activated switch, and the other for the mini-amplifier.