CHAPTER 10

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Single Switch Television Remote Control
A TV Controller For Use By Severely Disabled People

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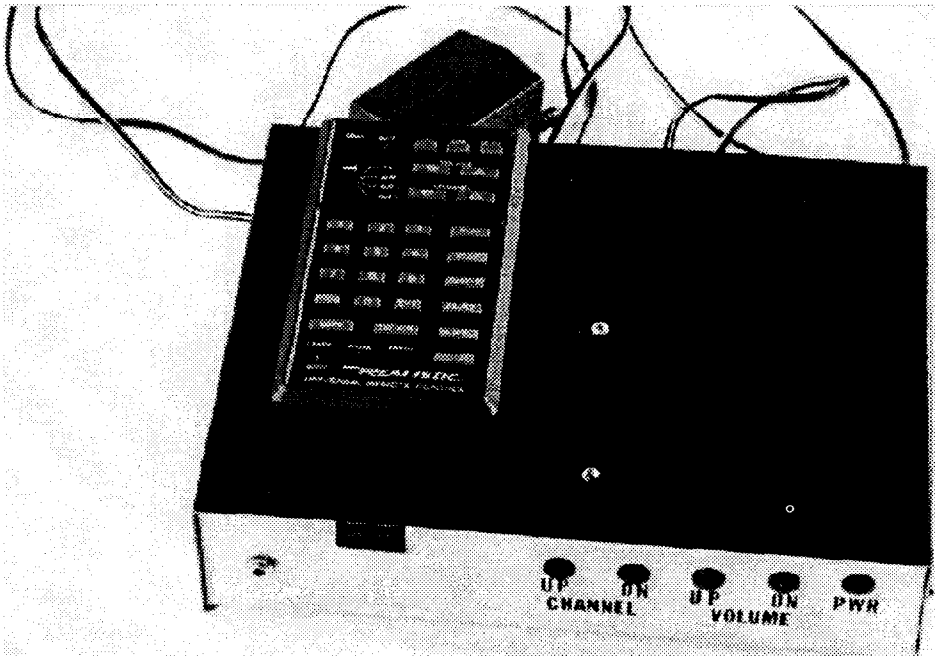
INTRODUCTION

The Single Switch Television Remote Control is a device designed for use by disabled persons who have the physical ability to operate a single switch. Persons who have limited manual dexterity can control the main functions of a remotely controlled television set with this single switch.

The device itself contains two major components. The first is a programmable universal remote control, and the second is the control circuitry that modifies the remote to be single switch compatible. The programmable universal remote control may be programmed by any infrared remote control allowing it to be used with other infrared controlled appliances such as a stereo or VCR. The remote itself is mounted in the top of the control box allowing full access to all functions by non-disabled users.

SUMMARY OF IMPACT

The Single Switch Television Remote Control is being used by an elderly woman who is restricted to bed and who cannot use her hands as a result of Multiple Sclerosis. The controller is interfaced to a pillow switch that she controls by moving her head slightly to one side. The system must operate at a very slow scan speed for her to control it but despite the slow speed she can once again exert control over the television receiver in her room without waiting for someone to come by to control it for her.



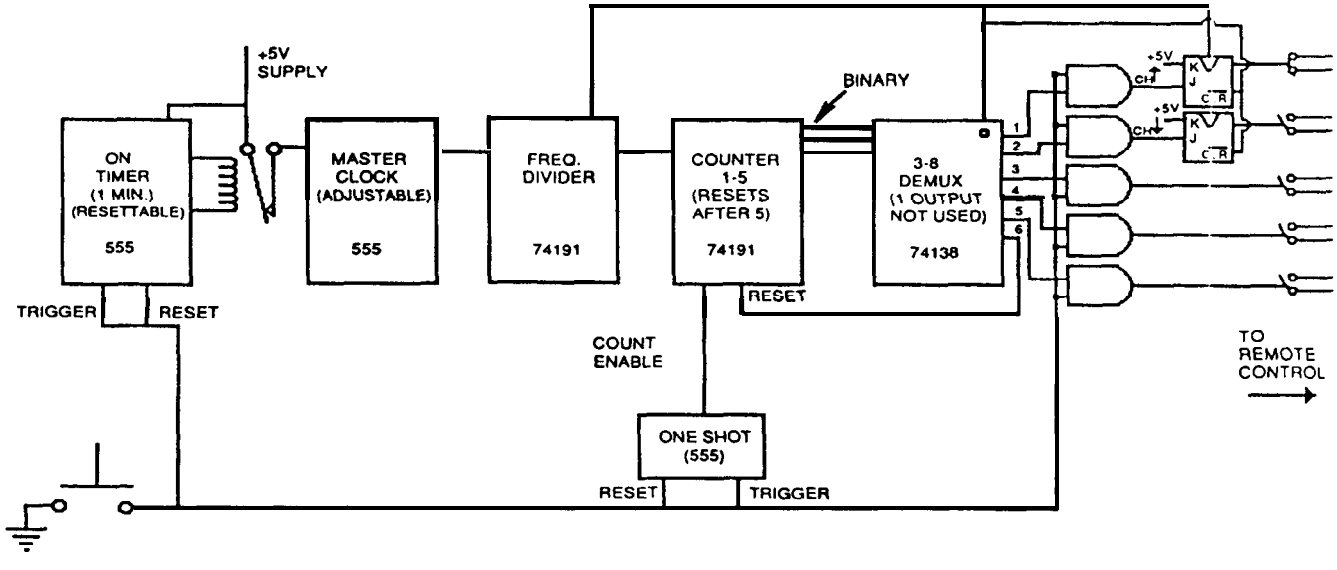
TECHNICAL DESCRIPTION

The system consists of a Radio Shack remote control (cat. #15-903) mounted in a 8" X 6" X 1.5" control box. This remote is controlled by custom circuitry within the control box. On the front panel are five indicator LEDs labeled channel up, one channel down, volume up, volume down, and power. Also on the front panel is a "learn window" to allow the remote to be programmed and a mini jack for connecting a single pole momentary contact switch. This switch is the only necessary user input once the remote is programmed. On the back panel is a fuse holder and the transmit window from where the infrared signal is emitted. The bottom panel has three holes access to adjustments for the circuitry. The circuitry contained within the control box begins with a 555 timer set up as a one shot. When the input button is first pushed, the one shot energizes a relay that powers the rest of the circuit. The time the circuit stays on is variable from 10 to 60 seconds. This time is adjusted by a potentiometer accessible as described above. After the elapsed time, the circuit shuts itself off until the next push of the button. Next comes the master clock that provides a square wave to the first of two 74191 counters. This counter is as a frequency divider to provide multiple frequency outputs. The slowest signal (the initial frequency divided by 16) is used to drive another 74191, this one configured to count from 1 to 6 and repeat. The counter is sent to a 74138 demultiplexer that produces 6 discrete outputs.

The first five output lines from the universal programmable infrared 74138 correspond to the five functions of the modified remote. The sixth output is used to reset the counter back to one. Each of the five function outputs is connected to both an indicator LED on the front panel and input of a NOR gate. If the user pushes the button, the second input of the NOR gate is enabled providing a high output.

Each NOR gate output is connected to a control line of a 4066 bilateral switch. When a NOR gate goes high, it closes the corresponding switch, which fires the remote control. In addition to firing the remote, pushing the button while the device is on resets the power-on one shot to insure the device does not shut off while the user is actively using it. The final function performed by pushing the button is firing another one shot which temporarily disables the counter, pausing the device on the selected function for a predetermined time. The length of this pause is adjustable through a hole in the box. This one shot is also reset by each push of the button.

While testing the prototype, it was observed that a built-in feature of some TVs is that after selecting a channel changing function for more than two seconds, they shift to a very rapid mode through channels. Because the device designed for disabled persons, this function was defeated by using a J-K flip-flop that toggles the channel change functions off and on. The finished system can be duplicated for about $250.



K.M.K. Wheelchair Maintenance Lift A Motorized Platform for Raising Defective Wheelchairs to Optimum Working Height

Designers: Brain D. Krafton, Karl Krueger and James Moore
Disabled Coordinator: Alan Ludivici, Mass. State Hospital School
Supervising Professors: Lester W. Coy and F yde yk E. Gorczyca
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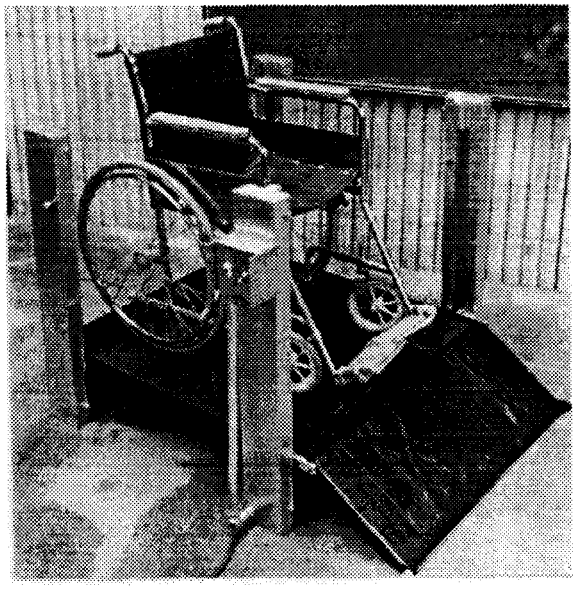
INTRODUCTION

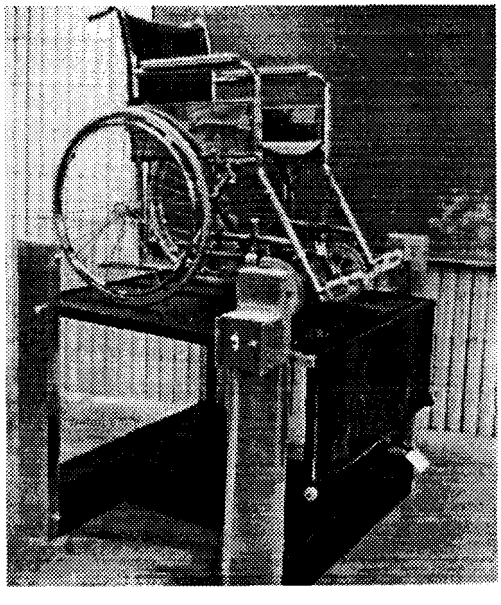
The K.M.K. Wheelchair Maintenance Lift is a powered platform designed to assist a person in repairing defective wheelchairs. Its purpose is to lift inoperative wheelchairs to a height that is comfortable for the mechanic, who is disabled. A provision is made so that the mechanic can get his wheelchair as close as possible to the platform that holds the broken chair. The wheelchair to be repaired is loaded onto the platform by pushing it up a short ramp. As the platform is raised, this ramp swings into a vertical position, where it is out of the way of the mechanic. To raise the platform, the power switch is turned on and the toggle switch is put in the "up" position. The platform will automatically stop when it reaches its maximum height. To lower the platform when the work is completed, the operator only has to put the toggle switch in the "down" position. The platform stops automatically at the floor. As the platform is lowered, the ramp returns to the loading and unloading position. The operator may stop the lift at any time by simply putting the toggle switch in the neutral position.

It was determined that the maximum weight of a fully-optioned wheelchair is approximately 225 pounds. The lift was designed for a maximum capacity of 250 pounds.

SUMMARY OF IMPACT

The wheelchair Maintenance Lift was designed and built to meet the specific needs of a disabled mechanic who repairs defective wheelchairs. Whereas some repairs are best made with the chair at ground level, most require that the chair being repaired be raised to work bench level. Until now this has meant that the mechanic had to be assisted by up to 4 individuals who would lift the defective chair to the work bench, sometimes return to reposition it and then return a second or third time to return it to the floor. Due to the lateness of finishing touches to the project it has not yet been placed in service. It should be in place following the mechanic's vacation and promises to be extremely useful in his work. The lift has been tested successfully under load in the lab.





TECHNICAL DESCRIPTION

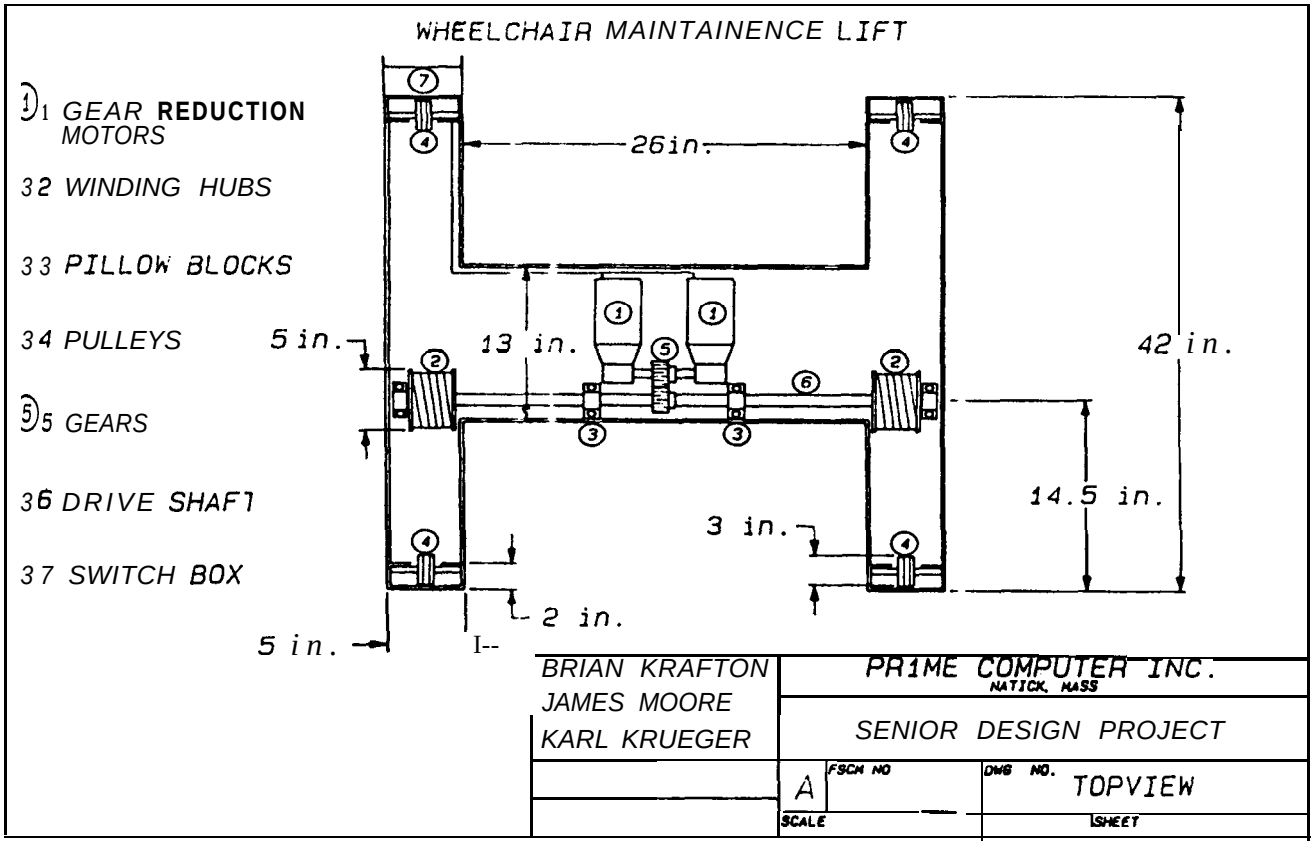
The basic design of the mechanism is an H-shaped base, with four vertical columns. Riding in the columns is a platform, with a loading ramp attached.

The power for the lifting operation is provided by two 115-volt AC/DC right-angle gearmotors. These motors produce a combined torque of 900 in-lbs. at a full load R.P.M.. of 2.9. The motors are geared to a driveshaft, with a cast-aluminum winding drum on each end. This shaft runs lengthwise through the base. The platform is raised by a cable and pulley mechanism. There is a pulley at the top and bottom of each column. The cable travels from the winding drum, around the pulley at the bottom, around the pulley at the top, and down to the platform. As the shaft rotates, the cable is collected on the winding drums, and the platform is raised. The lowering of the platform is accomplished by reversing the direction of the motors and unwinding the cable

The lift was designed to be semi-portable. Many of the components were made of aluminum to save weight. The columns, winding drums, blocks to mount the shaft, and pads for the base are all aluminum. The gears, base, cover, cable and shaft are made from mild steel. The platform is constructed from mild steel angle-iron, with a plywood decking. The plywood was used to reduce weight and cost.

The electrical system consists of a simple "on/off" switch for the main switch to control the direction of the platform. The four-pole, double-throw switch was necessary because both motors had to be started, stopped, and reversed at the same time. Limit switches were placed at the top and bottom of the platform travel to cut the power to the motors when the maximum and minimum heights are reached. The voltage at the limit switches is 12V, which is used to power a set of relays. This was done to reduce the chance of injury due to electrical shock. To prevent the motors from overloading they are individually fused. There is also a fuse in the input circuit for added protection.

For safety reasons, all the moving parts were enclosed. Safety pins are also provided to prevent the platform from falling when it is in the raised position. Total parts cost was $600.



The Yes - No Talker
A Portable Digitized Speech Reproducer

Designers: Janice M. *Coyne and Richard S. Rosa*
Disabled Coordinator: Ellen Breen
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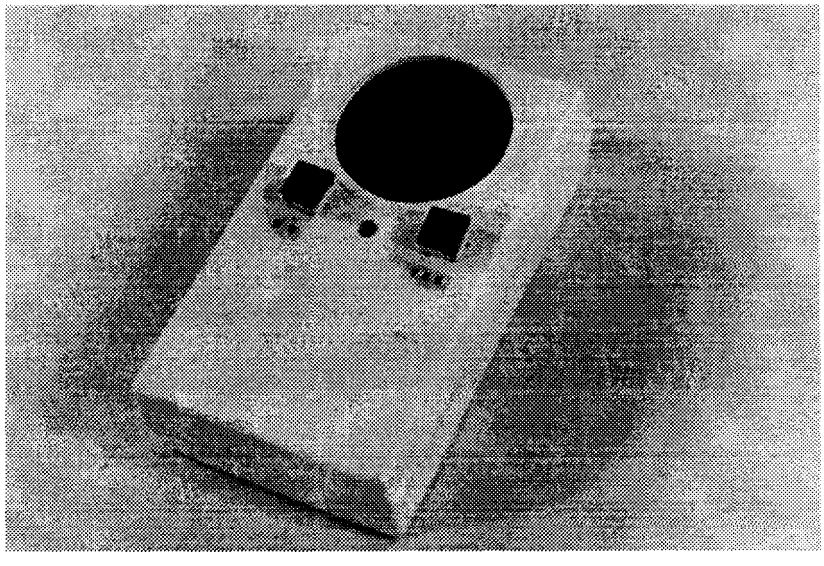
INTRODUCTION

The "Yes - No" Talker is a device that speaks "yes" when one button is pressed, and "no" when another is of pressed. It can be programmed to speak in any human voice: male, female or child. The Talker will be used as a training device by people who have lost the use of their voice or those who have never been able to speak. It can be used by the physically disabled as a first step in learning to use more advanced communication devices later in their rehabilitation.

This device is unique because it uses digitized human speech instead of synthesized speech. The digitized speech is stored in an EPROM that can easily be reprogrammed with a new voice to accommodate the needs of various users. The sound of a realistic voice coming from the device is intended to be more personal and appealing than a synthesized voice. The Talker is pocket-sized, slightly bigger than a pocket calculator. It is powered by a standard 9 volt battery for portability. External switch jacks been installed for versatility. This allows people who do not have control the movement of their hands to connect head switches or chin switches to the jacks to suit their needs. The device is only powered when a button is pressed making a power switch unnecessary.

SUMMARY OF IMPACT

The "Yes - No" Talker is in use by a pre-adolescent male who is non-vocal due to Cerebral Palsy. Because of his spasticity he has been previously unsuccessful in controlling alternate speech systems due to their requirement for fine motor control. With the "Yes No" Talker, the control switches can be located physically any distance apart thus ensuring that his responses are intended ones. This device will hopefully be a forerunner to a more sophisticated communications system as he gains physical dexterity by having the switches moved progressively closer together.



TECHNICAL DESCRIPTION

The box measures 5 1/4 x 3 1/4 x 15/8 (length, width, height). This is a convenient size because it can fit in almost any pocket. On the face of the box there are two single-pole, single-throw, momentary push button switches and a speaker grille.

Recording

Before the "Yes -No" Talker can be used, an EPROM must be programmed with the digital representation of human speech. A low impedance dynamic microphone was connected to a LM380 single-source Op-Amp. Once amplified, the signal was fed directly into a serial port of a Techmar Lab Tender signal processing board driven software was written in Turbo C. The signal processing board was installed in an IBM XT compatible computer. Speech was digitized at a sampling frequency of 8.89 KHZ set by a software routine. This produces approximately two 1 second words of speech using a 16 Kbyte EPROM. Once the speech is sampled and stored in the computer's RAM, it can be transferred to RAM in the EPROM programmer via a serial port.

The two push-buttons access two separate areas of memory on the 16 Kbyte CMOS EPROM. The switches are connected to a RS latch composed of NOR gates(7402). The RS latch output is used to select the 14th address line (#13) on the EPROM. This determines which half of memory is to be accessed and which word will be spoken.

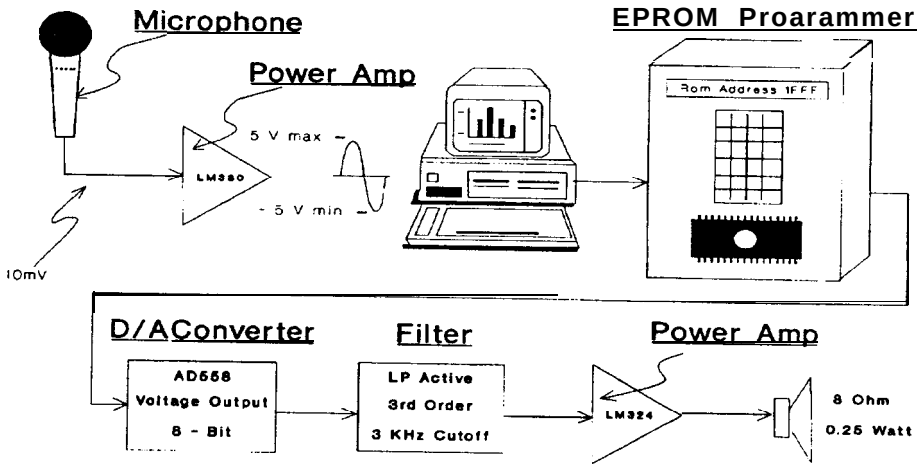
Playback

One side of a 556 dual timer was used for the system clock (8.89 KHZ), and the other side was used as a one-shot timer in the power-on circuit. When either button is pushed, power from the battery is sent to a reed relay. Using a feedback loop, the power is kept on for a period of time determined by the ON-time of the one-shot timer.

Four 4-bit counters are cascaded and used to access the EPROM's addresses. The counters (74HC393) are initially reset and receive their clock from the 556 timer. The outputs from the EPROM are connected to an AD558. The AD558 is an Analog Devices 5 volt, voltage output D\A converter. The output from the D\A converter is connected to the input of a 3rd order low pass active filter with a 3KHZ cutoff. This cutoff frequency was chosen because it allows speech to pass thru but eliminates the noise produced by the upper harmonics of the digitized signal. A single supply Op-Amp (LM324) was used in the filter.

The output from the filter is tied to the input of a power amplifier (LM388). This single source Op-Amp has a unity voltage gain but produces the power needed to drive the 8 ohm speaker.

The cost to produce the talker was approximately $100. These costs would be lower if the components were brought in quantity.



Active Stimulation Controller A Switch Training Aid

Designers: Luis Simoes and Nidal Bitar
Disabled Coordinator: Janet Labrecque
Supervising Professor: Professor Lester W. Coy
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INTRODUCTION

The Active Stimulation Controller(ACS) is a device to train and motivate physically disabled people to become proficient in the use of a switch. If the ASC is connected to a tape player, the disabled user will be able to control the playing of a tape by operating the switch at the appropriate time.

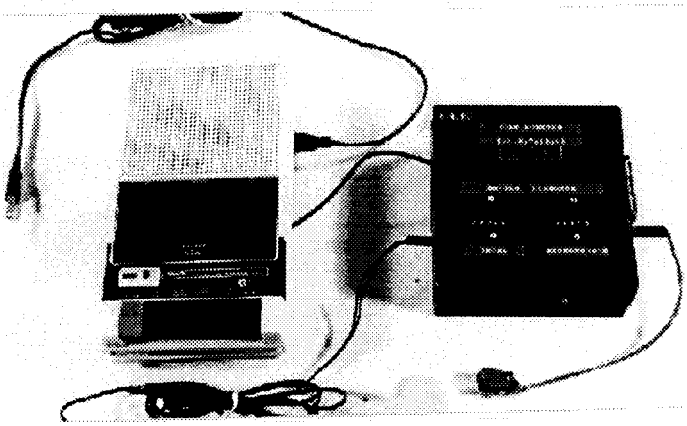
The ASC has two panel lamps (red and green), two counters (total and appropriate switch closures), an output jack to connect to the tape player and a jack for the user's switch. The object is for the user to operate the switch when the green lamp is ON and the red lamp is OFF. If the user is successful in pressing the control switch every time the green lamp is lit, the tape will continue to play. The user must not press the switch when the red light is lit (inappropriate switch closure) or the tape player will stop and stay off for 6 seconds.

The therapist uses the ASC to analyze the progress of a disabled person by comparing the total number of switch closures to the number of appropriate (or useful) closures displayed by the counters. Once the user can keep the tape player ON (non stop), the therapist may decrease the time the tape player remains ON for each appropriate switch closure. This makes the user press the switch more often to keep the tape player ON, thereby increasing the frequency of switch usage and ultimately improving the user's dexterity.

SUMMARY OF IMPACT

The Active Stimulation Controller is being tested for use by several multiply disabled youngsters who are residents of a state hospital. None of the users can independently communicate and none has displayed the physical or cognitive ability to effectively utilize a synthetic speech system.

The ACS will be presented to each child with a user-appropriate switch. It is hoped that one or two may have the physical and cognitive ability to succeed with this unit. If so, the objective will be to work toward providing them with a simple but effective scheme of independent communication.



TECHNICAL DESCRIPTION

The most important components in this system are two 5-bit counters, a green LED, a red LED, a potentiometer, **a** "switch' input jack, and a sub miniature phone plug output.

The output of the ASC can be connected to any equipment that has a remote input jack, such **as a** cassette player. Any momentary contact single pole, single throw switch can be connected to the ASC such as a handswitch, a head switch or even an eyebrow switch.

The "TOTAL" counter displays the total number of switch closures. The "APPROPRIATE"" counter displays only the total number of appropriate switch closures (the number of times the switch was pressed when the green LED was ON).

Timer 1 (U1) controls the remote(REM) and supplies one of the inputs to U5 (7432 OR gate). Timer 2 (U2) supplies the second input to U5 and when active disables Timer 1. When power is first applied to the circuit the output of both timers is low, pin 11 of U5 (OR gate) is low, the red LED is OFF and the green LED (through the 7474 inverter) is ON. This circuit has three basic states:

1. The green LED is ON and the REM is disabled.
2. The REM is enabled and the red LED is ON.
3. The REM has been enabled for a full duration without a switch closure.

State One:

The green LED is ON and pin 4 of U6 is high. When the switch is pressed, a transition from low to high occurs at pin 2 of U8 that produces a positive 35nS pulse at pin 6 of U9 (one shot). The pulse from U9 triggers a one second pulse at pin 3 of U4, which increments Counter T. At this state, pin 4 of U6 **(NAND** gate) is high (green LED is ON). Therefore the pulse from U9 generates a pulse at pin 6 of U6. The pulse from U6 performs two functions. First it generates a one second pulse from U3 that increments Counter A and secondly it triggers U1. Pin 3 of U1 enables the REM and drives pin 11 of U5 high, which turns the red LED ON and turns the green LED OFF. If the switch is pressed before Timer 1 runs out the circuit will enter state two, otherwise it will enter state three.

State Two:

REM is active, the red LED is ON and the switch is pressed. The 35ns pulse from U9 increments Counter T and passes through U7 (since pin 11 of U5 is high) to trigger U2 producing a six second pulse. While pin 3 of U2 is high the output is U1 is held low (disabling the REM) and the red LED is turned ON. After the output of U2 decays, the circuit returns to state one.

State Three:

U1 has remained high for a full duration without a switch closure. Pin 3 of U1 goes low disabling the REM, turning the red LED OFF and the green LED ON. The circuit returns to state one. The total system will cost about $110 to duplicate.

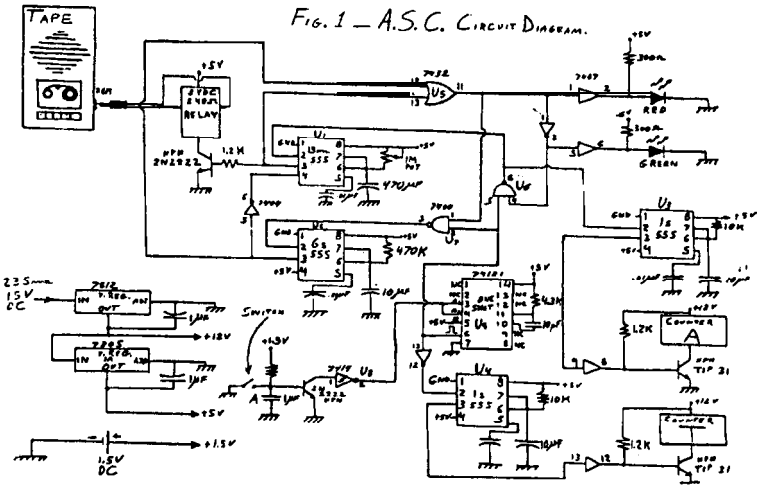


Fig. 1 — A.S.C. Circuit Diagram.

Single Switch Telephone Controller
A Device to Enable a Quadriplegic to Answer and Initiate Phone Calls

Designers: John F. Grady and George Teixeira
Disabled Coordinator: Thomas Riley
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INTRODUCTION

The Single Switch Telephone Controller was designed to enable a quadriplegic to use a telephone independently. Every function of the controller (dial, hang-up, answer) is selected by operating a single switch. The switch may be a sip switch, a head tilt switch or whatever is appropriate for the user. The display scans repetitively through the digits (O-9) and commands (clear, dial and hang-up). When a desired number is displayed and the switch is pressed, that number is stored in memory, and the display scans again. When the clear command is displayed, pressing the switch clears or erases the numbers from memory.

When the dial command is displayed, pressing the switch dials the number that is stored in memory, and turns on the external telephone, generally a speaker phone to allow for hands-free operation. When the conversation is finished, pressing the switch again hangs up the phone.

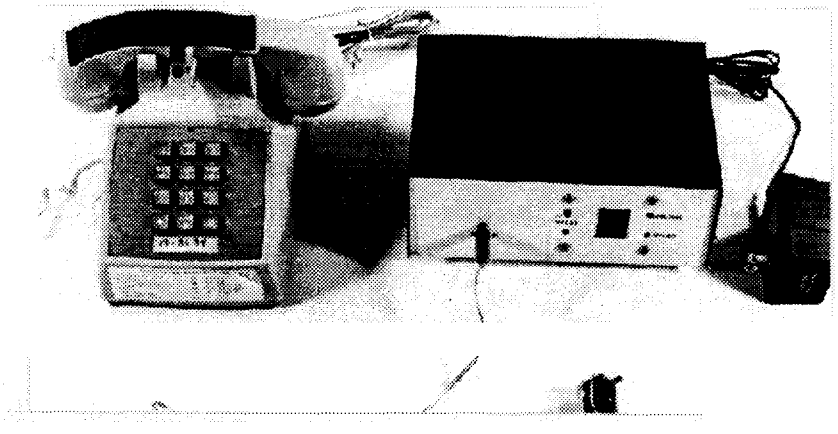
When the hang-up command is displayed, pressing the switch clears the number in memory, and turns the display off. Pressing the switch again turns the unit back on for use.

The user can answer incoming calls by pressing the switch when the phone is ringing. When the conversation is finished, pressing the switch again hangs up the phone.

The controller has three controls. The first varies the speed of the scan on the display. The second is the volume control for the ringer. The last varies the delay time between entries.

SUMMARY OF IMPACT

The single switch telephone Controller was designed to enable a woman who is paralyzed below the neck to answer and initiate phone calls. She operates the controller by a sip switch. She lives independently despite her disability due to a childhood bout with polio more than 30 years ago. The telephone controller will enable her to maintain her household more efficiently and to live more productively. She can confirm working schedules with her personal care attendants by phone and summon help when required.



TECHNICAL DESCRIPTION

The Telephone Controller has seven distinct sections: Counter, Memory, Data Selector, Display, Keyboard Interface, Telephone Section and Logic Control.

The Counter circuit generates a count sequence of 0-12 using a 555 timer. The timer uses a variable resistor to adjust the period of the clock from 0.4 to 7 seconds. The output of the counter is sent to Memory, Data Selector and to the Logic Control.

The Memory circuit stores digits of a phone number in consecutive addresses, or retrieves the number stored and sends it to the Data Selector depending on the signals from the Logic Control. A total of fifteen digits can be stored in memory.

The Data Selector circuit routes the counter and the Memory contents to the Display and the Keyboard Interface. The Display circuit sends the data from the Data Selector to a BCD to seven segment decoder. The decoder drives the 7 segment display that displays digits (O-9) and commands (clear, dial and hang-up). The Keyboard Interface converts data from the Data Selector into signals for the dialing circuit and Logic Control.

The signals from the Keyboard Interface are sent to a dialing circuit within the Telephone Section. When the dial command is activated, the relay closes; the dialing circuit holds the line OFF-HOOK and dials the number. When the Hang-up command is selected, the relay opens and the circuit is ON-HOOK.

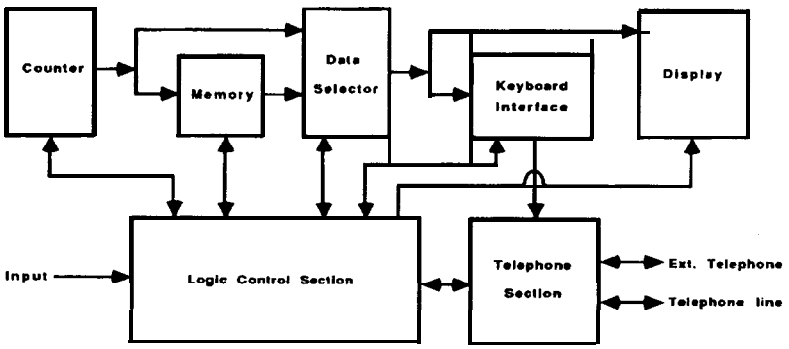
The Telephone Section also detects incoming calls. A ring detector is used and an audible ring alert is sounded.

The Logic Control Section controls the action of every other section. It processes the information from all the other sections and from the single switch input. The Count circuit is reset when the counter reaches 13. It also halts the count when data is being stored or when the controller is in the OFF mode.

The Logic Control resets the memory address, sends a write signal to memory and increments the address depending on the signals it receives. It also selects either the counter or Memory contents for the Data Selector, turns the Display ON and disables the Keyboard Interface.

The Logic Control Section controls data in the Telephone Section, it turns on the relays, controls the data going to the dialing circuit and turns ON the external telephone. When the ring alert is sounded and the switch is activated, it turns ON the external telephone.

The Single Switch Phone Controller can be built for approximately $190, not including the control switch and the external telephone.



Computerized Active Stimulation System (CASS) A Positive Reinforcement Generator to Reward Acceptable Behavior in Mentally Retarded Youngsters

Designer: Michael *McCarrick*
Disabled Coordinator: Rudy Ternbach
Supervising Professor: Professor Lester W. Coy
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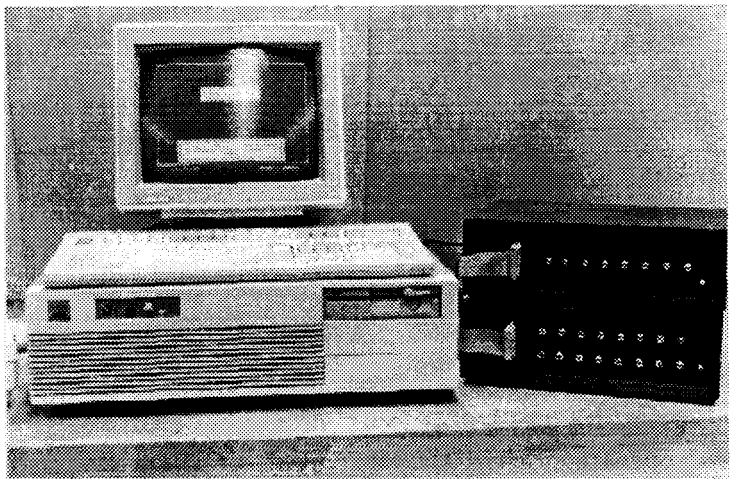
INTRODUCTION

The Computerized Active Stimulation System(CASS) aids in the rehabilitation of mentally and physically impaired individuals. It accomplishes this by enabling its user to turn ON and OFF up to 16 different devices by properly controlling a series of switches. Which device is controlled by which switch and how long it is ON/OFF is defined by a therapist who configures the system for each user through menu driven software. This system consists of three parts: the CASS computer/software, the Switch Input box and the Output box. The CASS software can monitor the progress of each of up to 500 patients. During a session the software monitors the Switch Input box for switch closures. If a switch is pressed at an appropriate time the pre defined remote is activated providing positive reinforcement to the patient. Detailed reports can be printed on each patient's progress over weeks or months. The Switch Input box enables the CASS software to monitor the closure of up to eight switches. Possible switch types include Foot (Pedal), Hand/Elbow and Head/Brow switches.

The Output box controls up to 16 devices through its remote jacks. Possible devices are Tape recorders, Fans, Foot massagers, Radios or Toys. Any device that has an ON/OFF switch can be controlled by the CASS software through one of the remote jacks.

SUMMARY OF IMPACT

The Active Stimulation Program stresses the principle of positive reinforcement based upon cause and effect relationships. The program allows people with multiple handicaps to acquire/learn better control over their environment. The system provides the therapist with accurate information on learning process and individual progress of up to 4 individuals simultaneously. The program monitors fine motor movement as switches are manipulated to activate the reinforcer. This system has been used with 15 people having varied degrees of verbal and physical handicaps. The program is most effective for people with severe retardation and with multiple physical handicaps and behavior problems such as self injurious behavior.



TECHNICAL DESCRIPTION

Remote Output Box

The Remote Output Box enables a Personal Computer (PC) to control up to 16 remote outputs selectively, turning ON or OFF up to 16 devices such as tape recorders, foot massagers, colored lights, etc. This box contains two addressable latches (see schematic) that drive 7406 inverters. Each inverter in turn drives the coil of a relay (16 in all), which controls the output jacks. The jacks are individually protected by fuses. The addressable latches are controlled via a parallel port (25 pin Centronics) on the PC. The bit/pin connections between the parallel port and the two latches are:

- DBO - DB2 (data bits 0 - 2, pins 2- 4) are connected to the address lines of both latches (so -S2).
- DB3 (data bit 3, pin 5) is connected to the data line on both latches (D).
- DB4 (data bit 4, pin 6) is connected to the enable line on the upper latch (G). The upper latch controls J1 through J8.
- DB5 (data bit 5, pin 7) is connected to the enable line on the lower latch (G). The lower latch controls J9 through J16.
- Pin 24 (GND) is connected to ground within the box.

Switch Input Box

The Switch Input Box enables the CASS software to monitor the closure of up to eight switches that are interfaced to the PC via a parallel port. Each switch controls an optoisolator (refer to the schematic labeled Single Isolated Input), which in turn drives the base of a transistor. Each transistor can pull down one bit of the parallel data port. The CASS software monitors the switch closures by writing OFFH to the parallel port and then reading the port. If a switch is closed, the corresponding data bit will be low. If the switch is open, the corresponding data bit remains high. The total cost of the system is $2,300.