CHAPTER 11
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Automatic Telephone

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INTRODUCTION

The telephone device here allows for the hands free operation of a telephone for incoming calls. When the unit is on, incoming calls are automatically answered and transferred to a separate speaker phone unit. Normal conversation then takes place through the speaker unit. The unit also hangs up the line following an adjustable period of silence that occurs after the calling party hangs up their phone. These functions do not interfere with normal use of the telephone at the workstation.

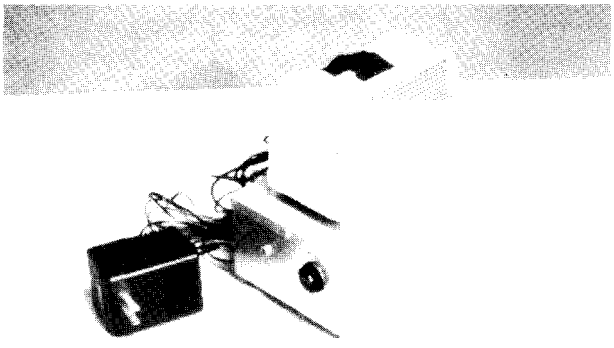

Figure 11 .1. Completed Unit Showing Speaker Phone and Circuit Box.

SUMMARY OF IMPACT

Many physically challenged people have difficulty using a normal telephone due to the lack of dexterity or strength that is required to answer an incoming telephone call, and to release the line when the phone call is completed. In addition to limiting personal use of the telephone, this difficulty impedes employment opportunities including such jobs as a receptionist. The device described here allows the user to respond to an incoming call, carry on a conversation, and terminate the call without the use of the hands or other switch operation. With limited other capabilities the user could take messages or perform other simple functions required of a receptionist.

TECHNICAL DESCRIPTION

This device consists of two subunits; one to answer incoming calls, and the other to terminate calls after the conversation has been concluded. The answering portion of the system detects the ring signal and processes this signal to accept the call and to turn on the modified speaker unit. The hang-up portion of the system is based on a voice activated circuit that monitors both the incoming and the outgoing portions of the conversation. Following a period of ten seconds of no conversation in either direction, the phone line is switched off.

The main components of the answering portion of the device are an R-S latch that is connected to the phone line through a 555 astable timer to provide a short delay in answering. The phone line is connected to the system through two normally closed relays. When the circuit detects the ring signal these relays are switched to the open position that activates the speaker phone and disconnects the detection circuit from the phone line. This was found to be necessary in order to isolate the detection circuit to prevent noise and other interaction between the ring detection circuit and the open phone line. The 90 volt 20 Hz ring signal is processed through a NAND gate and associated components to produce a square wave. This signal is then sent to the R-S latch. The R-S latch performs several functions; opening the call to the speaker unit, disconnecting the ring detection circuit from the now open phone line, and transferring control to the hang up portion of the system. The R-S latch enables the counter that is clocked by the 555 timer connected in an astable function. When eight pulses are received by

the counter, output QD changes from zero to one. This clocks in the value at the D input of the flip-flop. This in turn closes transistor Q7 that places 5 volts across the coils of Q1-Q5. Q1 disconnects the positive phone lead from the detector circuit while Q2 disconnects the negative lead, in each case providing continuity to the speaker unit. Q3 turns on the speaker phone. Q4 disconnects the R-S latch from the flip-flop and connects pin 2 of the invertor to the D-input of the D flip-flop. Q5 disconnects QD of the counter from the clock and connects pin 10. Thus Q4 and Q5 transfer control to the hang-up circuit.

The hang-up portion of the system consists of a microphone, voice operated switch (VOX), a missing pulse detector (MPD), and an invertor chip. The microphone is mounted on the face of the speaker unit and picks up the voice signals of both parties when they are speaking. When the VOX receives signals from the microphone it pulses from a low to a high signal. This signal is connected across the coil of relay Q6. The output of Q6 serves as an input to the MPD. The output from the MPD is activated high when there is output from the VOX through Q6. If the MPD does not receive an input for a ten second period, the output from the MPD goes low. This causes the phone to be hung-up as follows. The MPD output is connected to a series of invertors. To close the phone line pin 6 of the D flip-flop must be changed from high to low which requires a high D input and a clock signal. When the output of the MPD goes low (no conversation), the D input is turned high and the clock is pulsed. The sequence of invertors is required to allow sufficient set-time for the D input. Once the D flip-flop is clocked the phone line is switched back to the answering portion of the system, while resetting all other functions to an awaiting call status.

Operating the hang-up portion of the system from a direct, external VOX approach provided considerable advantages over earlier attempts to measure bi-directional speech directly from the phone lines. The latter was found to be substantially complicated by unequal signal strengths for the incoming and outgoing portions of the conversation, and by noise on the phone line that could not be readily distinguished from speech. The use of the VOX approach required equal access to both portions of the conversation. The use of the speaker phone facilitated monitoring both portions of the conversation by using an external microphone. The speaker phone also turned out to be an enhancement of the system over previously considered alternatives such as a pre-positioned hand set or a head set. One disadvantage of the speaker phone, besides the usual complaints associated with such devices, is that environmental noise can not only interfere with the conversation but can also be detected as conversation on the line thereby interfering with the hang-up function. The original unit is also subject to occasional false answering. This is currently being addressed in a redesign effort.

The cost of the current unit was $160. The largest single contributor to this cost was the speaker phone ($24), followed by the microphone, 6 volt AC-DC adapter, metal project box, and the circuit boards. The remaining cost was in individual components.

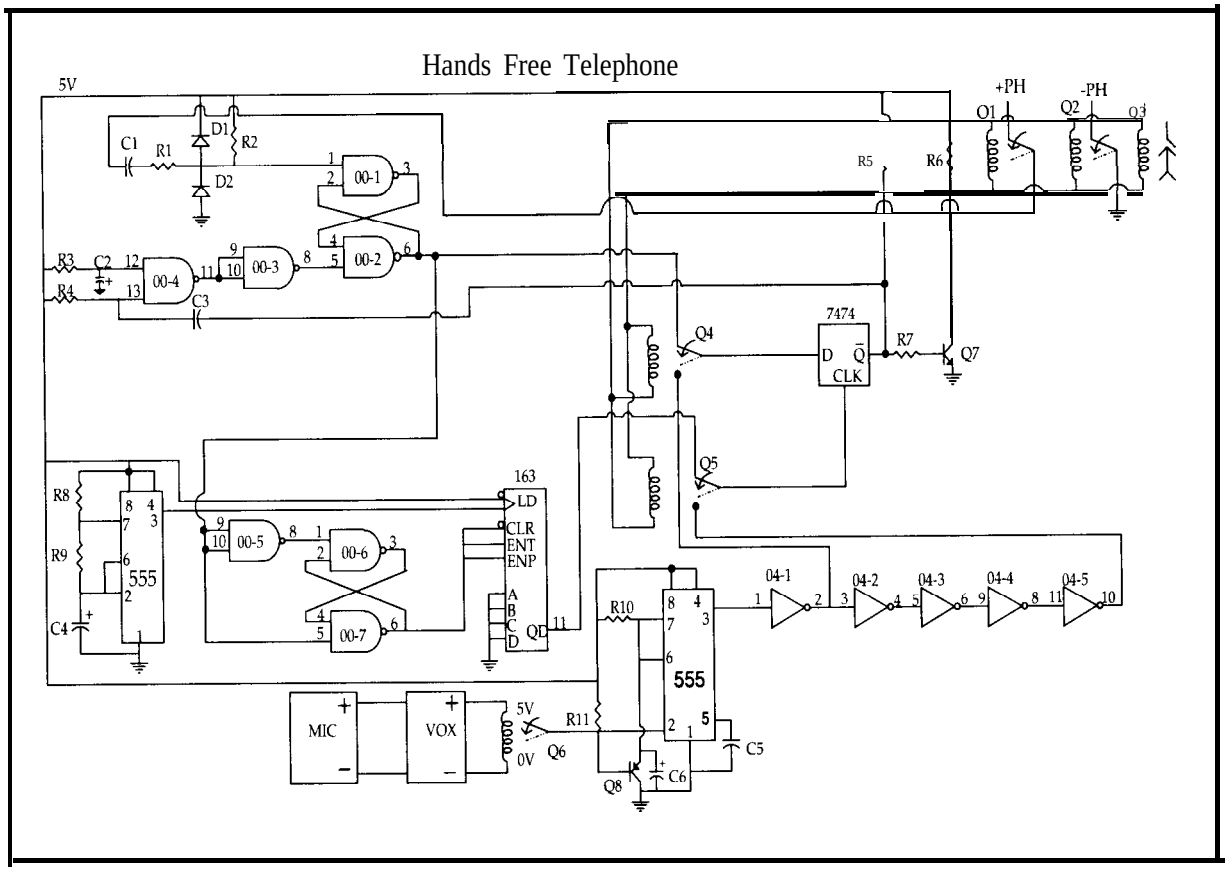

Figure 1 1.2. Circuit Schematic.

A Custom Corner Chair for Pre-school Children

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INTRODUCTION

This project is a corner chair designed to the specifications of the therapists at UCP/Houston for use with small children. The chair provides support for symmetrical posture and midline control of the head and trunk, as well as improved breathing for children with low trunk tone. Commercially available chairs were found to be too large, and not sufficiently adjustable, to meet the needs of the population served here.

SUMMARY OF IMPACT

This chair has seen extensive use at the UCP facility since it was delivered. As an aid to therapy, it serves the purpose of providing the support and stabilization necessary during related manual and vocal activities.

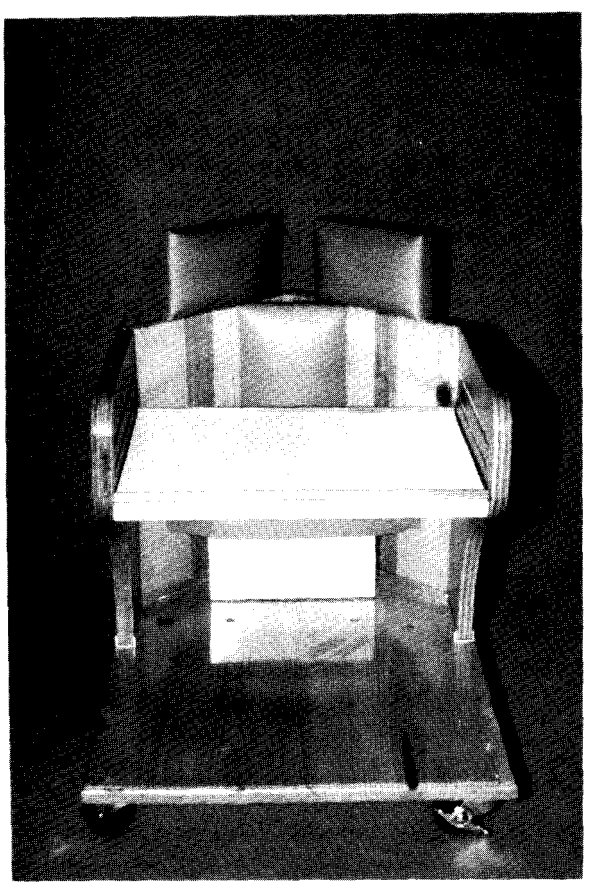

Figure 11.3. Corner Chair.

TECHNICAL DESCRIPTION

The design challenge in this project was to achieve the wide variation in sizes requested by the therapists, while retaining the flexibility of easy adjustment. The 90" corner shaped back and adjustable tray prevents shoulder retraction that is common in children who cannot stabilize against gravity. Padded backboards in two widths are available for comfort and additional support. The backboards are stabilized with easily removed screws located at the tops of the side boards. The seat design allows various heights and depths that allows adjustment over the range of sizes requested by the therapists. Three different seats are provided which are installed with dowel pins, or by screws if the backboard is not used. A padded head support, and tray, are also provided. Both are fully and easily adjustable vertically. The tray is also adjustable horizontally. The tray and its side supports are connected to the back with hasps. The laminate top on the tray allows for easy clean-up. Lockable casters are attached to the bottom of the chair.

The chair is of wood construction with polyurethane finish, with the addition of vinyl covered padding and laminate as indicated. The few tools required for adjustment are attached to the back of the chair with hook and loop fasteners so that they will hopefully remain readily available. The specifications for the chair (in inches) are: Base: 25x17; Sides: 15 with 5 inch head supports adjustable over a 5 inch range; Seat heights: 5,6.5 or 8; Backboard: 5 or 8; Tray: 18x20 with adjustable position; Casters: 3 inch swivel and locking. The materials cost for the chair was about $50.

A Laser Pointer Receiver for Environmental Control

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INTRODUCTION

We have previously described a laser diode, visible light device for use in pointing communication; head mounted for close (communication board) and far field pointing, or for input to a light sensing environmental control unit (ECU). The same technology can be used in the form of an off-the-shelf laser pointer for non-verbal individuals with some hand dexterity. The project described here is a new ECU featuring four sensors on one unit. The main unit provides four sensors that act as momentary switches through four relays which are accessible through $\frac{1}{8}$" jacks. This unit can be combined with momentary-to-latching converters so that any or all of the sensors can be operated as latch on/latch off. Alternately any two of the sensors can be used in conjunction with an R-S latch to provide a latch on/latch off function using any two sensors. Any combination of momentary, single sensor latching, and dual sensor latching can therefore be achieved.

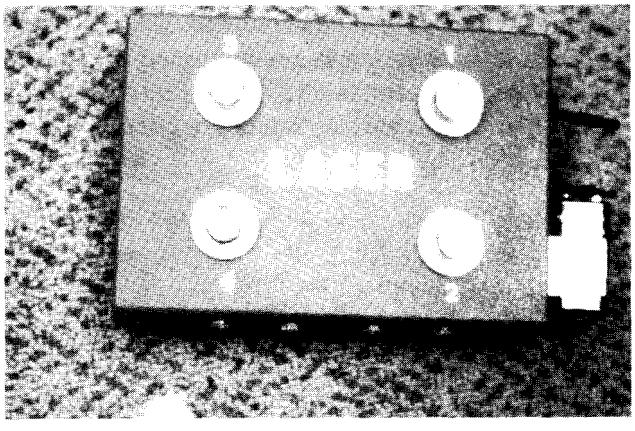

Figure 11.4. Laser Receiver for ECU Functions.

SUMMARY OF IMPACT

The head mounted, laser diode, visible light pointer has been a popular device at the Fort Worth State School. The original impact was as an alternative to incandescent pointers that were heavy, hot, manually focusable to only a relatively large spot size, and significant battery consumers. The laser pointer is used to access communication boards where a bright, focused beam is required. Distant pointing for general communication and as an ECU input was an obvious extension and several single purpose (e.g. TV on/off) receivers were designed previously. The new unit adds additional versatility for ECU applications and has increased the number of independent activities available.

TECHNICAL DESCRIPTION

The pointer provides a $\frac{1}{8}$" diameter, visible red spot. Each receiver consists of an externally accessible photocell connected to a 311 voltage comparator. When the laser beam is incident on the photocell, the output of the comparator turns on a 2N222 transistor which in turns energizes the coil of a 5 volt single pole relay. The output of the relay serves as a switch to any independently powered device. The sensitivity of the input light detection can be adjusted with resistors R1 and R2. In this basic mode, each of the four sensors mounted on the unit act as independent momentary switches which are accessible through jack inputs to the four relays. If required, a momentary-to-latching interface can be used between the relay and the device being operated. The receiver operates from a 9-volt external battery which allows easy battery replacement as well as the use of a clip on 9-volt AC to DC power supply.

An R-S latch accessory was also designed to allow for any pair of sensors (photocells) to be used as separate on and off switches to a single external de-

vice. Two independent R-S latches are contained in a separate unit. Each latch accepts two of the four outputs from the receiver, connected to one of the two NOR gates on a 74LS02 chip. When one of the sensors is triggered, it acts as a momentary switch to trigger and maintain one output high. When the corresponding sensor receives the laser input, the resulting momentary switch closure turns the NOR output to off. Following the NOR gates the circuit is similar to that in the main unit, with the gate output triggering a transistor to energize a relay coil. The output of the relay in the R-S latch unit is connected to the device being operated through $\frac{1}{8}$" mini-plug jacks and cable. The R-S latching unit is also powered by a 9-volt battery.

The four sensor receiver cost $30. The R-S unit cost $10.

REFERENCE

Hyman WA, Miller GE, and Neigut JS, "Laser Diodes for Head Pointing and Environmental Control", *Proceedings-RESNA International 91, 377-379, 1992.*

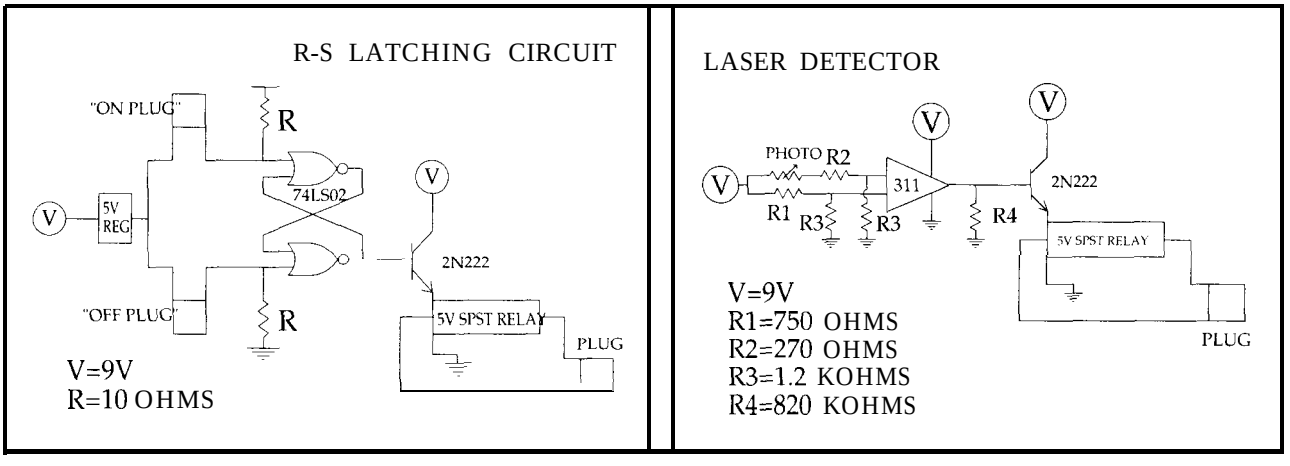

Figure 11.5. Laser Receiver Circuit (one of four) and R-S Latch (one of two)

User Operated Timers for Control of Decorative Mobiles

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INTRODUCTION

This device provides for the timed motor driven rotation of a ceiling hung mobile in response to the closure of a SPST input switch from the user. The duration and speed of the mobile movement are selectable, and any type of switch can be used as required by the physical abilities of the user. The design described here is based on a commercially available timer. This design replaces a previous version of the device in which the timer function was designed by the same team at the component level. The present design is not only simpler (parts count and time to execute), but is also more reliable and easier to repair.

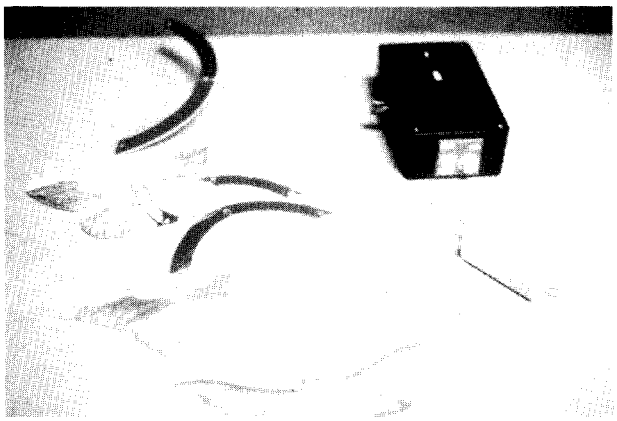

Figure 11.6. Mobile Timer Unit.

SUMMARY OF IMPACT

This unit serves the needs of several residents of the Fort Worth State School who have severe motor limitations. It provides education in switch operation and cause-and-effect concepts as well as providing for self operation of an attractive visual display while in bed.

TECHNICAL DESCRIPTION

The system consists of an input switch, a commercial multi-function variable timer (Carlton Bates), a variable speed DC motor and a mobile. The input switch can be activated as either a momentary input or a sustained input. The timer is appropriately configured as provided by the manufacturer so that whichever input is used results in a selectable duration of output. For sustained input the timer can be configured in two ways. One is to run continuously when the switch is closed, followed by a delay-on-break period of operation. If the delay on break is zero, the timer passes the input as a simple switch. Alternately, the timer can be configured to provide the timed duration of output following switch activation regardless of whether the input switch is held closed. The output of the timer provides power to the ceiling mounted motor that drives the mobile. A separate variable control on the timer box is used to control the motor speed and thereby the visual display obtained from the mobile. The duration setting and motor speed are not accessible by the user with significant disability in the current design. They are set by the attendant. The physical configuration is that the motor and mobile are suspended from the ceiling and connected by cable to the timer box. The timer box can be table or wall mounted, and can be either battery powered or supplied with DC through an AC to DC converter. The user switch is generally connected to the timer box by cable and jack and plug, although an RF or other remote switch could also be used. The timer box also has a momentary switch and alternative plug input so that the attendant can independently operate the device. This design was found to be far superior to the built-from-scratch unit in terms of simplicity of fabrication, versatility, and reliability. The dual design ef-

fort provided an interesting opportunity to compare component versus subsystem design.

The unit without the mobile cost $140, with the major financial components being the timer and the motor.

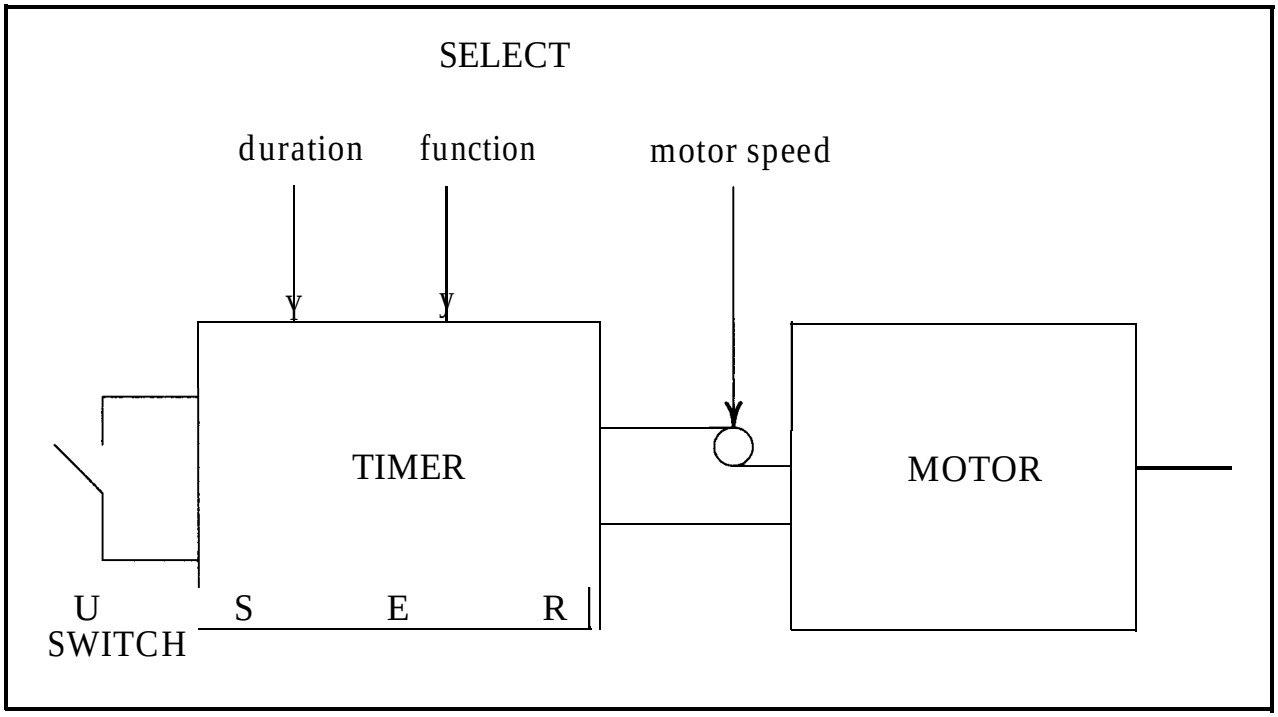

Figure 11.7. Schematic of System.

Systems for Providing Visual Stimuli to Speech Input

Designers: Monte Highsmith, Marc Pinney, Juan Chow, Joseph Neigut, Felipe Elizondo
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INTRODUCTION

Speech therapists working with infants and preschool children find that it is useful to provide automatic visual feedback when the child or children produce speech or other audible utterances. Three such systems are described here. The first uses a three channel, tunable color organ to convert speech or singing input into a multi-light display. The second uses a simple voice activated switch to provide momentary switch closure to any external device, including a set of mounted, multi-function Christmas lights. The third system used a commercially available motor driven, frequency dependent visual display as the output, with a simple amplifier circuit providing the input.

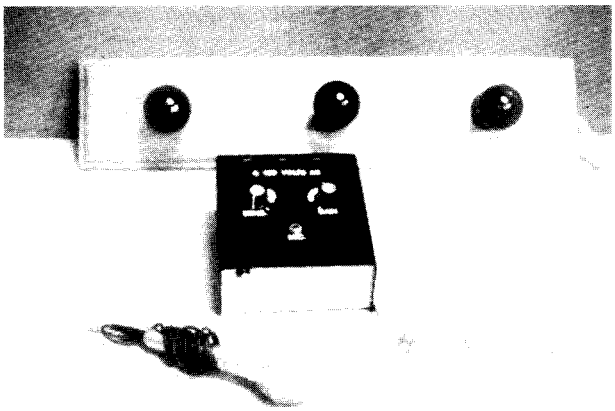

Figure 11.8. System l-Color Organ.

SUMMARY OF IMPACT

Each of these systems is in daily use in the programs of UCP/Houston. They are used for a variety of individual therapy and group activities. The response of the children using these systems, as reported back to the design teams by the speech and other therapists, has been excellent.

TECHNICAL DESCRIPTION

System 1

Color organ systems have become widely available for connecting music systems to display lights. This project required the design of a suitable front-end voice amplifier, the construction of a three channel color organ circuit, and the design of display lights. The audio signal is received by a microphone and amplified using a variable gain amplifier. The amplified signal was then transformed to a higher frequency range. A potentiometer controls the transformed signal input level that is sent through a series of filters that divide the signal into three bands. The cutoff points for each band are adjustable. The output signals from the three bands control the gating of AC current through their respective silicon controlled rectifiers. The three AC outputs energize different colored lights that are arranged on a board. Any other set of three devices can be substituted by direct plug-in to the three AC outlets.

System 2

A simple VOX switch was modified from a commercial toy as an alternative to building one from scratch. In the toy the switch operated a motor. The VOX component therefore provided sufficient current and voltage to operate a relay. The output from the relay can operate any single switch operated device. Multi-function Christmas lights, which included a momentary switch function, change capability were provided as one form of display. These lights were mounted in an acrylic covered display frame and modified to accommodate a jack input in parallel with the function push button switch. With the VOX circuit connected to the lights, any vocal sound produced at the input to the VOX changes the display pattern from the lights. In this system the therapist was provided with two additional controls. One to trigger the system as a prompt, and the second to cut off the system so that

the therapist's vocal encouragement would not trigger the system.

System 3

The third system utilized a commercially available, frequency sensitive, light display that was intended to receive input from an audio system. The display unit consists of a motor driven bar with different color LEDs mounted along its length. The bar rotates at a constant speed while the LED pattern responds to the frequency of the incoming audio signal. The rotating pattern of lights produces a variety of two dimensional patterns. For our purpose a small audio amplifier that would produce appropriate signal strength and frequencies was added as the input to the system. Again prompt and cut off signals were provided for the therapist. Subsequent to the design of this combination, Radio Shack introduced a similar product with a built in microphone and amplifier. However this system would still require modification for the prompt and cut off functions.

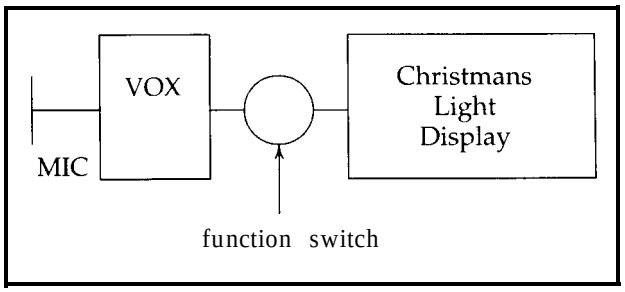

Figure 11.9. Schematic of VOX to Light Display System.

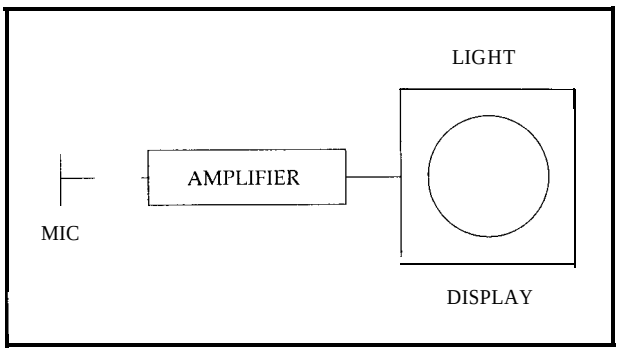

Figure 1 1 .1 0. Schematic of Color Wheel System.

Power Saver Modification for a Digital Voice Recorder

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INTRODUCTION

Digital, multi-channel voice recording and playback systems have become a standard part of the alternative communication repertoire.

Many of the systems that perform this function that are sold as rehabilitation devices are much more expensive than the underlying technology. We have therefore worked with several versions of digital record/playback systems at the board level in order to provide more economical solutions to this form of communication. One recurring problem with the systems we have used is the stand-by power drain that results in a loss of memory over too short a period when the system is supplied with battery power. The purpose of the modification reported here was therefore to investigate the design and function of the board level recorder to identify a modification that would reduce the stand-by power drain. The solution found was substantially successful in this regard.

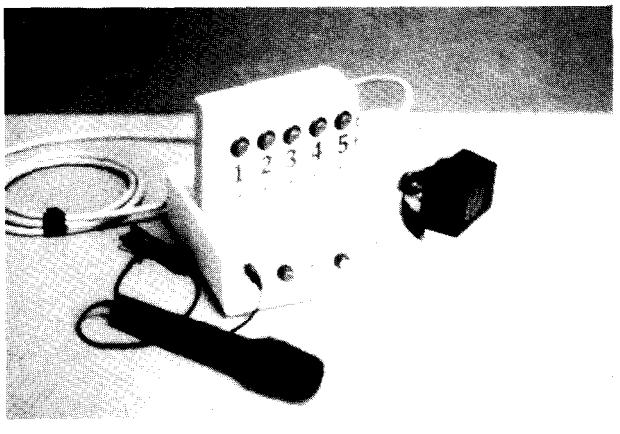

Figure 1 1.11. Modified Multi-Channel Record and Play System.

SUMMARY OF IMPACT

Customized, and easily changeable, pre-recorded speech is of great value to non-verbal individuals. One application is that it has been found that attendants are much more responsive to simulated verbal requests than they are to buzzers or other sound/light emitting devices. This design greatly increased the versatility of a device that provides this function, while utilizing an industrial technology base that is available at substantially lower cost than comparable devices sold through the rehabilitation marketplace.

TECHNICAL DESCRIPTION

The Ming E&P DVM-120M is a commercially available multi-channel digital voice recorder. It offers up to 16 channels, which are accessible by binary code or by individual momentary switch. An accessory unit was designed which provides direct access to five of these channels, although a larger number could be easily accommodated. The microphone is used to record messages on individual channels. A built in speaker is provided, or an external speaker can be added. The internal board of the DVM-120M is also commercially available for applications in which the configuration shown is too bulky. Because of its current demands, the DVM-120M is powered by an AC-to-DC transformer. An onboard capacitor provides memory retention for brief power interruptions, and an internal battery can be added for several hours of use. Since the memory is volatile, loss of power is more critical than limiting function in that the memory is also lost requiring that all messages be re-recorded. The stand-by current can be further reduced by disconnecting power to the speaker when no messages are being played. Although energizing the speaker upon switch input would be straightforward, it is also necessary to disconnect the speaker after a message is played in order to return to minimal stand-by current. This ap-

proach was combined with the existing programmable timer circuit that is intended to power the circuit only for the amount of time that a message is being played. To accommodate messages of variable length, the timer is automatically programmed for the respective channel whenever a message is recorded. The actual solution was to connect the power lead of the speaker through a 5-volt relay. The relay is using the existing transistor on the DVM-120M board that is switched by the output timer circuit. A battery charger circuit was also added so that rechargeable batteries can be used without changing batteries. A standard plug in transformer is used to supply 12 volts to eight AA batteries through a 100 Ω/10W resistor. This configuration allows 16 hours of battery power that is more than adequate for a full day of normal use.

The packaged DVM-120M is priced at $200.00. About $40.00 of accessories were required to do the modification described.

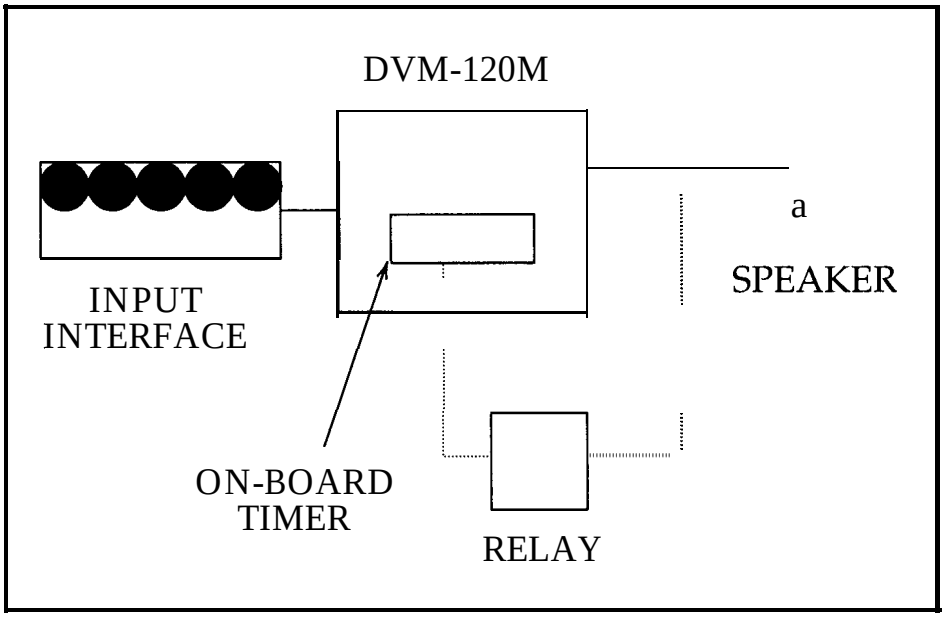

Figure 1 1 .1 2. Modification Schematic.

An Overhead Track for Supported Ambulation

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INTRODUCTION

The system described here is a permanently installed overhead track in a corridor at UCP/Houston. It is used to provide vertical support during ambulation so that children developing walking skills can move somewhat freely without the fear or danger of falling. The sling support can be at a fixed height, spring supported, to limit falling while lessening the sense of being held up, or manually controlled by the therapist. The length of track is suitable for beginning ambulation for the young clients served at this facility. Plans are underway to extend the track through other parts of the facility.

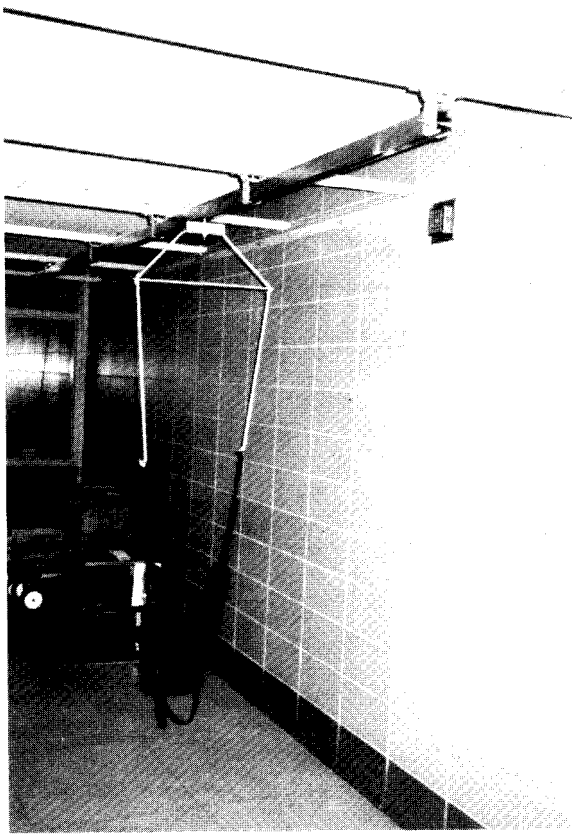

Figure 11 .13. Photograph of Installed System.

SUMMARY OF IMPACT

This system is in daily use by the physical therapists at UCP/Houston. It has proven to be an important milestone toward unsupported ambulation, following work with parallel bars, a vertical bar ambulation track which we previously reported on, wheeled walkers, and other forms of support. An early indication of the success of this device was its immediate use, following installation and testing, by a child who had not previously walked unaided. The child instantly mastered the concept and propelled herself down the length of the track. It was apparent that she found this to be a most enjoyable experience, while her mother and therapists were equally excited.

TECHNICAL DESCRIPTION

The track portion of the system, along with the primary hangers and the trolley that runs in the track, are components of a commercial overhead crane system (McMaster). The track hangers are mounted to square cross section bars at several points along the length of the track. The bars are perpendicular to the track and reach across the hallway. The bars rest on angle iron that is mounted to the wall along and beyond the length of the track. The angle iron is attached to the wall using molly bolts appropriate to the glazed cinder block construction. Bolts through the last hanger provide end stops for the trolley. Hanging from the trolley is a support harness with an integral spreader bar at the top. Straps on the sling seat can be adjusted for final height selection. As shown, the hanger provides fixed height support. However a spring or pulley can be substituted for the fixed hanger as desired. Design concerns included stiffness, strength and durability of the overall system. The design is functionally

very stiff and, by calculation and test, can support loads greatly in excess of not only child weight but also adult weight. The design includes redundant hangers, cross bars and wall bolts to guard against failure. The installation of the system has been checked several times; all fasteners and other components have remained tight and secure. All components were obtained in advance of installation that took place over a two day period on site in Houston.

The mechanical components of the system, especially the track, hangers and trolley, resulted in an approximate cost of $250.

Figure 11.14. Child using the System for the First Time.

A Visual Display for Computer Audible Messages

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INTRODUCTION

This device is a low cost, add-on accessory for the deaf personal computer user. It converts what are intended to be audible tone messages from software to a visible light. Thus the deaf user is alerted to such messages. The system consists of a suction cup mounted microphone, a momentary VOX switch, and a light. The microphone can be externally positioned over the speaker of the computer, and the light positioned as required. This approach eliminates internal modification or dependency on specific software revisions.

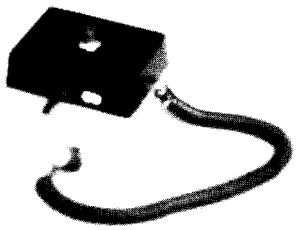

Figure 11.15. Accessory Light Display.

SUMMARY OF IMPACT

The loss of audible ques from computer software leaves the deaf user without software generated feedback. This device replaces the audible que with a visual one. Computer users find that this aids their productivity and performance in that it helps them to be more responsive to audible tone information. Since the device is an external accessory, it can also be used with any other tone/sound emitting equipment.

TECHNICAL DESCRIPTION

Technically the device is very simple. The microphone captures the audible tone externally from the computer speaker. The VOX component closes a switch whenever there is input from the microphone. The switch closure operates the light on top of the display box. The sensitivity of the VOX can be adjusted so that tones from the speaker are emphasized over other computer or environmental noises. In the current design the main VOX unit was salvaged from a noise responsive toy. If necessary, the microphone can also be placed inside the computer enclosure, without requiring direct attachment. This system responds to, but does not distinguish between, all of the different tones that some computers and software can generate. While such a system could be built, the additional cost and complexity does not appear to be justified for most applications since the issue in most cases is to gain the operator's attention rather than transmit specific information.

The system as described costs $20.

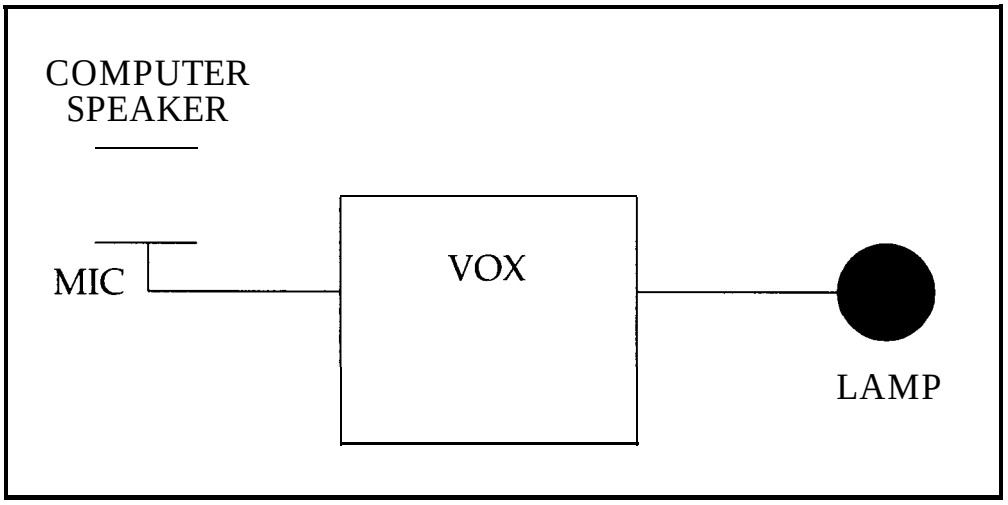

Figure 11 .16. System Schematic.