Chapter 15
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WHEELCHAIR LIFT

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INTRODUCTION

A mobile device was designed to lift and support a 28-year-old client with hemiparalysis due to hydrocephaly. He is four feet tall and weighs approximately 130 pounds. The client's family members were having great difficulty lifting him. They requested a removable mobile seat that includes an armrest and a lifting mechanism. The device was to be easy to operate, stable and secure.

SUMMARY OF IMPACT

The device met all the client's requirements. A motorized lift was originally included in the design, but the client's family requested a manual lift for weight reduction. Family members are now able to successfully lift and transport the client without difficulty. A suggestion for improvement was a higher back on the chair portion, so a headrest was added.

Figure 15.1 Wheelchair Lift.

TECHNICAL DESCRIPTION

The removable seat and seat back are constructed of 3/8-inch square steel tubing along with 0.5-inch thick plywood, padded with foam and covered in vinyl. The armrests were removed from a standard wheelchair. New armrests were made of plywood and covered with foam and vinyl.

The bottom side of the chair is fitted with hollow channel to accommodate the lift mechanism. A pair of handles on the back of the chair assists in moving and guiding the chair. It is set on four swivel casters to allow for mobility when on the floor. The leg rest was made out of 0.5-inch plywood and has two more casters at one end. The opposite end was connected to the seat frame using nuts and bolts.

The lifting mechanism is shown in figure 15.2. The side frames and wheel are parts from a standard manual wheelchair. The frame of the lifting mechanism is attached to the side frames using U-bolts. The lifting frame is made from steel tubing. The fixed portion of the frame consists of 1) two horizontal 4” x 4” pieces of tubing attached to the side frames, and 2) two ground and hardened 1” shafts attached vertically between the tubing. The device was built from two pieces of 2” x 4” tubing (attached to the vertical shafts using 4 linear bearings), the forks and the lifting mechanism. The forks are made from 1” x 4” tubing and are attached to the 2”x 4” tubing with wing nuts and bolts. Also attached to the fork mechanism is the lifting device, similar to those commonly used on boat trailers. The handle is side mounted. The 5” wheel was removed from the bottom and replaced by a 2” wheel to prevent tipping. To operate the device, the fork mechanism is engaged with the hollow channel on the seat. The hand crank is used to raise the seat. When raised to the full position, the combined unit operates like a manual wheelchair.

The total cost was $ 820.

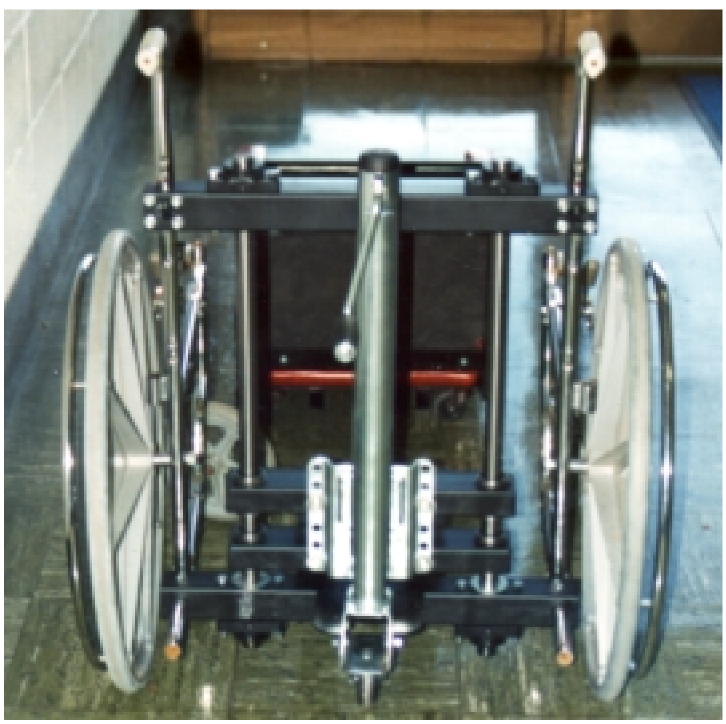

Figure 15.2. Close up of Wheelchair Lift.

TUMBLE FORM LIFT

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INTRODUCTION

A device was designed to assist a caregiver in lifting a client from a Tumbleform chair into his or her arms. Caregivers who regularly lift clients are susceptible to repetitive strain injury to the lower back. The greatest risk of injury is when the caregiver lifts a person from the ground to a height of 18 inches. Beyond 18 inches there is less strain because the shoulder and back work together to avoid injury. The requirements for the device were that it: lift the patient and Tumbleform chair 18 inches off the ground, be safe for the caregiver and patient, lift the patient in a reasonable amount of time (approximately 15 seconds), be mobile, be compatible with and not damage the Tumbleform chair, lift between 250 and 300 pounds, and be powered internally.

SUMMARY OF IMPACT

The Tumbleform Lift meets the design criteria. The limited switches work well, and the caregivers find the main control switch to be useful.

TECHNICAL DESCRIPTION

The main components of the Tumbleform lift are the frame, the linear actuator and battery, the lifting spoon, and the spoon support. These components and their production are described in detail below.

Frame:

The frame is made primarily of two-inch square steel tubing, welded together. Two solid steel shafts and two one-inch square steel tubes support the top piece of the frame. The solid steel shafts, one inch in diameter, also serve as the guide rods for the lifting spoon. The shafts are attached to the frame at the top and bottom by steel shaft supports. The shafts are secured in the shaft supports by a setscrew or pin. The one-inch square tubes are bolted to the rest of the frame and function as supporting members and as a conduit for the electrical wiring from the battery.

The frame rides on four rotating, locking rubber castors, mounted at each corner. The wheel size of the castors is 2 ½ x 15/16 inches and the mount height is 3 3/16 inches. The plate size is a perfect fit for the two-inch-wide frame at 1 3/16 by 2 inches. Each wheel is rated at a capacity of 90 pounds, which gives a sufficient total capacity of 360 pounds. The caregiver pushes the device with the two bike handlebars, which are welded to the frame.

Linear Actuator:

The linear actuator is simply a screw gear that converts rotary to linear motion. A 12-volt DC motor controls the actuator. The actuator is a standard model with an 18-inch stroke. It lifts up to 500 pounds. The speed of the lift is dependent on the load applied. For typical loads, the speed is 60 inches per minute, which translates to 18 seconds per stroke, close to the target speed of 15 seconds per stroke.

The actuator is safe. It is equipped with an over travel protector, secondary brake, telescoping tubes for shielding, and thermal overload protection. Additionally, the motor is encased in sheet metal to prevent patients or caregivers from coming into contact with it.

The linear actuator is connected by pins to the frame and lifting spoon. The power source for the motor is a 12-volt DC, deep-cycle marine battery. The battery is stored in the steel battery rack bolted to the back of the frame.

Lifting Spoon:

The lifting spoon is the component on which the tumbleform chair rests. It is made of three pieces of sheet steel and three pieces of angle iron, welded together. The angle irons are 2 x 1 x 3/16 inches. The back and side sheets are 1/8 inch thick, and the bottom sheet is 3/16 inch thick. The lifting spoon is designed so that it will extend 4 inches down from where it is welded to the spoon support so that base of the Tumbleform chair can roll over it.

Spoon Support:

The spoon support is the component to which the lifting spoon is welded. It glides up and down the solid steel shafts. The spoon support is made up of welded 2-inch square tubing. Four flanged linear ball bearings are bolted to the support to provide a smooth glide on the shafts. When the bearings are lined up correctly, the nuts can be securely tightened to hold the bearings in place.

The total cost for this device was $ 950.

Figure 15.3. Tumbleform Lift.

ROTATING TASK TABLE FOR FOUR

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INTRODUCTION

A table with a rotating surface was built for use by two to four clients engaged in tasks to develop motor skills and hand-eye coordination. Clients sit at the table and engage in a sequence of therapeutic tasks, for example, taking plastic square blocks from a small basket and placing them in a container with a square opening. When a client completes a task, he/she presses a large mushroom button. When all of the clients at the table have pressed their buttons, the rotating surface turns, delivering a new task to each client.

SUMMARY OF IMPACT

In the past, each client sat at separate half-moon tables and worked separately. The teacher hand delivered each task and secured it to the table with Velcro. When the client was finished with a task, the teacher removed the task and again hand-delivered a new one. The design of this table allows the clients to work together and have more control of their workspace.

Figure 15.4. Rotating Task Table.

TECHNICAL DESCRIPTION

The table has a square tabletop with a rotating round center that is flush with the top of the table. The equipment for the tasks is attached to the round section with Velcro strips. A motor is mounted beneath the center of the table with cross-type bracing to support it. A cam switch controls the rotating motion. The power source is AC.

The motor is 1/14 hp with a gear reduction of 1:256. The final speed is 5.6 rpm. The four switches on the table and a limit switch mounted to a cam on the shaft control the motor. When all four buttons are pushed, the tabletop rotates 1/4 turn. If less than four clients are at the table, the switches are disconnected, automatically closing the relay. The circuit is shown in Figure 15.5.

The tabletop is 75” x 75”, constructed of multiple sheets of 3/4” plywood. The moving portion is made of sheet metal. Both the moving and fixed parts of the table were covered with 1/4” Plexiglas. Cutouts were made in the table to permit wheelchairs to be moved close to the table. The legs are removable so that the device is portable.

The total cost for the table for four was $875.

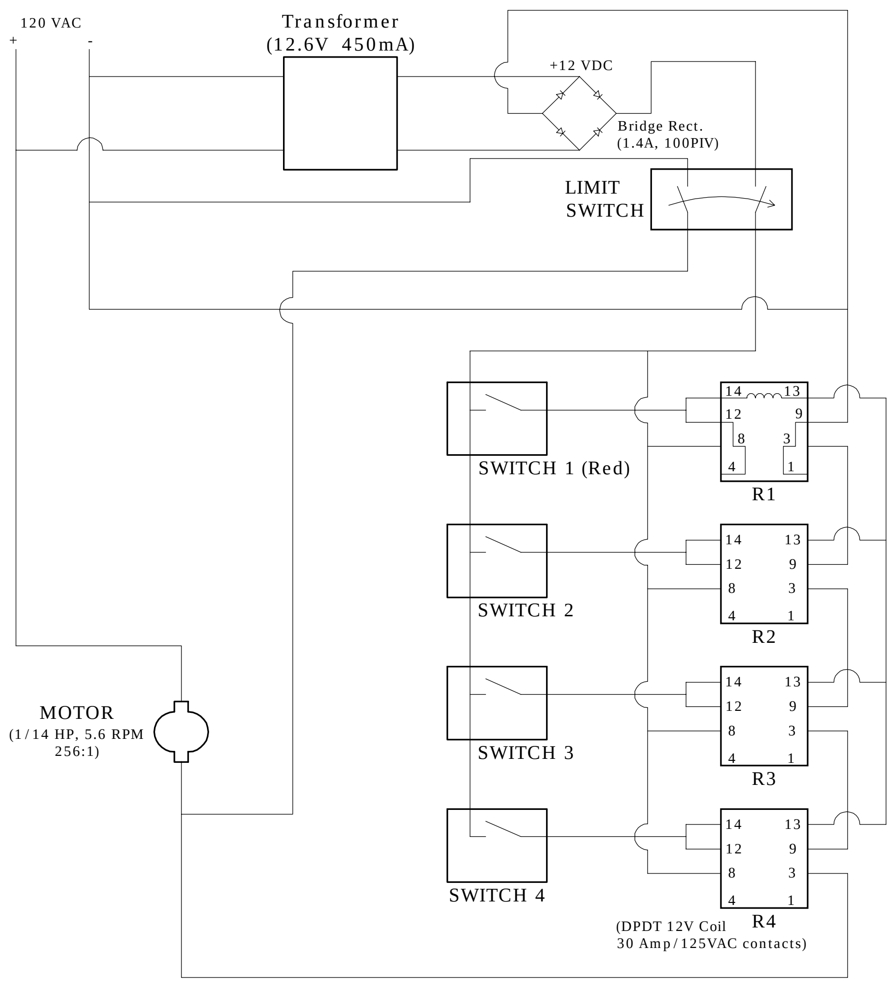

Figure 15.5. Circuit Diagram for Rotating Task Table.

SUNSHINE ON DEMAND

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INTRODUCTION

The Sunshine On Demand project was created to assist a client with seasonal affective disorder. One treatment for seasonal affective disorder is increased real or simulated exposure to sunlight. A light box was built, using high intensity fluorescent bulbs to simulate sunlight. The client sits in front of the light box for 30 to 60 minutes per day, providing her the benefit of sunlight on days when it is not possible to go outside.

SUMMARY OF IMPACT

Sunshine On Demand provides an artificial sunlight source in a safe and practical manner. The light box uses minimal space and is portable, having wheels and weighing only 13 pounds. The design is also safe. A Plexiglas diffuser protects all of the bulbs in the light box. Power to the foot switch has been reduced to 12 volts DC. The timer helps prevent overexposure.

TECHNICAL DESCRIPTION

The light box was purchased from SunBox Company of Gaithersburg, Maryland, and has a 7-year warranty. The light box measures 23 by 15.5 by 3.25 inches and weighs only 13 pounds. It produces 10,000 LUX of light, sufficient to treat the client.

A timing circuit was added to control the client's daily exposure. This circuit uses a motorized timer to keep track of the total time the light box is on each day. For example, if the timer is set for 30 minutes and the client activates the light box for 5 minutes, the timer counts off 5 minutes and allows the remaining 25 minutes to be used at a later time, until the timer is reset. The timer is controlled by a foot switch for easy use. As a safety precaution, power to the foot switch has been reduced to 12 volts DC. The circuit is shown in figure 15.7.

The light box and timer are mounted to a tubular steel stand. The frame was be made of 1-inch tubing for the main supports and 1-inch tubing for the cross braces. All tubing was welded together for strength and appearance. Wheels were added to the back of the stand to allow for easy moving, but they do not touch the floor unless tilted, to prevent unwanted rolling. The stand was painted yellow with DuPont® paint. The light box was mounted onto the stand and an adjustable bracket was used to allow the light box to swivel. The timer circuit was placed in a plastic electrical box and mounted onto the stand.

Figure 15.6. Sunshine On Demand.

The total cost for this device is $700, including the light box.

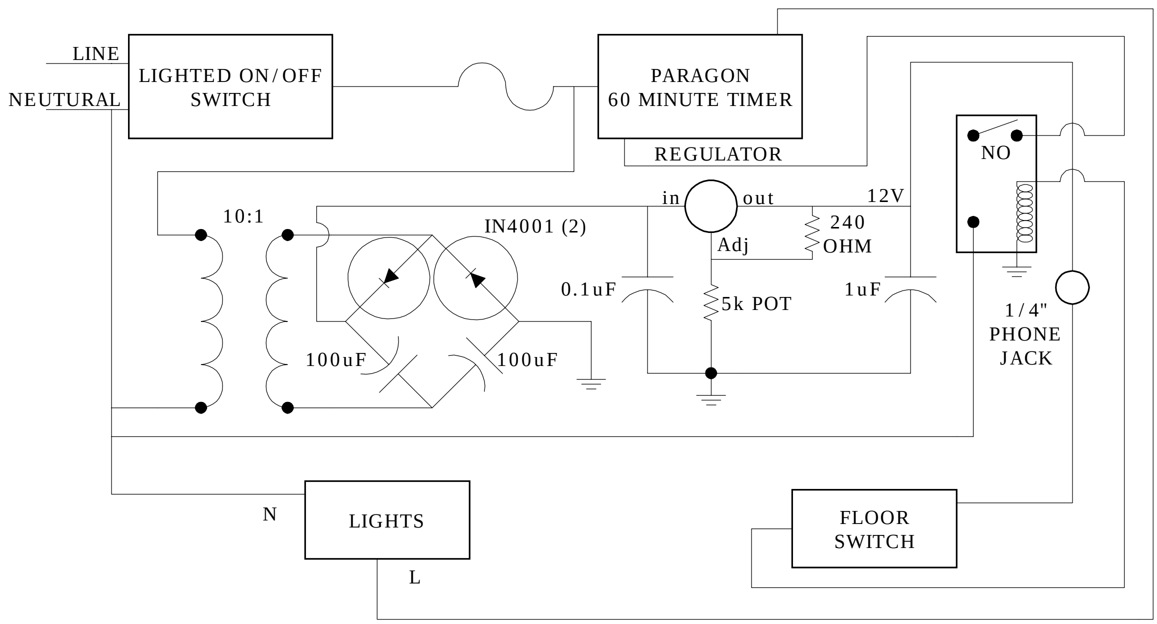

Figure 15.7. Circuit Diagram for Sunshine On Demand.

PAIN-O-METER

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INTRODUCTION

The Pain-O-Meter was designed to allow a nonverbal client and/or a person with a cognitive disability to communicate the extent of pain to a caretaker and/or doctor. Keys display a series of facial expressions depicting varied levels of pleasure and pain. The number of keys was reduced to four to facilitate decision making for the patient.

SUMMARY OF IMPACT

The project assists caregivers in determining the extent and type of pain so that they may respond quickly and appropriately.

Figure 15.8. Pain-O-Meter

TECHNICAL DESCRIPTION

Circuit: The circuit (Figure 15.9) consists of a variety of electronic elements. Five digital voice chips were used to produce the five different pain level indicators. Five uA741 op amps were placed between the voice chips and the speaker to act as a buffer. A microphone, 5 mini momentary SPST push buttons, and 5 SPST toggle switches were used for recording sounds on the voice chips. The toggle switches were used as a safety device to prevent accidental erasure of the set recordings. The push buttons allow the recorded message to be changed after the toggle switch has been turned on. The power source is an AC/DC 9-volt converter that can be plugged into a wall outlet to run off a typical 110-voltage source (household electricity). A 2K-ohm resistor and a 2.5K resistor were used to step the 9-volt power source down to a 5-volt power source that can be used by the voice chips. A DPST toggle switch was used to turn the power on and off for the Pain-O-Meter. Five momentary SPST pushbutton switches were attached to the voice chips so that, when they are pushed, a voice is heard describing the level of pain that the patient has. There are indicators for five different levels of pain, varying from no pain to excruciating pain.

Cabinet Dimensions: The cabinet for the Pain-O-Meter is made of ABS plastic. The keyboard top and the back panel are made of aluminum so that the parts to the design can be mounted easily. The entire size of the cabinet is 10" in length, 8.0" in width, and 4" in height. The aluminum keyboard panel was 8" in length and 8.31" in width. The push buttons that indicate each level of pain have a 0.25" diameter. The labels that represent each level of pain are located above each push button. The microphone is located on the upper right corner of the rear panel, along with AC/DC plug and the five toggle switches.

The total cost is $ 300.

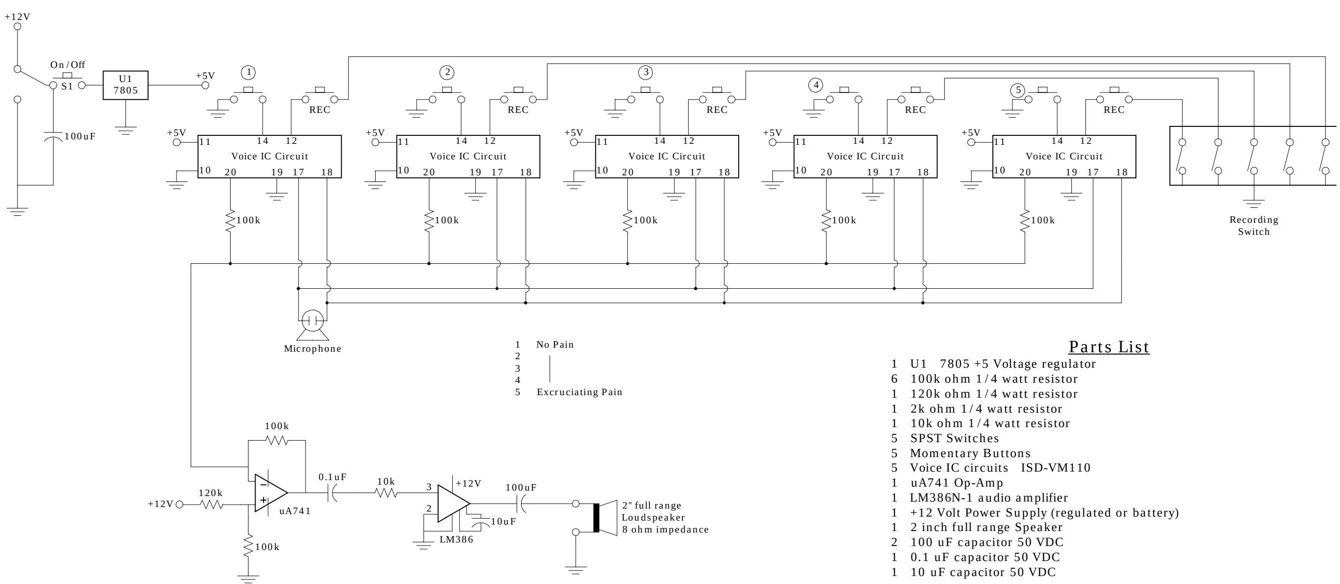

Figure 15.9. Circuit Diagram for the Pain-O-Meter.

MOTORIZED SWING

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INTRODUCTION

The motorized swing allows children to teach themselves cause and effect relationships while enjoying stimulating motion. The swing can be controlled by a child, using a remote switch, or by a caregiver. A timer on the device allows the client to operate the device for a set period of time. For the swing to continue to move, the client must restart the swing. The most important design considerations were safe operation, mobility, ease of accessibility, and a maximum weigh limit of 100 pounds.

SUMMARY OF IMPACT

The swing is in use and the client appears to enjoy it greatly.

TECHNICAL DESCRIPTION

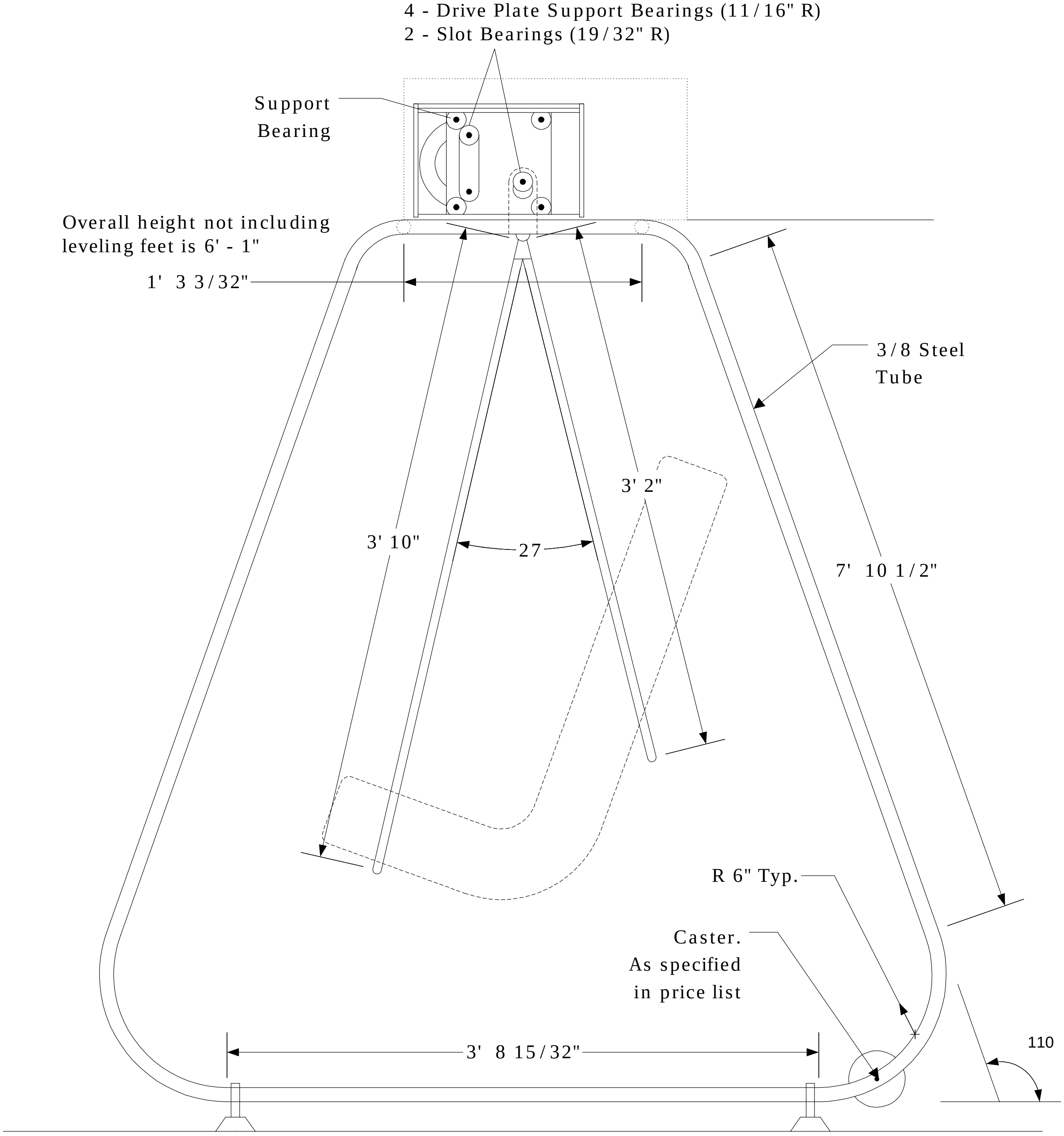
The final design for the motorized swing is composed of an A-frame, constructed from 3/4" pipe, and a drive mechanism, incorporating a DC variable drive motor connected to a drive plate to move the swing arm.

The entire swing rests on four "feet", which level the swing on uneven floors. The swing becomes mobile when tilted back onto two casters on the back of the frame base. The frame can be easily moved from room to room. The bars that support the Tumbleform chair are covered in foam pipe insulation for added safety. A sheet metal box encloses the motor with two exhaust fans to reduce heat build-up. The swing is manually operated by either: 1) the child, via a pressure plate switch located on a tray in front of him/her, or 2) the caregiver, via a manual on/off switch. A "panic" button, on the front of the motor cover box, automatically shuts off the swing. A fuse box on the inside of the motor cover box protects the motor and circuitry in case of a power surge.

The frame was bent using a conduit bender, then welded at the top center. The crossbars were cut with a pipe cutter and welded into place. All of the plate metal pieces were cut from a single sheet of 1/4" steel using a torch. The rough edges were ground off using a disc grinder. The holes for the drive plate bearings and the hole in the drive wheel were drilled. The slots in the drive plate were machined. The bolt holes in the motor support plate were drilled.

Figure 15.10. Photograph of the Motorized Swing.

The total cost for this device is $900.



Swing (Side View)

Figure 15.11. Mechanical Drawing of the Swing.