

# CHAPTER 6

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# THE GRIPPING SYSTEM

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## INTRODUCTION

The Gripping System for golf clubs provides a larger circumference at the golf club grip for people who are unable to tightly grasp the small, standard handle of a golf club. Because of an injury, the client is unable to tightly close the fingers of his right hand around objects that are small diameter. Therefore, the client cannot securely grasp a standard golf club. He needs a device that securely attaches to the butt end of a standard golf grip, providing a large diameter surface which would be easily gripped, and could be quickly removed and placed on any of his golf clubs.

## SUMMARY OF IMPACT

The Gripping System is a single piece of specially shaped plastic that enlarges the circumference of golf clubs at the grip. The Gripping System attaches to any golf clubs having a standard circular grip. Changing the grip of the putter to a similar grip would enable him to use it while putting, too, although this may be unnecessary. The Gripping System is fast, convenient, secure and inexpensive. Also, the Gripping System allows the client to maintain a relatively natural golf swing. The placement of the hands on the club handle and the Gripping System remains consistent with the traditional golf gripping method, although its bulk requires a slight repositioning of the left hand (Figures 6.1, 6.2).

## TECHNICAL DESCRIPTION

The Gripping System holds onto the golf club while the bulk of the device creates a larger handle for the client to grasp. The Gripping System is a C-shaped piece, machined from a block of Teflon (Figure 6.3). The Gripping System is made from a 2 inch x 3 inch x 2 inch block of Teflon. While many plastics would have worked, the Teflon met the requirements needed for strength, light weight, and the right balance of flexibility and stiffness.



Figure 6.1. The Gripping System.

The design of the Gripping System makes attachment and removal easy. The Teflon piece is milled out with a taper to match the existing taper found in the shafts and grips of standard golf clubs. The slot is sized to allow a golf club shaft to easily pass through it. The user simply puts the shaft through the slot, and then slides the piece up the handle until it jams securely at the top of the grip. To enhance gripping security, the outer portion of the Gripping System has grooves cut into it to match the grasp of the client's fingers. The grooves add comfort and confidence when grasping the club.



Figure 6.2. The Gripping System Attaches to a Standard Club while Maintaining a Typical Golf Grip.

The dimensions for the Gripping System were initially determined using a piece of clay. The clay was wrapped around a golf club, and the circumference of the clay mold was increased until the client could securely grasp the club. This mold was then used to design the Gripping System with the optimal dimensions. While this prototype was machined, it is likely that a production piece could be molded to reduce costs.

The cost of materials is \$5. At a reduced rate of \$10 per hour for labor, the final prototype device was manufactured in three hours for \$30. At typical labor rates of \$68 per hour, the total cost is estimated at \$35.

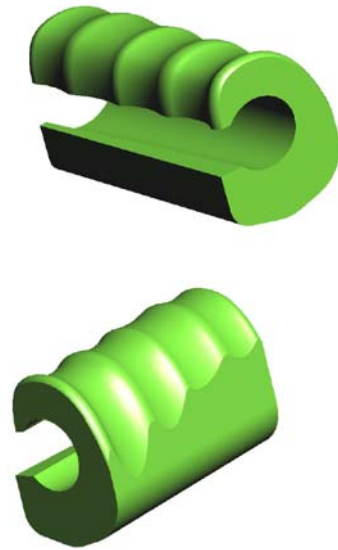


Figure 6.3. The Gripping System is a C-Shaped Piece Cut from a Block of Teflon.

# SPLIT-HOOK PROSTHESIS FOR LOCAL PRODUCTION IN DEVELOPING NATIONS

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## INTRODUCTION

The popular voluntary opening, split-hook terminal device provides amputees with a strong and versatile artificial hand. However, the high price of these devices makes them unattainable to many citizens in developing nations. Even if a modern aluminum split hook could be imported, specialized repair parts would inevitably be needed. Rural, remote environments pose particular problems for roller bearings, which wear quickly in the presence of sand and grit. Additionally, heli-arc or TIG welding facilities for repairing aluminum parts are scarce.

A possible solution is to carve functional split-hook prostheses out of native hardwoods. Inexpensive but high quality prostheses would enable the amputee population in developing countries to work and perform daily tasks. This project investigated the possibility of manufacturing a split-hook terminal device out of wood which would combine the beauty of wood with the functionality of aluminum. At issue were questions of strength, redesign necessary to support useful loads, and simplicity of production (without requiring expensive parts or complex machinery).

## SUMMARY OF IMPACT

A prosthesis for poor citizens of developing nations must be inexpensive but durable enough to withstand heavy use in manual labor, both indoors and outdoors. The populations at risk for losing a limb are generally engaged in manual labor. In these difficult economic and labor conditions, the loss of a limb can mean a drastic decrease in one's ability to provide income through labor. A split-hook prosthesis improves the functionality of the amputated limb. The split-hook also provides a level of functionality that cannot be achieved with a simple hook by giving the user the ability to grasp



Figure 6.4. Split-Hook Prosthesis with Grasping Ability.

objects between the hooks (Figure 6.4). The ability to grasp increases functionality and is important to perform useful work and the tasks of daily living. Taking advantage of local resources, such as the presence of both hardwoods and the local woodcarving labor force will allow the devices to be produced at affordable prices. It will also provide possible new markets for woodcarvers.

## TECHNICAL DESCRIPTION

The basic mechanics of the wooden split-hook prosthesis are similar to those of modern, commercially available, voluntary-opening aluminum split-hook prosthesis. One hook attaches to a cuff on the amputated limb with a bolt. A second hook, which rests on top of and curves with the other hook, is attached to the first hook by a bearing. This allows the hooks to open and close, enabling the user to grasp objects similar as if between the hooked middle and forefingers. The hooks are closed, and held shut, by an elastic band wrapped around their shafts, near, but on the distal side of the bearing. In commercial split hooks, the

hooks are opened by an actuating cable, which is attached to the upper, moving hook, and controlled by a shoulder harness. The wooden split hook is opened using the contralateral hand or an object such as the edge of a table surface.

The wooden split-hook incorporates design changes to optimize it for simplicity and wood construction (Figure 6.5). The hooks are broader than they are thick, and do not extend as far from their shafts as the hooks on a commercial metal prosthesis would. The shafts of the hooks are also much thicker than those on a metal split-hook. These two modifications are necessary to minimize the bending stresses placed upon the hooks while supporting a useful load, here defined as the weight of a five pound bucket. The shafts of the hooks are also much thicker than those on a metal split-hook. The bearing, which the hooks pivot on, is made of a simple brass tube, with its ends hammered and flared to hold it in place. Washers protect the wooden hooks from being worn by the rough edges of the axel and assist in keeping the movement of the bearing free.

The wooden split-hook is constructed of ebony wood. Ebony wood was chosen because it is both a material available to woodcarvers in many developing nations and was the densest, hardest wood available for purchase.

The cost of materials for this prototype is approximately \$40. Most of this cost is incurred in purchasing the wood, which, as an exotic species, is expensive. The cost would be significantly lower for a tradesman in a country where ebony is a native wood.

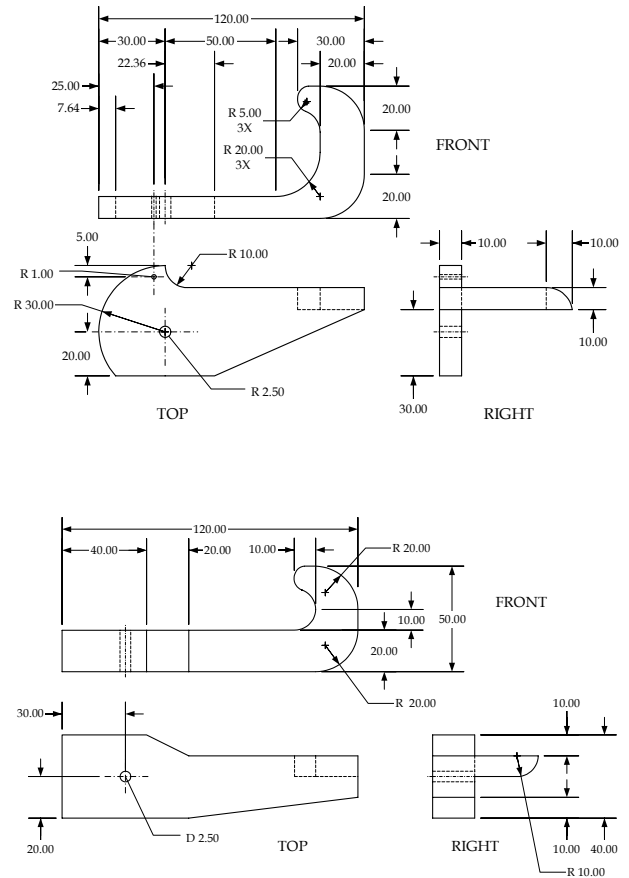


Figure 6.5. Wooden Split-Hook Design.

# FISHING REEL ASSIST DEVICE

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## INTRODUCTION

Persons with limited use of muscles in one hand and arm often find the sport of fishing difficult. These individuals typically use their stronger hand to hold the fishing rod, and their weaker hand to grasp and turn the reel handle. The client loves to fish in both fresh and saltwater, but has difficulty holding onto the handle of the reel and is unable to reel the line in quickly and powerfully enough to land a large fish.

The Fishing Reel Assist Device (FRAD) assists individuals who have trouble grasping and turning the handle of levelwind (revolving spool) fishing reels. The client's brain injury caused atrophy, weakening, and contractures of the right elbow, wrist, and fingers. The client cannot easily open the fingers, or grasp the reel handles. Currently, there are no devices that could enable a client to perform normal fishing motions and assist him while reeling in the fishing line. The specific need is to assist in grasping and releasing the handle. To fulfill this need, two devices were made. One device was for freshwater fishing reels and the other device was for saltwater fishing reels, which have different handle designs and functional requirements (Figure 6.6).

## SUMMARY OF IMPACT

The design criteria for the Fishing Reel Assist Device are defined by the client's physical capabilities. The FRAD is designed to be safe, versatile, and easy to use. Safety is a large concern, particularly while big-game fishing in saltwater. Therefore, both the



Figure 6.6. The Freshwater and Saltwater Fishing Reel Assist Devices.

freshwater FRAD and the saltwater FRAD devices can be quickly released even while under tension. Freshwater fishing reels have a variety of handle designs. Therefore, the freshwater FRAD includes an adjustable clamp, which allows the client to use a variety of freshwater fishing reels. The saltwater reel handles most often employ a T-shaped handle, and are built to crank against 50 to 80 pound line tensions with gear ratios of about three to five. These reels are very expensive, so the FRAD had to be built in such a way that it attached securely without damaging the reel handles. Because both versions of the FRAD are safe, versatile, and easy to use, the client can now safely enjoy a variety of recreational fishing activities.

## TECHNICAL DESCRIPTION

The main components of the freshwater device consist of commercially available Pro Tec Wrist Braces (\$14.99 US) interfaced to two aluminum plates. The aluminum pieces were anodized with a 0.001-inch hard black coating for corrosion resistance. While not absolutely required for freshwater use, anodizing the aluminum pieces improve the appearance greatly. One aluminum plate (1.4 by 6.9 by 1/8-inch) has a swiveling T-shaped latch and is mounted onto a wrist brace. The other aluminum plate (1.4 by 4.3 by 1/8-inch) has an adjustable clamp mounted onto it and a slot that allows for the T-shaped latch to securely fasten the two plates together. After the two aluminum plates are assembled and fastened together, the user can easily and securely grasp various fishing reel handles to reel in the fishing line.

To use the device, the client places the wrist brace on the right hand and attaches the aluminum plates with the clamp to the wrist brace. To reel in the line, the client presses the device onto the fishing reel handle (Figure 6.7) and uses his shoulder and elbow motion to reel the line in. The freshwater FRAD allows the user to cast a fishing rod with the stronger, more functional hand, and reel in the fishing line with the weaker hand.

The saltwater FRAD has a similar, but stronger design with modifications to grasp a T-handle (Figure 6.8). An aluminum plate (1.4 by 5 by 1/8-inch), with a hard black anodized coating, is mounted onto an arm brace. However, the saltwater device differs in that a milled aluminum part in the shape of a “c” or a claw (2.25 by 1.59 by 1/4-inch), with a 3/8-inch slit through the center, is mounted onto the aluminum plate. This device works similarly to the freshwater FRAD. However, instead of pressing the FRAD onto the reel handles, the saltwater FRAD easily *hooks* onto the saltwater fishing reel handles. The slit in the center of the claw is placed over the handle of the saltwater fishing pole, and with a slight twist of the user’s arm, the claw grasps the handle. The saltwater FRAD allows the user to cast a fishing rod with the functional hand, and reel in the fishing line with the weaker grasping hand.

The total cost of the freshwater FRAD is \$58.28, including the wrist brace and anodizing. The total cost of the saltwater FRAD is \$61.98, including the wrist brace and anodizing.



Figure 6.7. The Freshwater FRAD Attached to a Fishing Reel Handle.

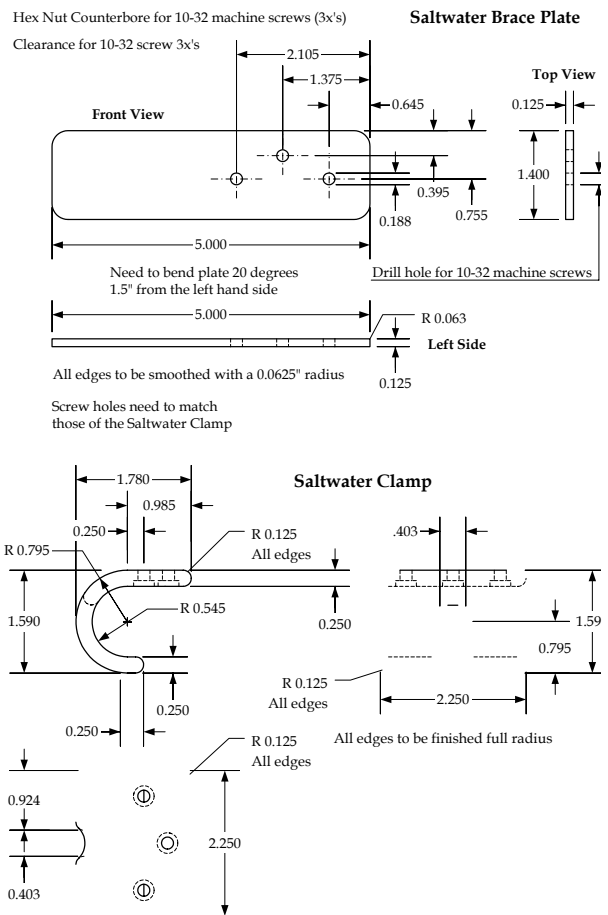


Figure 6.8. Design of the Saltwater FRAD, Including Brace Plate (top) and Clamp (bottom).

# ROWING MACHINE FOR AN INDIVIDUAL WITH PARAPLEGIA

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## INTRODUCTION

Individuals with paraplegia lack motor control and sensation in the lower extremities and are unable to provide the lower extremity force and motions (plantar/dorsiflexion, knee/hip extension, and knee/hip flexion) necessary to operate a traditional rowing machine. However, certain aspects of the rowing motion, namely the large hip and knee motions, might be beneficial to individuals with paraplegia who wish to mitigate the effects of lower extremity immobilization. Upper extremity exercise, besides providing upper extremity muscle toning and cardiovascular benefits, can be used to drive the lower extremities throughout their range of motion. Regular range of motion exercises are thought to decrease muscle spasticity and improve circulation in the paralyzed extremities.

The Paraplegic Rowing Machine (PRM) is designed and constructed as an exercise machine for individuals with paraplegia (Figure 6.9). The PRM uses the force produced by the user's arms to move the user's legs through a range of motion. The rowing machine is designed for a specific individual, but can be adjusted to accommodate different users.

## SUMMARY OF IMPACT

Individuals with paraplegia must mobilize and bear weight on (or "load") their legs to prevent muscle atrophy and bone degeneration. Regular exercise also prevents declines in circulation and cardiovascular fitness. Traditionally, individuals with paraplegia load their legs by static standing with standing frames and help from others. Individuals with paraplegia also participate in exercise programs. Spasticity is another common problem that occurs after a spinal cord injury. An exercise machine that would allow a paralyzed individual to exercise independently would improve

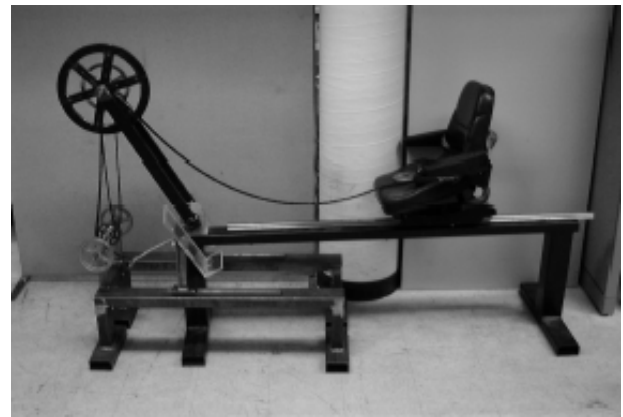


Figure 6.9. Rowing Machine for an Individual with Paraplegia.

convenience, reduce costs, and increase independence.

The Paraplegic Rowing Machine is designed to help provide independent and regular exercise for the client. Not only can individuals with paraplegia use the PRM independently, but the PRM also helps to improve circulation, upper body strength, and cardiovascular fitness.

## TECHNICAL DESCRIPTION

The PRM coordinates the movements between the arms and the legs in an ergonomically proportional manner, thus allowing for a full arm motion without causing an over-extension in the legs. The PRM consists of two independent, rigid, steel frames. The seat is positioned on one frame and the feet slide on foot rests mounted to the other frame. A flywheel (with fan blades) and two springs provide resistance for the arms. The user transfers to the swivel seat, swivels, and locks the seat in the forward facing position. He then manually lifts one leg over the center bar of the main frame, places each foot on a footrest and straps the feet in place. The user then



grasps the rowing handle and pulls it to drive the flywheel via the chain and sprocket mechanism. Another chain and gear system attaches the flywheel using two small pulleys. These pulleys rotate as the user pulls the handle, causing the footrests to move forward and backward. This motion flexes and extends the legs. Together, the PRM and user create a cyclic leg movement and a rowing motion is mimicked.

Material selection involves many important topics such as: cost, time, functionality, safety, and availability. The base of the rowing machine is constructed of steel. Plastic coated aircraft cables,

bicycle gears, and a bicycle chain are used in the gear system. The footrests are constructed from Plexiglas. Guide blocks, slide rails, and steel connecting rods are used in one frame to allow the feet to slide. Also, the PRM design as built was limited by material and component availability. For example, spring loaded pulleys would have been ideal for the return mechanism, but were unavailable. Therefore, simple pulleys were used with extension springs.

The total cost of materials for the rowing machine was approximately \$1283.

# REHABILITATIVE DRINKING AIDS FOR PATIENTS WITH TRAUMATIC BRAIN INJURY

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## INTRODUCTION

Individuals with traumatic brain injuries (TBI) often need to relearn how to swallow when drinking from a cup. Some patients have difficulty holding a cup due to strength limitations and/or tremor, and need a straw. However, simply providing a straw does not solve the problem, as it often provides an uncontrolled, open passageway for fluids to be quickly aspirated if the user has not regained the proper muscular control to swallow liquids. Various

exercises are used to train the tongue and muscles of the throat to prevent aspiration of liquids. A rehabilitative drinking cup that could control the flow of liquids to the throat was initially suggested as a means of assisting in this training. Requirements for such a device were to deliver a small, fixed amount of fluid at a time, with a mandatory rest (no suction) interval in between. Other requirements included adjustability (by the caregiver) of fluid amounts delivered, easy cleaning,



Figure 6.10. Rehabilitative Drinking Cup Prototype.

readily manufactured, and fail-safe.

## SUMMARY OF IMPACT

The particular individual for whom this device was designed was an elderly stroke patient, who was in speech-language pathology and physical therapy to relearn the ability to swallow. Unfortunately, she suffered another stroke midway through the year, and did not survive. We believe that the drinking cups would have been of great assistance to her, and continued the projects in the belief that they would help others in a similar predicament.

## TECHNICAL DESCRIPTION

All three devices (Figures 6.10, 6.11 and 6.12) incorporate a lid, a straw and double checkvalve, and a cup to accomplish the task of holding a liquid and metering its flow. The basic components of these devices are the straw and double ball/checkvalve arrangements, which utilize some form of modification from an earlier device by Toth and Yamaguchi (NSF 1999 Engineering Senior Design Projects to Aid Persons with Disabilities, pp. 36-37). One checkvalve is used to prevent fluid within the straw from flowing backward (back into the cup). This is necessary to prevent frustration, as the user might have exerted a great deal of effort to fill the straw with fluid in the first place, only to gain a single sip. With the first checkvalve in place, the straw need be filled only once. The second checkvalve closes after the measured amount of fluid is delivered, and maintains its closed state until suction from the mouth is completely released. This is necessary to allow the user time to swallow the measured amount of fluid, and importantly prevents the user from potentially aspirating the entire cupful of liquid. As in the earlier device, the second checkvalve is most commonly made using a freely moving ball and seal. If the ball is only slightly denser than the fluid, it will move upward

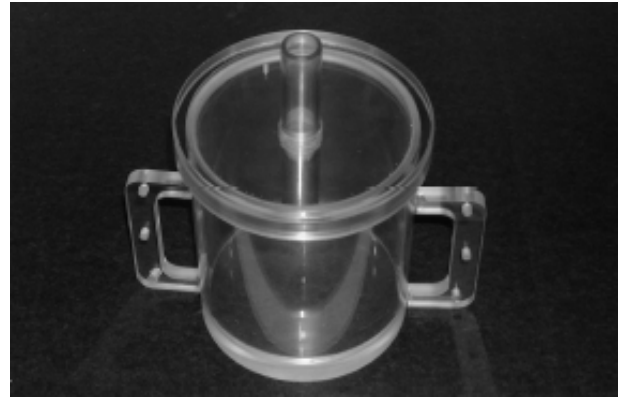


Figure 6.11. Rehabilitative Drinking Cup.

with the fluid during fluid delivery, block the flow when the measured amount of fluid is delivered, and sink downward within the straw when suction is released. As it sinks, the ball releases its block on fluid motion, and resets itself in the time it takes to sink to the level of the first checkvalve. Polypropylene balls were found to be good for this purpose, and allowed the user to take another sip after an interval of about 10 seconds.

The cost of materials for the drinking cups was nominal. Each of them was constructed using plastics for material costs of approximately \$30 each. The most expensive was \$31.10, primarily because the cup was large and required a large block of acrylic to be purchased.

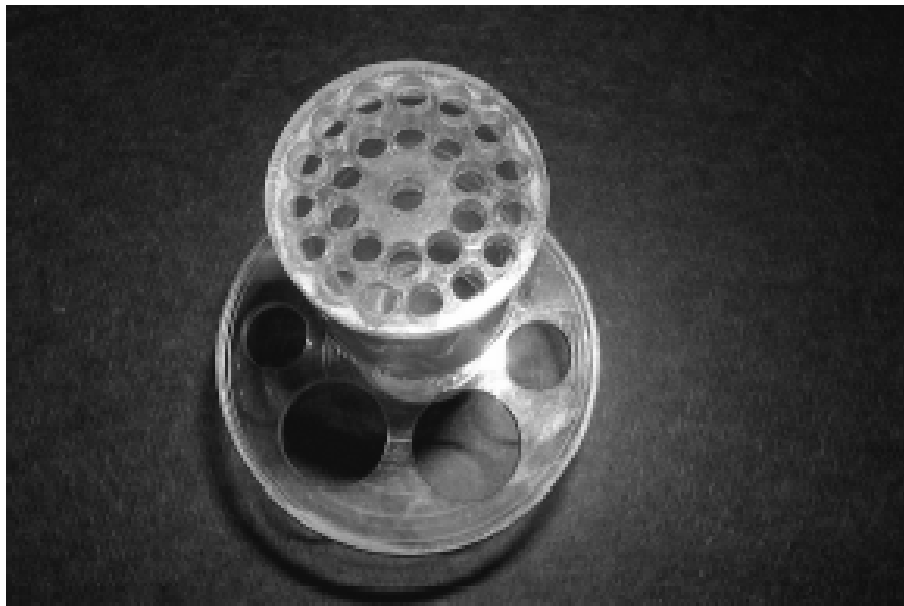


Figure 6.12. Working Portion of the Rehabilitative Drinking Cup.