CPVC Assessment Kit

Drill (cordless)
Shears
Hex Key Set (Master Mechanic)
Hack Saw (Master Mechanic)
Needle Nose Pliers
Mayes 12" Metal Ruler
Multi-bit Screwdriver (Master Mechanic)
10 piece Drill Bit Set
Drill Screwdriver Bits

Various length 1/2" CPVC
1/2" 90 elbows
1/2" 45 elbows
1/2" tee
1/2" straight coupler
1/2" female adapter
1/2" Male adapter
1/2" end cap
1/2" torque flange
1/2" to 3/8" reducing bushing
3/8" close nipple
ground clamps
1/4" x 21/2" machine screws
10/32 x 3/4" machine screws
10/32 x 1" machine screws
10/32 nuts
lock washers
hose clamps
cotter pins
PVC cement
PVC cleaner
nylon twine
adhesive velcro (reg. & heavy)
pencil/pen/paper

WORK BENCH COPY

ROUGH DRAFT
(Not for distribution)

Achieving Switch Mounts Using CPVC Pipe and Fittings[1]

Introduction

Commercially available mounting kits can be costly and frequently require considerable ingenuity when interfacing the various component parts to achieve that sometimes allusive "stable, optimal switch mount."

An inexpensive and easily constructed alternative to commercially available hardware can be found in the plumbing section of your local hardware store. CPVC (chlorinated polyvinyl chloride) pipe is a beige colored, rigid, heat resistant tubing that is typically used as hot and cold water supply pipes in residential homes. CPVC pipe is sized nominally according to it's inside diameter. The 1/2" CPVC pipe is the size most amenable to building switch mounts. Half inch CPVC pipe, once permanently assembled with solvent cement, can withstand 20 pounds of water pressure. It is therefore highly suited to building switch mounts able to withstand the pressure of forceful switch activation. Even prior to permanently gluing the component parts, the assembled mount is sturdy enough to allow the switch set-up to be subjected to systematic evaluation with a client. Thus the switch set-up can be thoroughly tested prior to making the mount permanent.

CPVC pipe is typically purchased in 10 feet lengths that can be cut to any size using a hacksaw or a CPVC pipe cutter. This ease of achieving variable pipe lengths is what makes CPVC mounts easier to assemble than most commercially available mounting hardware.

Included in the CPVC product line are a variety of 1/2" CPVC fittings. These CPVC fittings include elbows (that allow the pipe to turn corners), straight couplers (that allow two lengths of pipe to be joined, and tees (that allow three pipe lengths to be joined simultaneously). CPVC male and female adapters are also available and are employed in

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[1]To appear in Goossens', C. & Crain, C. (in preparation). Utilizing switch interfaces with severely physically challenged children: Assessment and Intervention issues. San Diego: College Hill Press/Little Brown and Company.

In addition to being a strong and easily assembled medium, CPVC materials are relatively inexpensive. Most switch mounts can be constructed at costs under $5.00. This feature is especially desirable when working with children. Growth spurts frequently necessitate changes in the child's seating and positioning. These changes in turn mandate frequent alterations in switch mount configurations. When CPVC materials are being used as the mounting medium, changes can be easily accommodated without inordinate long range expense or time.

In this handout the reader will receive information on how to assemble a basic CPVC mounting kit, how to adapt switch interfaces to accommodate CPVC mounts and how to design and assemble a CPVC mount.

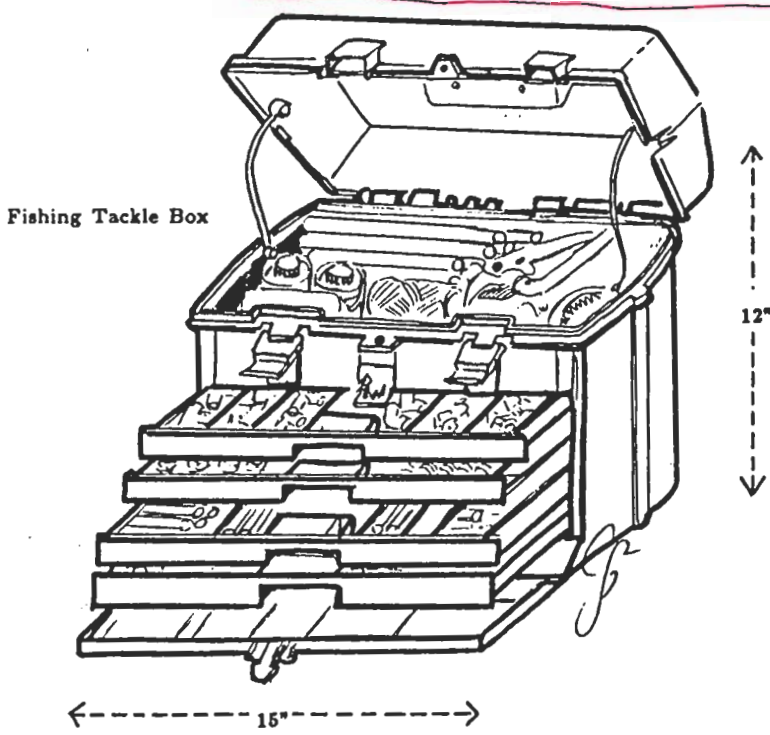
Assembling A Basic CPVC Switch Mounting Kit

An organized CPVC Mounting Kit can greatly facilitate the process of quickly assembling switch mounts. Illustrated in Table 1 are the component parts that comprise a basic CPVC mounting kit. Also included is information regarding the number of duplicate parts required and the use of each part in the assembly process.

Ideally the kit should include a variety of commonly used switch interfaces, pre-adapted to accommodate a CPVC mount. When a switch interface is pre-adapted, a CPVC mount can be achieved in a matter of minutes by experimenting with various configurations constructed from pre-cut lengths of CPVC pipe. To facilitate this trial and error process, it is recommended that the basic kit include two sets of pre-cut pipe ranging in size from .5" to 12.0" (.5" increments). The length of each pipe is numerically coded (e.g. .5, 1.0, 1.5) midway on its length. These length codes greatly facilitate the process of quickly locating a larger or smaller pipe as needed during the assembly process. A multi level fishing tackle/tool box (large enough to house a power drill and various switch interfaces) can be used to keep the kit organized and the materials readily accessible for assembly. When working in a diagnostic

center where switch mounts are assembled on a frequent basis, component parts can be stored in larger quantities in organizer or storage bins. Figure 1 visually depicts the storage options for the materials needed for constructing CPVC switch mounts.

Figure 1: Storage Options for CPVC Switch Mounting Materials



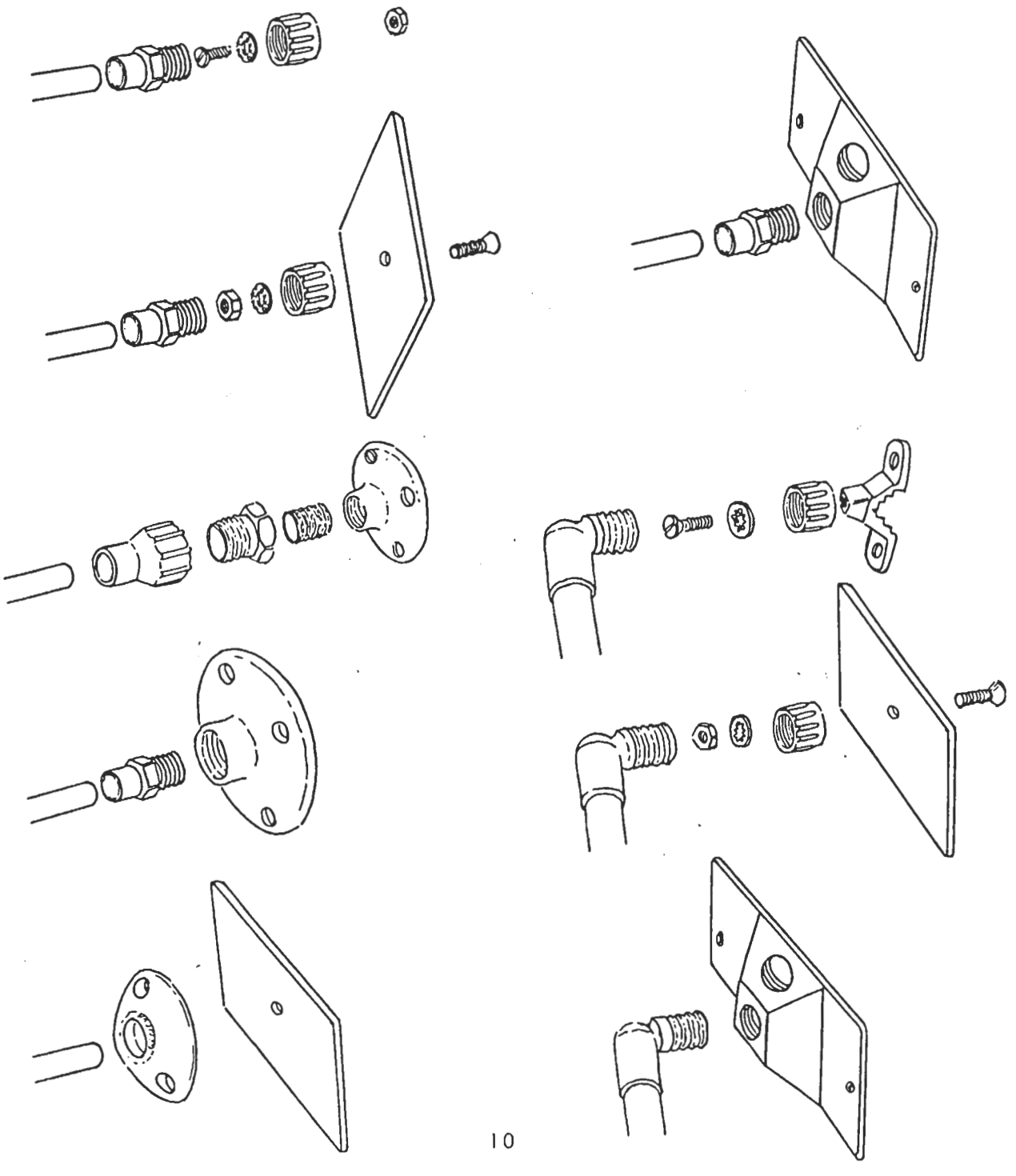
KMART
FISH TACKLE BOX
#30-40

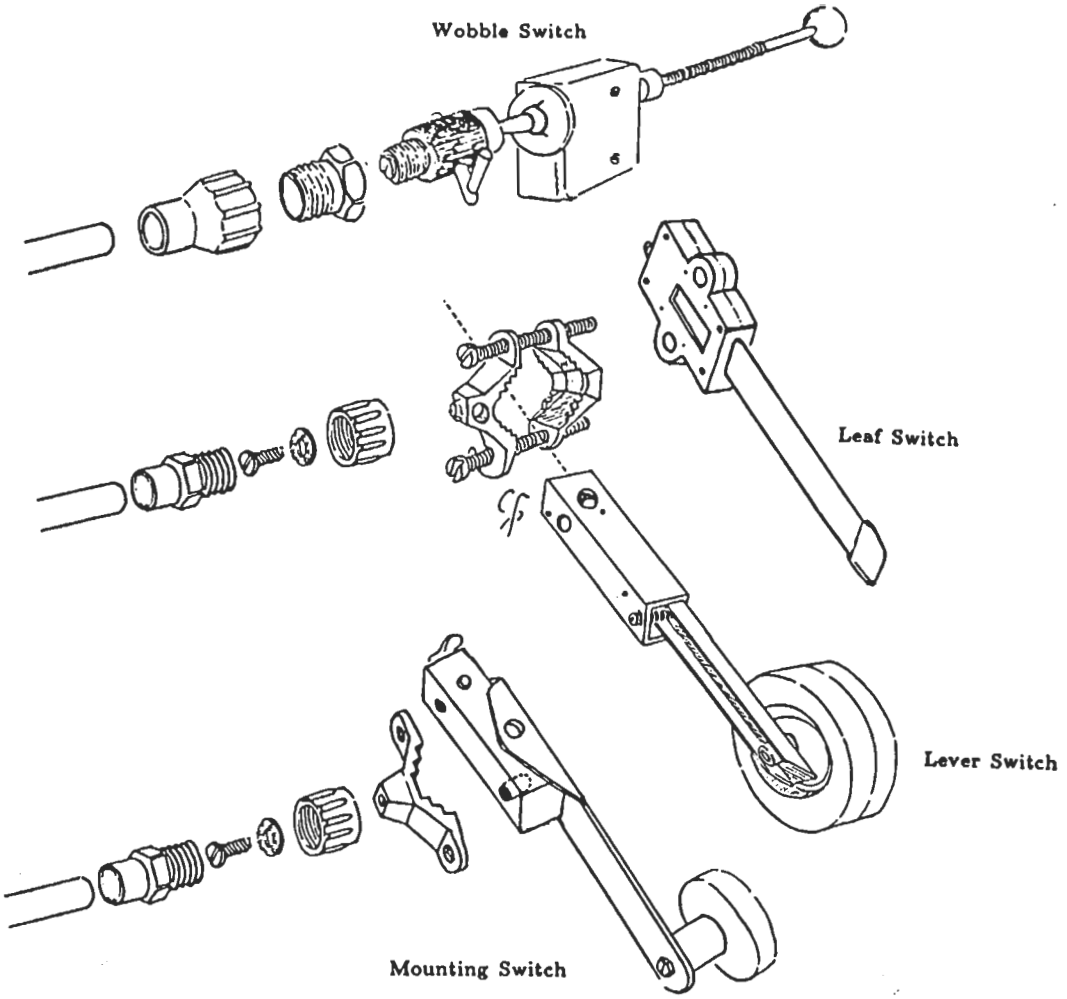
Adapting Switch Interfaces To Accommodate A CPVC Switch Mount

Many switch mounts can be adapted to accommodate a CPVC switch mount in a variety of ways. In general, methods vary in the relative strength of the adaptation (some adaptation are better able than others to withstand forceful pressure), the weight of the adaptation (especially crucial when the mount design necessitates suspending the switch a long distance out in free space); the cost of the adaptation (some component parts such as a genoangle adapter or a saddle tee are more costly); the permanence of the adaptation (some methods permanently adapt the switch therefore precluded its use in other formats); the flexibility of the adaptation to accommodate use in a variety of therapeutic positions (one method may be preferred over another because it can accommodate the mount designs for alternate therapeutic positions).

Visually depicted in Figure 2 are some methods of adaptation for a variety of commonly prescribed switch interfaces. Although far from exhaustive in terms of the number of switch interfaces that are now commercially available, the major types are represented serving as a guideline for similar adaptations.

Figure 2: Methods for Adapting Commonly Prescribed Switch Interfaces





Assembling CPVC Switch Mounts

Designing the Basic Mount. Handhold the switch interface in the desired location, relative to the control site (body part that will make contact with the switch interface). A position is required that: a) allows the client to reliably initiate, maintain or release contact with the switch interface, b) is close enough to the control site to allow activation without over exertion, yet far enough away to minimize accidental activation c) does not reinforce abnormal movement patterns or promote excessive overflow movements.

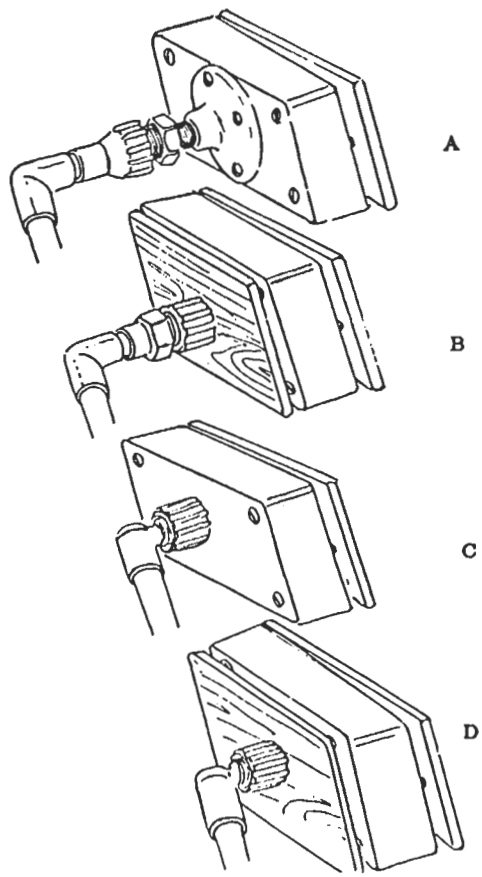
While holding the switch interface, visualize the most direct three-dimensional path that the CPVC pipe must take to attach the switch interface to the wheelchair frame. As a general rule, the more direct the path (i.e., the fewer the number of turns required and the shorter the distance a pipe must cross "free space"), the more stable the mount. Using the precut lengths of pipe and the fittings in the CPVC mounting kit, assemble the visualized mount much like

using an erector set. Use the length codes on the precut pipe to assist you in quickly selecting larger or smaller pipe lengths during the assembly process.

Selecting the Method of Switch Adaptation

As previously discussed, several options may exist for adapting a particular switch to accommodate a CPVC mount. Depending upon a) the design of the wheelchair frame, b) the need to utilize a specific switch with more than one control site or c) the need to utilize a specific switch in a variety of therapeutic positions, one method of switch adaptation may be preferred over another. Presented in Figure 3, are four options for adapting and mounting a head-activated pressure switch on a particular wheelchair frame.

Figure 3: Options for Adapting and Mounting a Head-Activated Pressure Switch on a Hypothetical Wheelchair Frame



Of the four options presented, options c and d are preferred for the illustrated wheelchair frame as they permit a more stable mount to be achieved with fewer turns. If this client's therapeutic plan, however, necessitated motor training with this same switch in a lap-tray presented, hand-activated format, option c would present as problematic. Option c permanently adapts the switch therefore precluding its use in a lap-tray presented, hand-activated format. As option d allows the same switch to be utilized in both a head-activated and hand-activated format, it would be the method of choice for this particular client.

Attaching the Mount to Supporting Therapeutic Positioning Equipment

When constructing a wheelchair mount for a head-activated switch, the vertical upright of the wheelchair frame (supporting the back) frequently serves as the mount attachment site. Although the wheelchair hand grips can also serve as an attachment point, this location may be less than optimal if presence of the mount compromises its use as a handgrip.

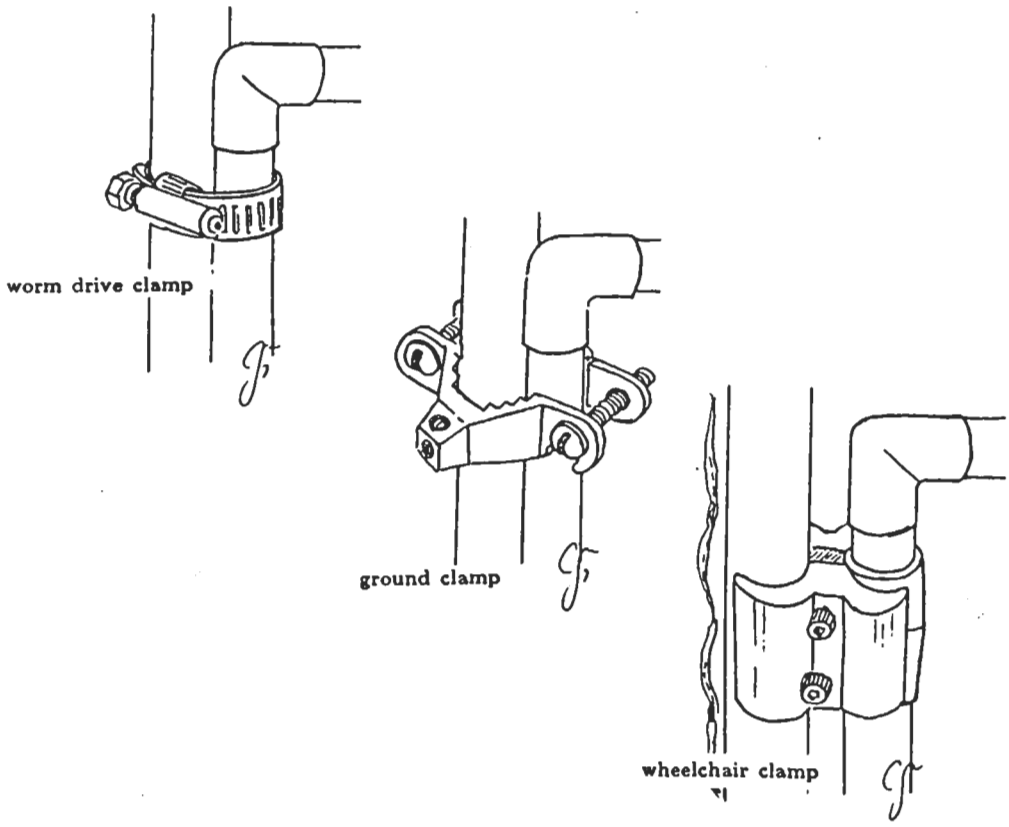
When constructing a wheelchair mount for a knee-activated switch interface, the point of mount attachment is frequently the wheelchair frame supporting the arm rests. This structure can also serve as a point of mount attachment to position a hand-activated switch at the end or side of the wheelchair armrest.

Three methods can be used to attach the CPVC pipe mount to the supporting structure of therapeutic positioning equipment: 1) metal ground clamps (typically used in electrical work for fastening a ground wire to a grounding rod) 2) metal worm drive clamps (typically used in plumbing and automotive work to secure a hose) 3) commercially available wheelchair clamps (specifically designed to attach commercially available adaptive fixtures to the wheelchair frame). When the wheelchair upholstery attaches directly to the wheelchair frame, the more expensive commercially available wheelchair clamp is the only alternative feasible for CPVC mount attachment.

When attaching clamps, care should be taken to position them at angles easily accessible for loosening and adjusting the mount during the "fine tuning" that occurs later in the

assessment process. Figure 4 visually depicts three methods for attaching the CPVC mount to the supporting structure of therapeutic positioning equipment.

Figure 4: Methods for Attaching the CPVC Mount to the Supporting Structure of Therapeutic Positioning Equipment



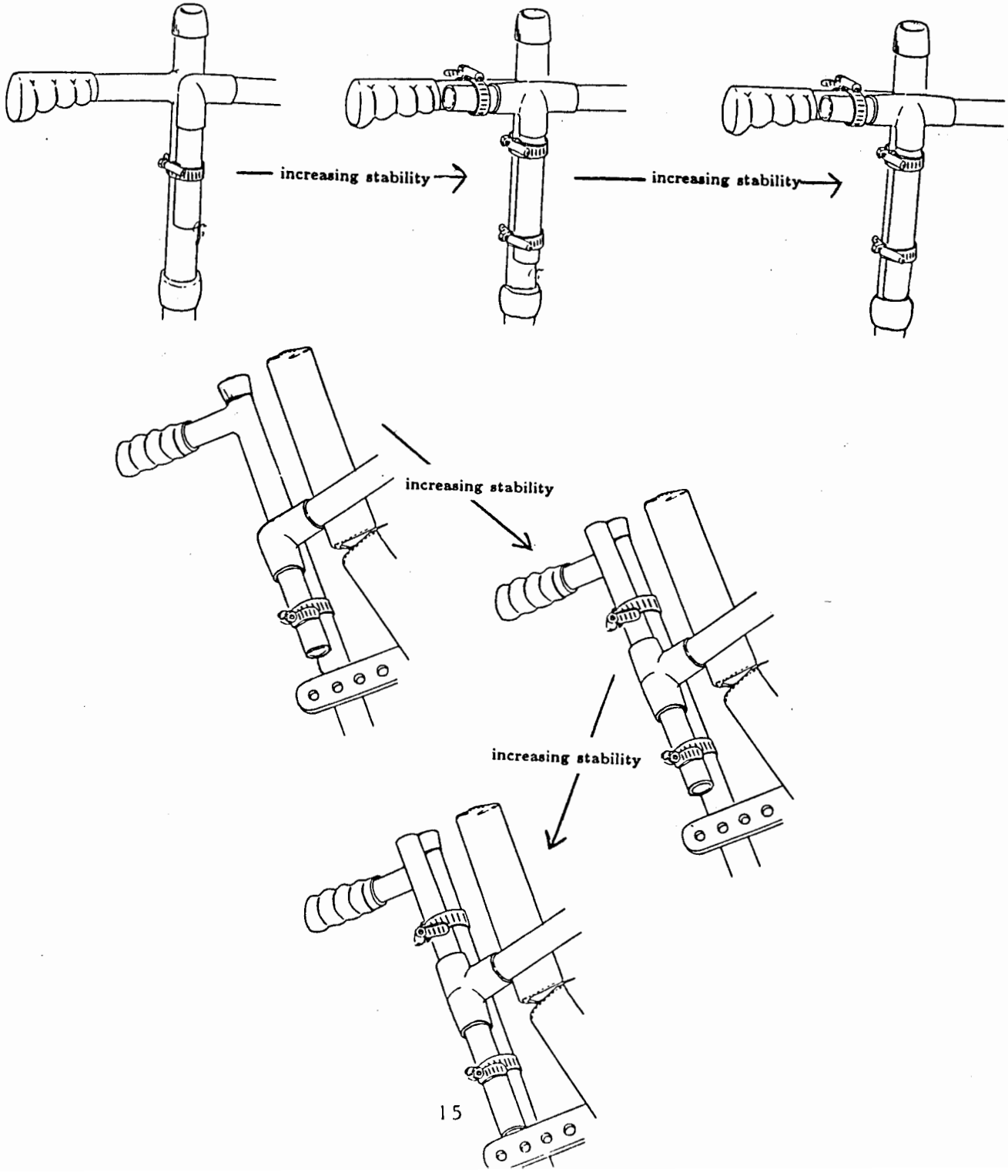
Increasing Mount Stability

It is not unusual for severely motorically involved clients to require an exhaustive number of trials to acquire proficiency with a target motor response for switch access. As a general rule, the more consistency that can be built into the response required for switch activation, the faster the speed of skill acquisition.

As the CPVC mount serves as the supporting structure for the switch set-up its stability is germane to the consistency of the motor response required for switch access. As previously discussed, the more direct, the path that the mount assumes, the greater its inherent stability. As illustrated in Figure 5, stability is also greatly enhanced when the mount design utilizes: 1)

more than one clamp, 2) tee fittings (permitting perpendicular clamping), and 3) pipe lengths that allow the mount to rest on or butt against existing frame structures. When constructing a head-activated switch set-up, stability can be further enhanced by designing the mount to allow the switch to be partially supported by the headrest. Care should, however, be taken to ensure that the headrest does not interfere in any way with optimal operation of the switch.

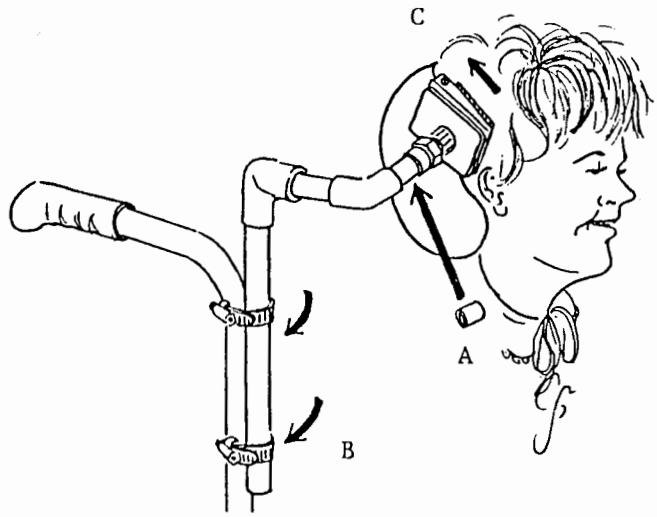
Figure 5: Methods of Enhancing Mount Stability



Fine Tuning the Mount

Once the preliminary mount is completed, assessments are conducted to determine if the mount continues to position the switch interface in a functionally optimal position for the client. It is during this phase of the process that different types of switches with accompanying CPVC mounts might be subjected to systematic evaluation. When a good set-up has been approximated, further fine tuning of the mount may occur. For example, if accidental activations present as problematic during assessment, the Interventionist may wish to increase the distance between the control site and the switch interface. As illustrated in Figure 6 this can be achieved by: a) substituting a shorter length of CPVC pipe to increase the distance between the control site and the switch, b) pivoting the CPVC pipe mount away from the control site at the level of wheelchair attachment or c) adjusting the orientation of the switch on it's velcro or duolock attachment point.

Figure 6: Options for Fine Tuning a Switch Mount

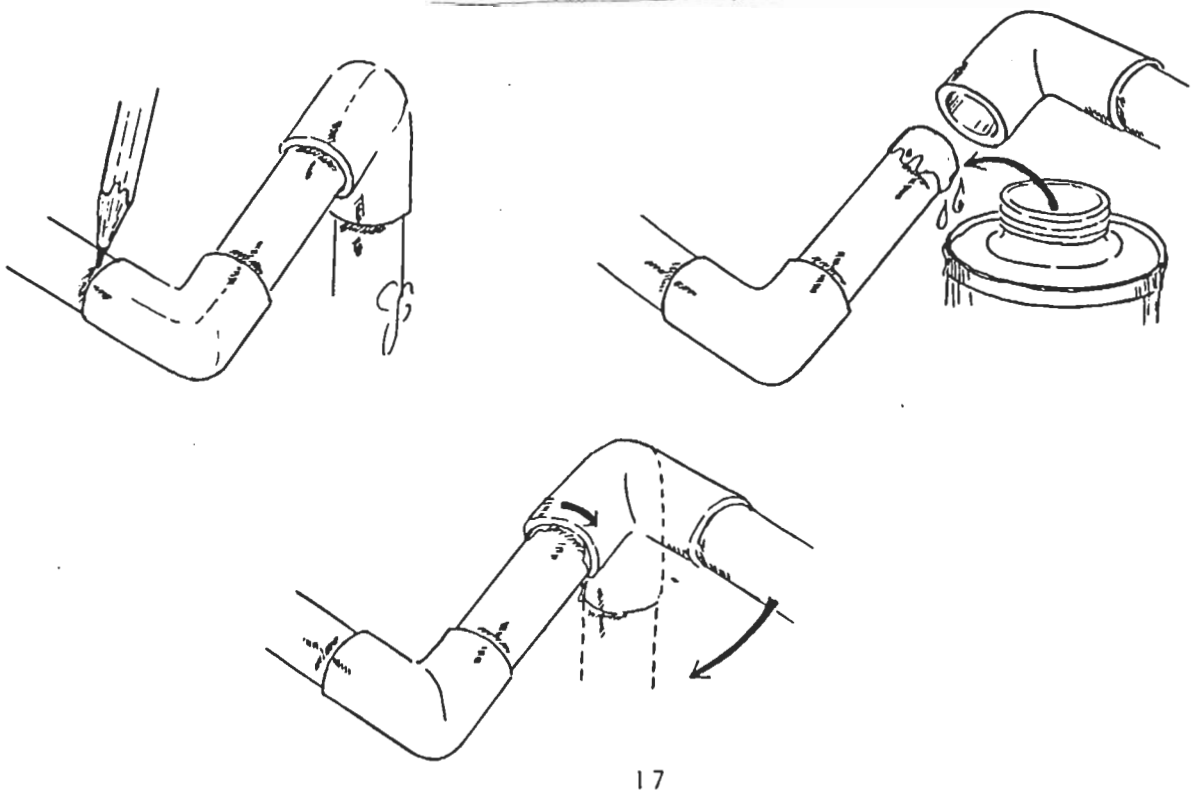


Making the Mount Permanent

When the Interventionist is sufficiently satisfied that a viable switch set-up and mount has been achieved, steps can be taken to make the mount permanent. Using CPVC solvent cement, all joints will be solvent welded except for one joint that will serve as a "removal joint". It is important to note that the assembled precut pipes of the kit are used in the client's permanent mount. The kit is later replenished with duplicate lengths. To maintain the exact three dimensional configuration of the mount during the solvent-welding process, a pencil is used to mark off each joint.

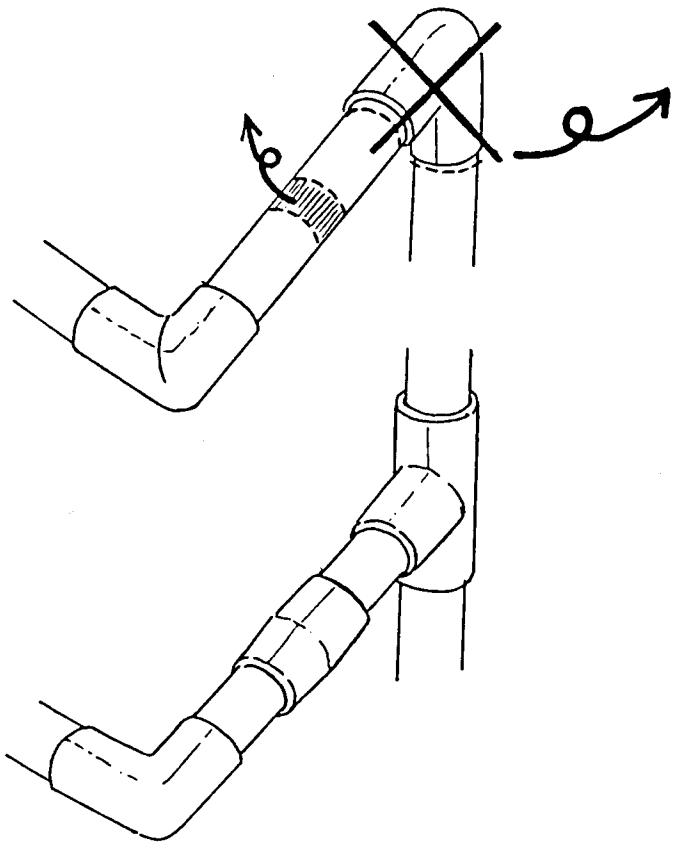
Joints should be solvent-welded one at a time. To weld a joint, dip the end of the CPVC pipe into the solvent cement, coating it approximately 1/2". As the solvent cement dries quickly and permanently, it is important to work quickly. Immediately join the pipe and its fitting full depth with a slight twist to bring it to its correct alignment (designated by the pencil markings). The twist breaks up insertion lines in the solvent cement. Hold the fitting until the solvent cement grabs tightly. Wipe away excess solvent cement with paper towels. Cement on your hands can be removed with hand cleaner. Figure 7 diagrams the process for solvent welding a joint.

Figure 7: Making the Mount permanent through Solvent Welding



Solvent welding is normally a one-way process, i.e., you can install the fitting but you cannot remove it. If you accidentally put the wrong fitting on the pipe, you must cut the fitting out leaving at least 1/2" of pipe so that straight couplers can be used to allow the correct fitting to be incorporated into the mount. Figure 8 visually presents this procedure for correcting errors.

Figure 8: Procedure for Correcting Errors

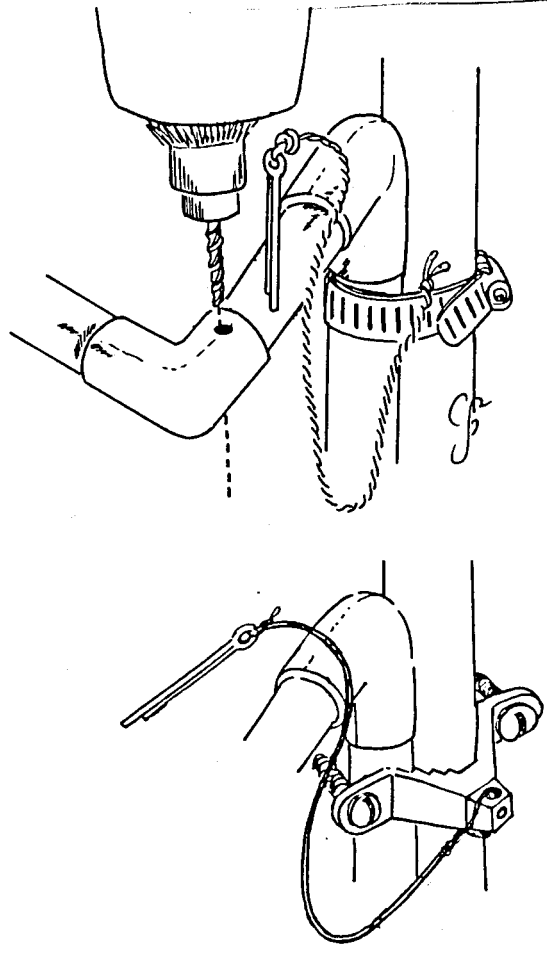


Incorporating a Removal Joint

The mount design must incorporate a method for easily and quickly removing the switch interface when transferring the user in and out of the wheelchair and the switch from one therapeutic position (e.g. seated in wheelchair) to another (e.g. on prone stander, in sidelying) and when removing the switch to minimize damage that might occur when transporting the wheelchair in the trunk of a car. Stability and consistency of switch presentation must, however, be maintained in the process. If a removal joint is not incorporated into the design, the Interventionist must either a) loosen, then tighten the mount

at its attachment clamps, (a time consuming process that jeopardizes attempts to maintain the required motor response highly consistent across time) or maintain looser attachment clamps allowing the entire mount to be pivoted away from the control site (compromising mount stability and consistency). As illustrated in Figure 9, a more acceptable alternative is to incorporate a cotter pin removal joint into the mount design.

Figure 9: Constructing a Cotter Pin Removal Joint



An electric drill is used to drill a hole through both the fitting and the inserted pipe of the removal joint. A cotter pin is inserted into this drilled hole to stabilize the joint. When drilling a hole for the cotter pin, care should be taken to ensure that the pipe is fully inserted into the fitting prior to drilling. To permit easy insertion, the cotter pin hole should be slightly larger than the outer diameter of the cotter pin. This can be achieved by using a drill bit equal in size to the cotter pin and reaming the hole slightly during the drilling process.

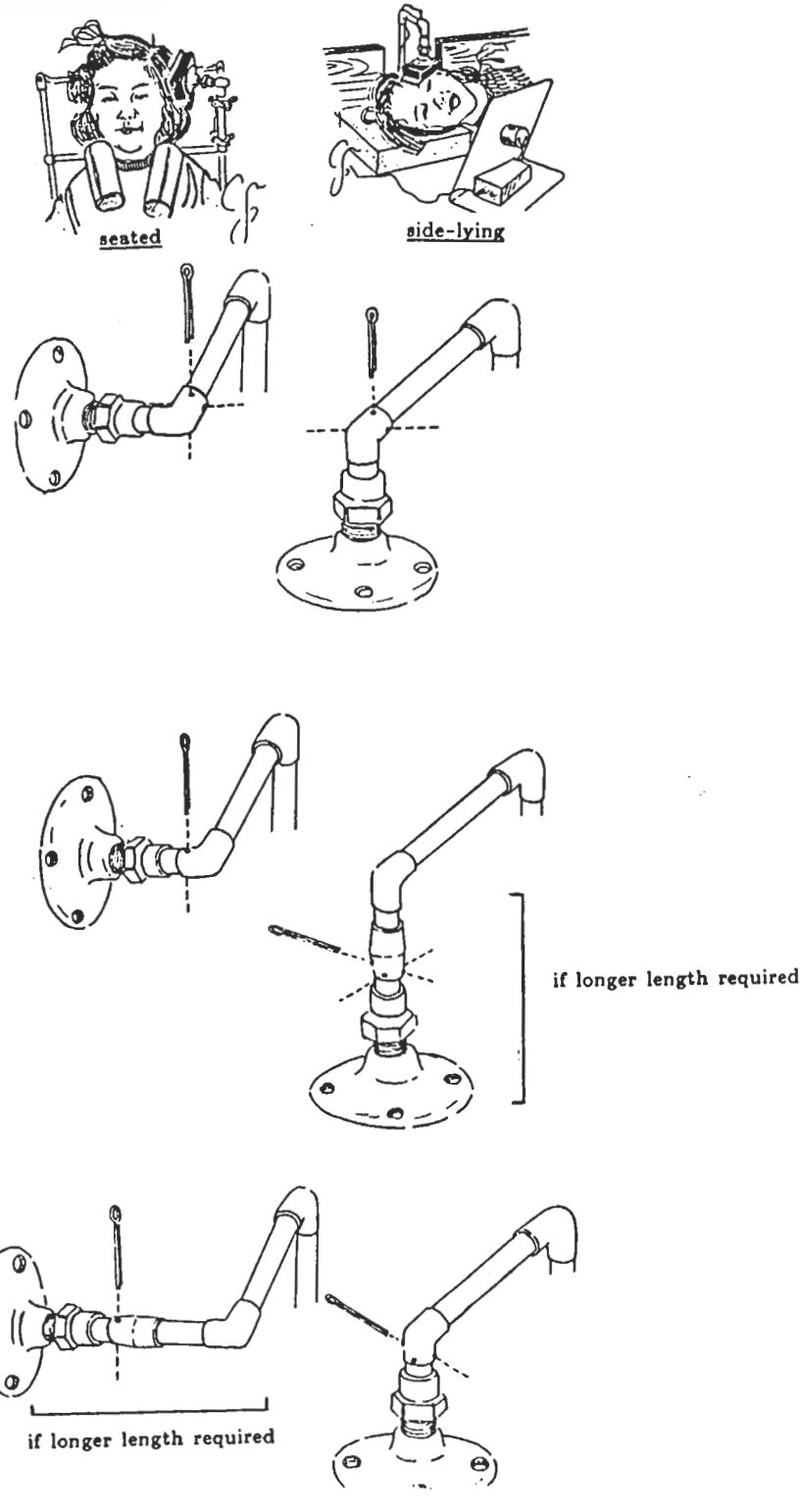
When selecting the joint to serve as a removal joint, care should be taken to select a joint that allows the switch interface to be easily removed from the CPVC mount without having to first move it into the control site. Figure 10 visually presents both incorrect and correct options for head and knee-activated formats, when selecting the joint to serve as a cotter pin removal joint.

Figure 10: Selecting the Joint to Serve as a Cotter Pin Removal Joint

Vertical placement of the cotter pin hole is preferred over horizontal placement. Horizontally inserted cotter pins tend to fall out especially given the vibration of wheelchair transport. When a pin is vertically inserted, gravity assists in keeping the pin intact in the mount. Although vertical insertion of the cotter pin is preferred there are instances in which true vertical insertion is not feasible. Limitations in the space needed to manipulate and insert the pin may preclude vertical insertion. In such compromised situations, the cotter pin hole should be vertically angled to ensure both easy insertion and secure stabilization.

As illustrated in Figure 11, cotter pin placement may also vary with the mount requirements for alternative therapeutic positions. If the mount for an alternative therapeutic

Figure 11: Designing the Removal Joint Mount to Accommodate Switch Use in Alternate Therapeutic Positions

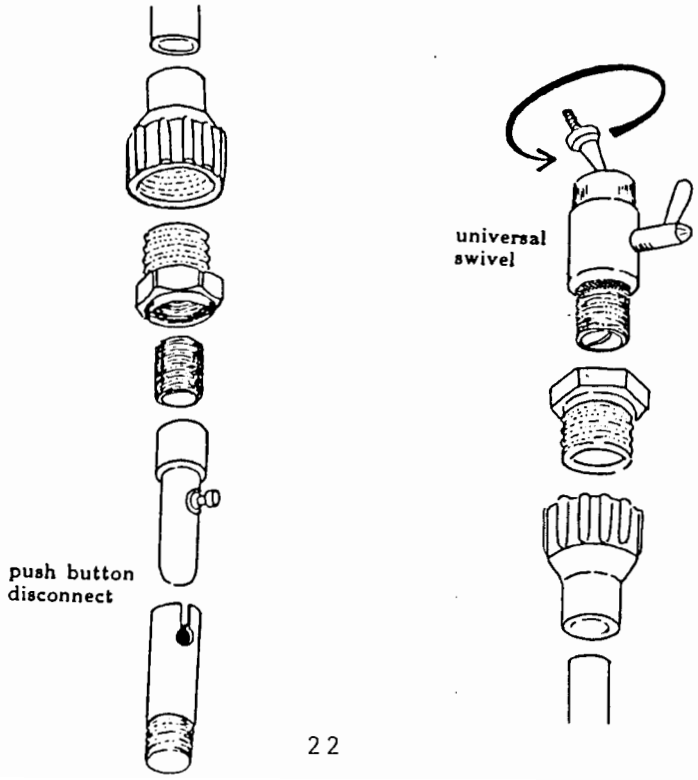


position necessitates extending the pipe length, CPVC straight couplers can be used to achieve this extension.

Constraints of transport must also be taken into consideration when designing the location of the cotter pin removal joint. Many wheelchairs are collapsible and transported in the trunks of cars. The size of the trunk may impose limitations on the distance that the CPVC mount can extend beyond the chair. The overhead clearance for entering the door of vans may impose similar limitations. In such instances, the amount of permissible clearance must be taken into consideration, the mount being designed to accommodate a removal joint lower on the CPVC mount.

Some components of commercially available mounting hardware can be used in conjunction with CPVC materials. In particular a push button disconnect can be incorporated into a CPVC mount design, providing an alternative to the cotter pin removal joint. A swivel clamp can also prove useful allowing the more refined adjustment of the switch in relation to the control site. Figure 12 depicts these combined mounting options.

Figure 12: Combining Commercially Available Mounting Hardware with CPVC Material to Achieve Switch Mounts



Making the Mount Aesthetic

Aesthetics should not be overlooked when building CPVC switch mounts. It is important to make the mount as cosmetically appealing as possible. CPVC tubing typically has lettering and numbers along its length. This printing and any soiled areas can be removed using CPVC pipe cleaner/primer. Some clients and their families opt to spray paint the mount; some selecting colors to make the mount less conspicuous; others selecting bright colors that accentuate its presence. The disadvantage of paint, however, is that it becomes scratched with time. It is also possible to coat the assembled mount with heat shrink plastic. Heat shrink plastic is commercially available in a variety of colors. It can be purchased at Mayer Electric Company, 3405 4th Avenue South, Birmingham, Alabama 35201.

References

How to work with plastic piping #21. (1984) ServiStar Show How Projects. Home Center Institute/National Retail Hardware Association Free pamphlet available at Hardware stores.

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SUPPLIES FOR ACHIEVING CPVC SWITCH MOUNTS

DIAGRAM	NAME	FUNCTION
CPVC Components	1/2" CPVC plastic pipe (two sets 1/2" to 12" in 1/2" increments)	
	1/2" CPVC 90 elbows (ells)	to achieve a 90 turn in a CPVC switch mount
	1/2" CPVC 45 elbows (ells)	to achieve a 45 turn in a CPVC switch mount
	1/2" CPVC Tee	to permit simultaneous joining of three pipe lengths
	1/2" CPVC straight coupler	to increase pipe width to accommodate commercially available wheelchair clamp to join pipe lengths or extend a pipe length
	1/2" CPVC female adapter	to transition from a 3/4" metal floor flange via a reducing bushing and a close nipple

DIAGRAM	NAME	FUNCTION
CPVC Components (Cont'd)		
	1/2" CPVC male adapter	used in conjunction with weather proof box to support mounting of a pressure switch
	1/2" PVC or CPVC cap	used in conjunction with half of a ground clamp to adapt switches to accommodate a CPVC pipe mount
	genoangle adapter/street adapter	to attach CPVC mount to switch via a CPVC or PVC 1/2" cap
	1/2" torque flange	to attach switch interface to CPVC pipe. With a false bottom it may attach directly to the switch or may be attached to a wooden or acrylite plate that accommodates a velcro attachment of a switch
Metal Components		
	1/2" to 3/8" reducing bushing	to transition from a 3/8" metal floor flange to a 1/2" CPVC female adapter via a 3/8" close nipple
	3/8" close nipple	to transition from a 3/8" metal floor flange to a CPVC female adapter via a reducing bushing

DIAGRAM	NAME	FUNCTION
Metal Components (Cont'd)		
	ground clamps	to attach CPVC switch mount to frame of therapeutic positioning equipment
	1/4" x 2-1/2" machine screws	used in conjunction with ground clamps to accommodate a larger frame
	10/32 x 3/4" flat head machine screws with nuts	to attach half of the ground clamp assembly to PVC cap (to adapt switches to accommodate CPVC pipe)
	10/32 x 1/2" flat head machine screws with nuts	to attach PVC cap to wood/acrylite plate
	1-1/2" stainless steel worm drive clamps	to attach pipe to frame of therapeutic positioning equipment
	tooth lock washers, star lock washer, flat lock washer, split lock washer (#10 INT)	used when modifying a PVC/CPVC cap to transition to half a ground clamp; lock washers exert a constant pressure on nuts so they won't thread off inside the cap

DIAGRAM	NAME	FUNCTION
Metal Components (Cont'd)		
	? weatherproof box (1/2" IP holes)	serves as a base for mounting a pressure switch
	wheelchair clamp (Zygo Industries, Don Johnston Developmental Equipment)	to attach mount to frame of therapeutic positioning equipment
	3/8" or 1/2" metal floor flange (the lighter, less bulky versions are preferred)	serves as a base for mounting a pressure switches
	cotter pins	used to stabilize a removal joint in the CPVC mount
	push button disconnect	used as a removal joint in a CPVC mount; requires a close nipple, a reducing metal bushing and a CPVC female adapter to transition
Equipment		
	CPVC pipe cutter (or hack saw/jewelers saw)a tubing cutter has a special wheel for use in cutting rigid plastics	

DIAGRAM	NAME	FUNCTION
Equipment (Cont'd)	electric drill	to drill cotter pin hole in removal joint
	screwdriver - electric (optional)	to attach ground clamps to therapeutic positioning frame
	4-3/4" needle nose pliers	to assist in removing small lengths of pipe from fittings
	8 - piece Hex-key wrench set (1/16" to 1/4")	to attach wheelchair clamps to frame of therapeutic positioning equipment
Other	ASTM-rated solvent cement) CPV or All purpose	to solvent weld pipe and fittings together
	CPVC cleaner	to remove grease, oil, dirt, and to prepare the mating surfaces for solvent cement action
		

DIAGRAM	NAME	FUNCTION
Other (Cont'd)		
	braided nylon cord or heavy gauge fishing line	to attach cotter pin to mount
	adhesive velcro/duolock	to temporarily secure pressure switch on flange/wood or acrylite mounting plate or weatherproof hood base
	2 x 4" pieces of 1/4" thick wood/colored acrylite	to serve as mounting plate for pressure switches
	12" metal ruler	
	pencil	to mark alignment of pipe and fittings prior to solvent weldin
	small scissors or pocket knife	to cut string for cotter pin
	small notepad	to document the need for replacement parts needed