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Participant's Manual
for viewers of
**Wheelchair Inspection
and Maintenance**
A Stitch in Time



Foreword

Now that you've seen all (or part) of the A/V set, **Wheel-chair Inspection and Maintenance—A Stitch in Time**, you probably want to review what you saw and heard, so you'll remember it better.

This participant's manual will make your review easier. While you're reading it, you may want to inspect a wheel-chair to help you learn.

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AV-1 Introduction

If you do a few simple and easy maintenance steps, you can save time, trouble, and money. That's why it is said: "A stitch in time saves nine."

Where to learn how

- (1) Wheelchair makers and dealers
- (2) Community colleges, universities
- (3) Disabled rights groups
- (4) The owner's manual

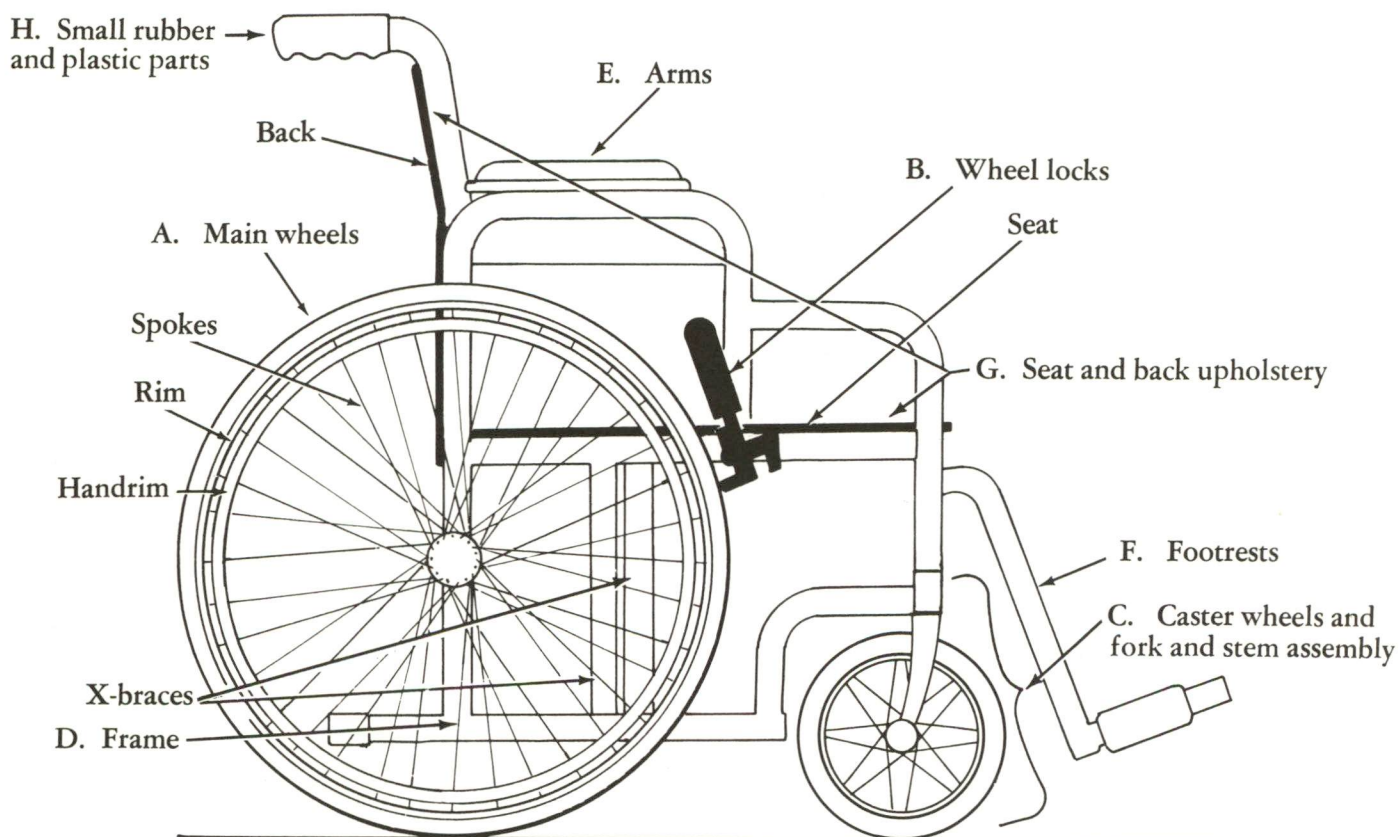
What you will need

- (1) A place to work
- (2) Knowledge of what to inspect and maintain
- (3) An inspection and maintenance schedule
- (4) Tools and supplies

For more facts, see—

- (1) the book, *Wheelchair Maintenance and Repair—a Stitch in Time*;
- (2) bicycle repair manuals; and
- (3) your wheelchair dealer.

Parts of the Wheelchair



No matter where you work, you should—

- (1) have a sturdy couch or chair;
- (2) put tools and supplies within easy reach;
- (3) use a newspaper to protect floor; and
- (4) sometimes, have a way to raise wheelchair above floor.

Inspecting wheelchair parts

A. Main wheels—check rims, tires, handrims, spokes (for tightness), adjustment of axle bolt connection of hub to frame, and grease in ball bearings in hubs.

B. Wheel locks—check for adjustment and wear.

C. Caster wheels and fork and stem assembly—check tires, axle bolt adjustment, bearing grease, tightness of stem, and grease in stem assembly bearings.

D. Frame—Check to make sure it is not cracked or warped. If folding, check lubrication of parts.

E. Arms—check condition of arm rests, side panels, arm locking and adjustment mechanisms.

F. Footrests—check adjustment and locking, and footplate swing. If present, check heel loops.

G. Seat and back upholstery—check condition.

H. Small rubber and plastic parts—check condition.

Special notes on repacking bearings

Grease is needed.

A grease solvent, like kerosene or carburetor cleaner, is needed.

BUT—Solvents are often flammable and give off fumes.

Try to get a non-flammable solvent.

Read the label carefully.

Use solvents only in a well-ventilated area away from open flames and smokers.

NEVER use gasoline as a cleaning solvent.

An Inspection Schedule

At least once a month:

- ☐ Check tire pressure of pneumatic tires (weekly is better).
- ☐ Check wheel lock adjustment.
- ☐ Inspect for loose or broken wheel spokes.

Every three months:

- ☐ Clean and adjust tightness of main wheel axle bolts, caster wheel axle nuts and bolts, and caster wheel fork stems.
- ☐ Clean and wax all chrome-plated parts.
- ☐ Clean and protect upholstery and armrests.

Every six months:

- ☐ Inspect and adjust all the normal wearing parts of the wheelchair.
- ☐ Lubricate main wheel bearings, caster wheel bearings, and caster stem bearings by repacking them with grease.
- ☐ Oil cross brace bottom tubes and center pin.

Once a year:

- ☐ Inspect and service the entire wheel chair. **This is a good time to take it in for dealer inspection.**

P.S. If you put more wear and tear on your wheelchair than most people, or use it outside a lot, you should inspect and maintain it more often.

Tools and supplies needed

- ☐ Wrench, other tools that came with chair
- ☐ Safety glasses or goggles
- ☐ Ball peen hammer
- ☐ A 3/8-inch box wrench and a 1/2-inch box wrench
- ☐ 8-inch and 10-inch adjustable wrenches
- ☐ Phillips screwdriver
- ☐ Regular blade screwdriver
- ☐ Offset screwdriver, with both Phillips and blade tips
- ☐ Spoke wrench
- ☐ Pliers
- ☐ File or sandpaper
- ☐ Tire pressure gauge
- ☐ Tire pump (it's safer than a gas station air hose)
- ☐ Mild cleaner, like dishwashing liquid
- ☐ Oil can with 30-weight oil (Household and sewing machine oil are too thin.)
- ☐ Paraffin wax, a common candle, or silicone-type lubricating spray
- ☐ Chrome cleaner and polish
- ☐ Plastic and rubber preservative
- ☐ Automotive cleaner/wax
- ☐ Cleaning rags or paper towels

AV-2 The Main Wheels

Spokes and rims

Loose spokes—

—weaken the wheel, and can cause punctures.

Spokes should be equally tight.

To test, strum spokes or tap each spoke separately, and listen.

A lower sound means spoke is too loose.

A higher sound means spoke is too tight.

With a snugly fitting wrench, tighten or loosen as needed, a small amount at a time, checking sound often.

After hard use of a wheelchair—

—check spoke tightness.

Broken spokes—

—should be replaced as soon as possible. This is difficult, and you may prefer that a repair person do it.

Inspecting the rim:

Look for dents, hop, or wobble.

Inspect by rotating a wheel and watching a reference point close to the rim. The wheel lock assembly is a good point.

The rim should not appear to move relative to the reference point when it is rotating. Apparent movement shows a problem.

If just one part of rim seems to dip away, it is dented.

If the entire rim seems to move toward and away, the problem is wheel hop.

If rim moves from side to side, the problem is wobble.

A dented rim—

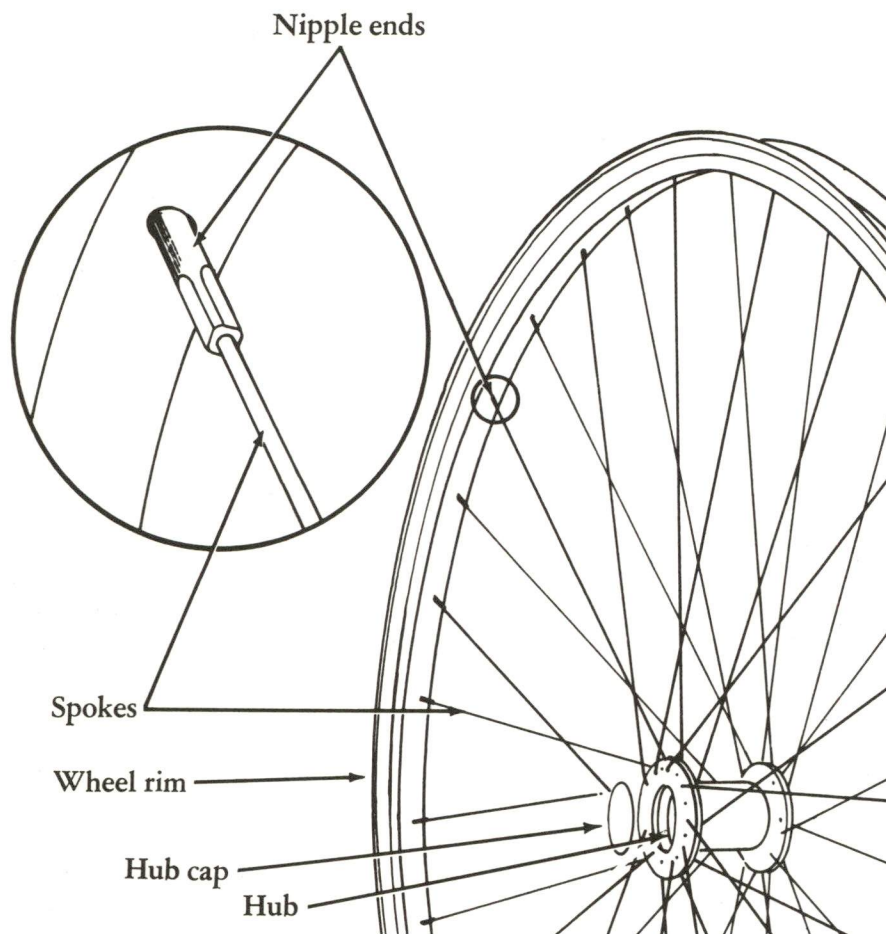
—is present if part of rim seems to dip away from wheel lock each time it comes around;

—is caused by wheel hitting something;

—may not cause a problem, but spokes may be loose near dent, and tire may be damaged; and

—may require repair or replacement by dealer or bicycle shop.

Parts of a main wheel



Wheel hop (radial runout)—

—is present if whole rim seems to move toward and away from wheel lock;

—is caused by careless spoke tightening that made wheel out-of-round; and

—can be fixed by (1) loosening spokes on side where rim is closest to hub, and (2) tightening spokes on side where rim is farthest from hub, to center the hub. (This operation is described in bicycle books under "wheel truing.")

Wheel wobble (lateral runout):

—is present if rim moves from side to side relative to lock when spinning;

—makes the chair hard to control and push, strains spokes and other parts; and

—is difficult to fix, so is probably better done by wheelchair dealer or repair shop.

Main wheel hubcaps, axle bolts, and bearings

Hubcaps—

- protect bearings from dirt and water;
- protect hands and clothing from grease;
- should always be present on main wheels;
- can be removed by prying around edge with a screwdriver; and
- can be replaced by lining up square with hub and tapping carefully with mallet or hammer.

Main wheel axle parts

The axle bolt runs through ball bearing assemblies and attaches axle to frame.

Each ball bearing assembly is packed with grease to let the wheel spin easily.

Axle must have a locknut to keep bolt from working loose, and permit tightness adjustment.

Main wheel axle care

Tightness of axle bolt must be correct. Worn bearings can become too loose.

To check, tilt chair and spin main wheel. Also, grab wheel by rim and try to wiggle from side to side.

Wobble, or side-to-side movement, means axle is loose.

If adjustment is needed, first unscrew axle locknut with one wrench while holding bolt head with other.

Then tighten bolt head just enough to remove wobble but let wheel spin freely.

Check tightness by tilting chair and spinning wheel. It should stop slowly and smoothly. Jerky stop means it's too tight. Loosen slightly.

When bolt tightness is right, retighten locknut. Use two wrenches as before.

Repack main wheel bearings with grease every six months. Sometimes replacement is necessary. See manual, *Wheelchair Maintenance and Repair—A Stitch in Time*.

Solid tire care

Inspect for wear and cracking. Replacement may be needed.

If tire is loose on rim, or there is a gap between ends, have tire replaced.

Tires with thick wire at center require dealer service.

Some types of solid tires can be installed by a non-dealer, but they are often not satisfactory for certain uses. Check with dealer.

Pneumatic tire care

Check tread grooves for damage, small pebbles, bits of glass, other objects. Remove if found.

Check sidewalls for cracking. Replace if badly cracked.

Check tread for wear. Replace tire if too worn.

Check tire pressure once a week. Do it first thing in the morning, for more accurate reading.

Best gauge type will hold reading until it is reset to zero.

Steps in checking pressure:

- (1) Remove cap from valve stem.
- (2) Push gauge squarely against end of valve stem. If done right, only a little air will get out and there will be almost an instant reading.
- (3) Remove gauge from stem and read pressure.
- (4) Compare reading with recommended pressure on tire sidewall.

Steps in correcting air pressure:

- (1) If too high, bleed air a little at a time by pushing center of valve stem. Check pressure often.
- (2) If too low, put more air in tire with gas station air hose or hand tire pump.
- (3) If used, hand pump should have flip-type coupler for quick attachment and removal.
- (4) Attach hand pump hose and pump the handle several times.
- (5) Remove coupler and take pressure reading.
- (6) If too high, bleed off air. If too low, attach hand pump again and put more air in tire.
- (7) When a gas station hose is used, put in only a little air at a time because it could blow tire out.
- (8) Press fitting against stem one second at a time, then re-check pressure.
- (9) Bleed air, add air, or stop, as indicated.

Handrims

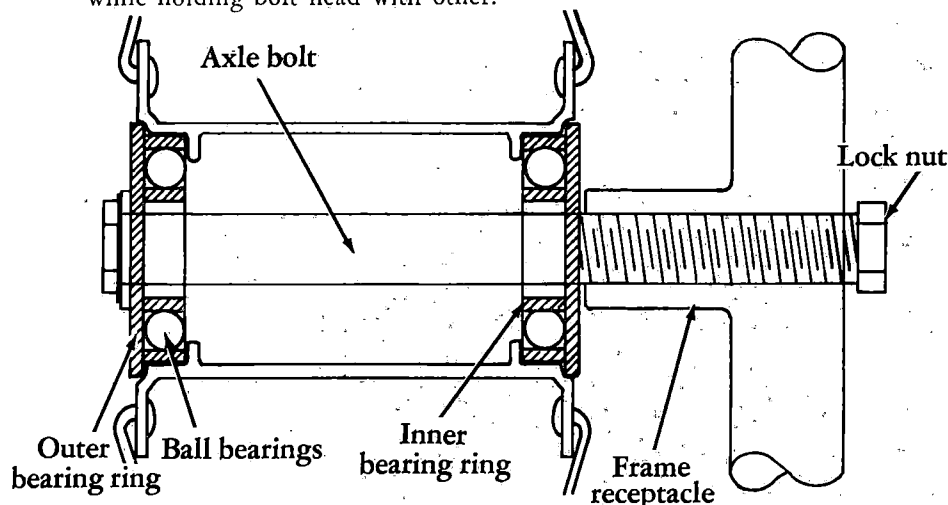
Handrim care

Check for smoothness or cracks in chrome plating that could cut your hands. Smooth rough places with file or sandpaper, or cover with tape.

Replace a damaged handrim as soon as you can.

Make sure handrims are firmly attached to brackets, and brackets firmly attached to the wheel rims.

Be sure none of the connecting parts are missing—screws, bolts, or washers.



The locknut holds the axle bolt in place, and makes it possible to adjust tightness correctly.

Caster fork inspection

Check to see if sides are bent.

Cracking of chrome plating may indicate bending.

Be certain stem is solidly attached to fork.

Caster fork stem housing should have a dust cap, for protection.

Caster fork stem tightening

Stem and bearing around it let caster wheel assemblies turn.

To check, grasp fork firmly and try to shake or twist up and down and back and forth. Adjust if fork wiggles or is hard to turn.

These are the steps in tightening fork stem:

(1) Remove dust cap by gently tapping.

(2) Tighten or loosen stem nut in same way main axle bolt was tightened.

(3) Caster wheel must be free from fluttering and shimmying. But don't turn nut so tightly chair becomes hard to steer.

(4) When tightness is correct, gently tap dust cap back on.

Stem bearings should be repacked with grease every six months. See *Wheelchair Maintenance and Repair—A Stitch in Time*.

Caster wheel axle tightness

Caster wheel bearings are similar to those in main wheel and in caster stem.

Usually caster wheels have felt washers and string guards to keep things out of caster wheels. Be certain both washers and guards are present.

To check adjustment, grasp fork firmly then spin and wiggle caster wheel. It should be snug but free-spinning.

A slight wobble means axle nut and bolt should be tightened.

If wheel stops very quickly bearings are too tight and axle nut should be loosened.

Bearings should be repacked with grease every six months, using same methods as for main wheel bearings and caster stem bearings.

Caster wheel tires—solid and semipneumatic

These must not be loose on the rim.

Replace solid tire if loose, worn, or badly cracked.

Replace semipneumatic if tread is worn or if damage has released air.

There are many types of tires and caster wheels, so you may want to discuss them with dealer when replacing.

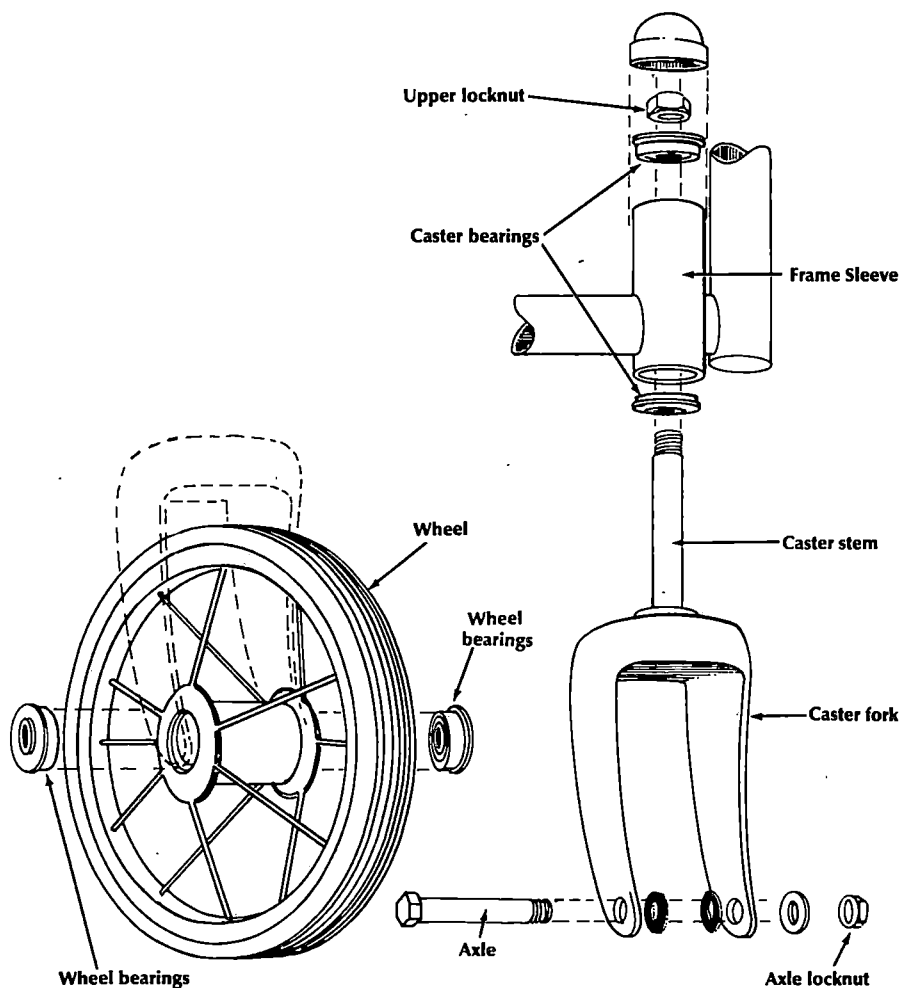
Caster wheel tires—pneumatic

Check and adjust pressure as often as for main wheel tires.

Check for sidewall cracking, tread wear, foreign objects in treads.

Be very careful when filling with gas station air hose, because tires can overfill quickly and burst.

Because there are several types, check with dealer when replacing.



Parts of a caster assembly

Wheel locks—

- prevent the wheels from turning, which holds wheelchair in place;
- have hand grips that are rubber-tipped and must be firmly attached;
- have pivots that must not be worn or wobbly, and need to be oiled with 30-weight oil once a month; and
- come in two types, toggle-type and lever-type.

Toggle-type wheel locks

This type works by pushing firmly against tire surface.

If pneumatic tire pressure is low, lock cannot hold as well. Also, tire wear causes lock to lose grip.

Lock should hold tightly, but not be too hard to work with hands.

Steps in adjustment:

(1) Loosen wheel lock assembly so it can slide.

(2) Put lock in "on" position and slide unit closer until bent metal shoe touches tire.

(3) Turn wheel lock to "off" position. Shoe will swing away from tire.

(4) Slide whole lock about 1/4-inch closer to wheel.

(5) Tighten mounting nuts. In most cases adjustment will be about right.

Lever-type wheel locks

These can also need adjustment, because of low tire pressure or worn tires.

Move lever back and forth to "on" and "off" positions.

Contact of projecting shoe with tire should keep chair from rolling.

Lever, notches, and pivot should not be so worn they slip or break. By having several notches, this type of lock can compensate for wear

easily. Also, on some chairs the notched plate can be loosened, slid, and retightened to adjust lock tension.

Antirollback devices

These let wheels move up inclines, but prevent rolling backward.

They are located next to toggle-type wheel locks.

Serrated pieces should pivot smoothly.

Locknuts should not be loose or missing.

Serrated piece is normally kept away from wheel by spring-loaded ball. Ball can become worn. To adjust for wear press screwdriver down over ball hard enough so blade can fit into slots at sides of ball. Screwdriver is turned counterclockwise to move whole unit outward.

AV-4

Frame, Arms, Footrests

Inspecting main frame and cross-braces

Be certain all screws, nuts, and bolts are tight. Replace if missing.

If fasteners have burrs or sharp edges, replace or smooth with file or sandpaper. Don't damage chrome plating of tubes.

Look for cracks or peeling chrome plating. They can show frame damage, and dealer inspection may be needed.

Check for smoothness of folding.

Sight down frame rails to be sure they are parallel and not bent. If bent, check with dealer about straightening.

Be sure center pin through cross-braces under seat moves freely.

Center pin locknut must be firmly attached. If missing, replace at once.

Lubricate center pin with drop or two of 30-weight oil every six months or oftener.

Bottom tubes of crossbraces also need lubricating, by putting drops of oil in small holes in the tubes.

Front post slides

If sliding or telescoping front posts are present, be sure they are round and straight. They must not come out of tops of tubes they slide in when chair is fully folded.

Unfold chair fully to be sure posts do not stick out of bottom of front tubes. They could damage caster forks, and block steering.

Front post slides need special lubrication. Use a dry, non-sticky lubricant, as a block of paraffin wax, a common candle, or silicone spray.

Seat rail guide tips

These keep the seat rails in the right position when chair is open or folded.

They are self-lubricating and normally need no maintenance. But if badly worn or missing they must be replaced soon as possible, by the dealer.

The arms

Screws connecting armrests to arm tubes must be in place and screwed down tight. If burred, smooth them with file or sandpaper, or replace. Be careful not to burr new screws.

Check for sharp edges or cracks which could scratch, pinch skin, or weaken armrest.

The armlocks

If detachable, work several times and be certain they latch fully and hold arms tightly.

Toggle-type arms should be lubricated at pivots with drop of oil or brief squirt of lubricant spray.

Pushbutton locks also need lubrication with oil drop or spray. Wipe off extra oil in both cases.

Detachable arms

Unlatch locks and slide arms out of sockets, then slide back into place. They should fit snugly and securely but not bind.

Lower ends of arms telescope, and should be lubricated with paraffin, candle wax, or dry lubricant spray. If hard to remove, they may be bent.

Here are steps for fixing a small bend:

- (1) Look closely to check which way to re-bend

- (2) Remove arm, turn upside down, and push, pull or twist tubes in proper direction.

- (3) It will be easier if screw-driver or metal rod is slid into each

tube end. But be careful not to change round shape. Distortion will prevent refit. (Be careful not to crack or warp arm side panels.)

Adjustable arms

These are like detachable arms, with extra section for height adjustment. Inspect, adjust, and lubricate as for detachable arms.

Sidepanels

Inspect these for sharp edges and burrs. Tape over or smooth with sandpaper or file.

Protruding corners or edges can be bent with pliers or light taps with hammer or mallet.

Fasteners should be in place and tight. Replace side arm panel if cracked.

Footrests

For swing-away type, check to be sure locks latch and release properly. Legrests should swing outward smoothly, and automatically relatch when swung back into place. Put a drop of oil on sliding parts of lock and on the footrest pivots.

For lift-off footrests, be sure latch latches and releases fully. It should not be warped. Put a drop of oil on latch pivot occasionally.

A few older wheelchairs have telescoping footrests. Tubes should not be bent and locks should work properly. Lubricate tubes with dry, non-sticky lubricant.

Footplates

Check for sharp edges, and smooth with sandpaper or file.

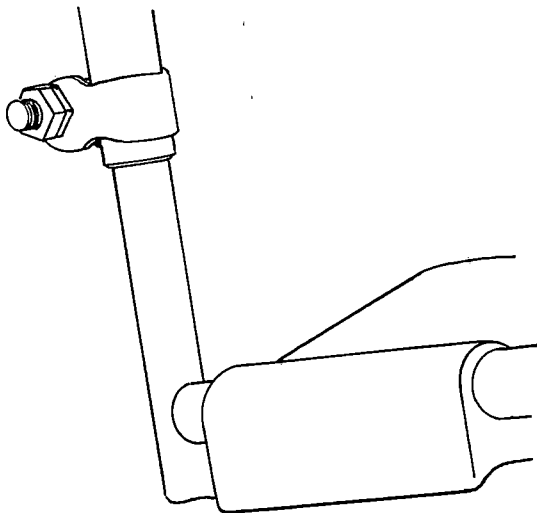
Fold footplate slowly up and down. It should stay in any position. If it flops, replace footplate spring. See *Wheelchair Maintenance and Repair—a Stitch in Time*.

Heel loops—

- should not be frayed or bunched up;
- should be held tightly in place by bolts and nuts; and
- can be replaced. See *Wheelchair Maintenance and Repair—A Stitch in Time*.

Footrest length—

- is usually set when wheelchair is first fitted;
- is kept the same by tight adjustment of either (1) bolt on bottom of each footrest tube, or (2) pinch-bolt part way up footrest tubes. (Note: these telescoping tubes should not be lubricated, because they should not move.); and
- should be at least 2 1/2 inches from bottom of footrest to the ground, when on a level surface. But, user comfort is most important, so a lesser distance may be needed.



Footrest frame, showing one of two types of bolts used for height adjusting. This one is a pinch bolt about half way up the frame.

AV-5 Upholstery, Rubber and Plastic Parts, Metal Surfaces

Upholstery—

- should be a material suited to your activities and weight;
- should be firmly attached;
- should be inspected outside for cracks and rips;
- may have something wrong with the inner liner;
- can cause you problems if it sags; and
- needs cleaning now and then.

Upholstery attaching parts

All attaching screws and load-spreading washers between screw-heads and material should be tightly in place.

Replace screws that turn freely. They have stripped threads.

Look for burrs or rough edges on screws, and smooth or replace them.

Upholstery materials and inner liners

Cracks and rips develop where material bends most during folding and unfolding.

Check along middle of seat and back.

Check where upholstery fastens to frame.

Minor cracks can be covered with mending tape. They also let you look through to inner liner to inspect it.

If liner is faulty, you may slide about in the chair.

Another way to see liner: (1) unscrew seat and back, (2) slit outer covers with knife along heat-sealed seam.

Reinstalling seat and back

Be certain screws go through metal reinforcing strips.

Tighten screws fully.

Fully open chair, then check slack at top and bottom of back. It should be about the same.

Next, with fully open chair, check slack at front and back of seat. It should be about the same.

Uneven slack may point to hidden damage of liners of back and seat, or frame damage. Dealer attention is needed.

Sagging upholstery

If seat and back have been used a long time, they may sag too much and not support body well. Sag can cause body and frame problems.

One sign is if seat has much more slack than back.

Second sign is if back has much more slack than seat.

Upholstery care

Plastic upholstery can be cleaned with mild detergent, saddle soap, or vinyl cleaner.

Seat and back surfaces need vinyl dressing or other protectant or preservative. Follow instructions carefully.

Armrest care

Check for sharp edges and cracks. It may be possible to smooth out or tape over minor sharp edges or cracks.

Replacement may be needed. For methods, see *Wheelchair Maintenance and Repair—A Stitch in Time*.

Armrests receive the same cleaning and preservation as backs and seats.

Rubber and Plastic Parts

Handgrips should be in good condition and firmly attached—not cracked, worn, or loose.

One way to fix a loose handgrip is to wrap black plastic electrical tape around frame tube, then slide grip back on.

Looseness can also be fixed by reattaching handgrip with adhesive of some type.

To remove old handgrips that won't be used again, slit with knife.

To prepare for new handgrips (1) clean tubing with solvent like nail polish remover, (2) either wrap tape around tube or apply adhesive, (3) if grips have finger notches, be certain they face down, (4) carefully slide on new grips, (5) wipe off excessive adhesive and let set.

New grips should be cleaned with detergent or vinyl cleaner, then preserved with same protectant used on seat and back.

Rubber tipping lever sleeves should be tight and not rotate on levers. They get same care as handgrips.

Rubber tips on wheel lock handles should fit snugly. If tape or adhesive won't ensure fit, replace.

ment may be needed. Clean tips with mild detergent and preserve with spray detector.

Wheel sidewalls resist cracking and aging longer if cleaned and preserved. Use same cleaner and spray as for other plastic and rubber parts. Keep spray away from tire treads. It could make tires slippery.

Metal Surfaces

Check plated metal surfaces for wear and rust.

Clean surfaces with dry rag or paper towels. Wash with detergent and water. Carefully dry.

Small bits of rust should be removed, with chrome cleaner and polish, following directions.

To protect spots after rust is removed, dab with clear nail polish.

Special problem areas for rust are footrest locks and pivots, sockets of detachable arms, and on the lower frame and crossbrace tubes.

Use automobile cleaner wax to protect frame tubes, caster forks, wheel rims, footrests, and arm side panels. Follow directions carefully.

Need for waxing depends on how you use it. More protection is needed if used outdoors a lot, or in damp conditions.

Even stainless steel can develop rust, so it should be cleaned and waxed for protection.

Many parts of a stainless steel-framed wheelchair are made of chrome-plated steel or various alloys. They need wax protection also.

AV-6 Motorized Wheelchairs

Motorized wheelchairs

Many of the maintenance steps given in the first five units can also be used on motorized wheelchairs, because many parts are similar. Often a motorized chair will require stronger and heavier parts because propelling equipment must also be carried.

Parts which make a wheelchair motorized are the electric motors, batteries, pulleys and belts that drive the main wheels, clutch levers to engage or disengage the motor drive, a control box, a battery voltage indicator, and an electronic circuitry module box.

For such components, some inspection and maintenance procedures are commonly useful. However, remember that each chair may also have some specific procedures or precautions that must be followed. Those specific procedures can be found in owner's manuals and other literature from the manufacturer. Problems can also be discussed with your wheelchair dealer.

Plugs, cables, fuses

Plugs should be securely attached.

Electrical insulation on cables and plugs should not be worn off or cracked.

Fuses in wiring, which protect against an overload, should not be corroded or have poor contact with cables. Usually a fuse is in a housing in the battery cable.

Battery charger care

Charger's electrical cables and connectors must be in good condition.

Charger should not get damp or wet.

Louvers or vent holes should be clear so air can circulate.

Mechanical inspection

Pneumatic tires need same inspection and maintenance as on a manual chair—including monthly pressure check. (See AV-2)

Each month, check adjustment of wheel locks and tightness of main wheel spokes—if they are similar to manual chair spokes. (See AV-2)

Check belt tension once a month, following separate procedures below.

Every six months, inspect condition of drive belts and pulleys. Replace a belt if worn, frayed, or cracked.

Check tightness of nuts, bolts, or screws that hold pulleys on main wheels and electric motors.

Carry out other inspection tasks where appropriate, from AV-1 to AV-5.

Drive belt tension adjustment

Check belt tension once a month, with motors off. Turn control box power switch to "off." Check each belt individually.

Steps and key points:

- (1) Put clutch lever in rearward (engaged) position.
- (2) Press middle of belt down firmly with one finger.
- (3) If belt deflects more than one-half inch from normal position, it is too loose.
- (4) To adjust tension, first disengage drive motors by swinging both clutch levers forward.
- (5) A metal adjustment rod is attached to clutch lever by a retainer clip. Pull retainer clip off adjustment rod, with pliers or screwdriver.
- (6) Slide top of adjustment rod out of the hole in clutch lever.
- (7) Rotate rod clockwise several times, then slide rod top back into

hole and push retainer clip back on.

(8) Slide clutch lever back to engaged (rearward) position.

(9) Recheck drive belt tension with finger pressure.

(10) If belt still moves more than one-half inch, adjust again.

(11) Do not over-tighten drive belt. Increased friction drains battery and wears out motor faster.

Electrical Maintenance Schedule

Recharge batteries daily, even if chair has been used only for short periods.

Test and fill batteries weekly.

Clean batteries and inspect wires every three months.

Inspect motor brushes every six months.

Once a year, have dealer service electric relays in electronic circuitry module. Normally, the dealer should do all the work on this module.

Recharging batteries daily—

—can increase battery life.

—helps because a fully charged battery is less likely to lose strength or freeze.

—can be dangerous if safety precautions aren't taken.

How to charge a battery

Do not plug in charger until several safety precautions have been taken.

Safety precautions

(1) Be certain room is well-ventilated. Gases from a battery can explode if they are allowed to concentrate and are ignited.

(2) Pick a room with a floor that battery fluid spill won't damage. Protect floor with plastic dropcloth.

(3) Be certain room temperature is comfortable. Batteries heat during recharging, and can be damaged by temperatures over 100° Fahrenheit.

(4) Be certain there will be no open flames, pilot lights, smokers, or electric sparks in area during charging.

Steps in getting ready to recharge battery:

(1) Chair should be placed where charger cord can be plugged directly into a 115-volt grounded electrical wall outlet. A grounded outlet has a third round hole, in addition to two normal thin rectangular openings. (But, do not plug in charger yet.)

(2) If direct plug-in isn't possible, use a heavy duty grounded extension cord, not a regular household extension cord.

(3) Be certain charger is right for make and model of chair.

(4) Move power switch on chair to "off."

(5) Lock wheel locks.

(6) Connect charger extension cable on wheelchair to matching cable of battery charger.

(7) Read both instructions printed on the charger and those that came with the charger. (And follow the instructions.)

(8) Plug charger power cord into wall outlet.

Steps in charging:

(1) Set timer on charger to amount of recharging needed. "Boost" if chair was used less than two hours. "Recharge" if longer.

(2) Timer will turn charger off at proper time.

(3) If charger doesn't have timer, watch a clock.

(4) Fully charged battery is shown by needle that sits still or wiggles slightly at low range of the meter.

(5) When charging is completed, remove cord from wall outlet.

(6) Disconnect charger cable from charger extension cable on wheel chair.

(7) Do not overcharge battery.

(8) Unplug charger as soon as convenient after charging.

Weekly battery checks--

—involve checking first the charge then the fluid level, and may require adding distilled water to the battery;

—begin with checking the charge, an hour or more after recharging for most accurate check;

—have a fluid level check only after the charge is checked;

—require various steps and precautions, given below.

Steps and precautions for battery checks

Safety precautions include:

(1) Wear protective goggles or glasses, and rubber gloves, when you work around a battery. Sulfuric acid in batteries can blind you, burn skin, and damage furniture, clothing, and floors.

(2) Never use lighter, match, candle, or other open flame near a battery. Any of these can cause an explosion, as can electric sparks.

Steps in checking a battery:

(1) Undo straps or catches that hold cover on case. (You may have to move electronic module out of way first.)

(2) Remove cover.

(3) Read cautionary information on battery top. (And follow directions.)

(4) Use a hydrometer to measure battery charge strength.

(5) Remove vent caps on cells.

(6) Insert flexible tube deep enough into cell to go below fluid level.

(7) Squeeze rubber bulb slowly then release to draw fluid into hydrometer.

(8) Read hydrometer, and compare with information that came with hydrometer, or in owner's manual under "battery testing."

(9) Usually, readings between 1.230 and 1.295 at room temperature mean battery cell is in good condition.

(10) With a floating ball hydrometer, all or most balls must be

floating to indicate cell is well charged.

(11) Return fluid to cell.

(12) Use same procedure to test all battery cells.

(13) If one or two cells have less charge than others, then battery may need to be replaced.

(14) If battery tests poorly, have dealer or repairer double-check condition.

(15) After testing all cells, wipe up any battery fluid that has dripped onto battery.

(16) Rinse hydrometer in water and dry it. Dispose of towels or rags that have battery fluid on them.

(17) Look down vent tube holes to check fluid levels. If you need light to see better, use flashlight or other electric light. (Any kind of open flame is **dangerous**.)

(18) If battery fluid level is below split rings near bottom of vent tubes, raise level to bottom of rings.

(19) Carefully add distilled water only. (It is sold at most supermarkets.) Use glass or cup and small funnel, or bulb type battery filler, or professional hydrometer.

(20) Do not overfill cells. (Some auto parts stores have battery filler bottles that automatically shut off to prevent overfilling each cell.)

(21) After filling cells, replace vent caps.

(22) Wipe up any spilled water.

(23) If there is acid battery fluid on funnel tip or battery filler, rinse and dry carefully.

(24) Replace battery case cover and latch or strap down securely.

(25) Each week be sure all plug connectors are securely attached. Connections are between: batteries and charge cable; battery and electronic circuitry module; circuitry module and motors; control box and circuitry module.

Three-month battery inspection

Dirt and corrosion can cause a battery to discharge even when not in use, and dirty or corroded connectors make electric flow difficult.

Some things needed during cleaning are sold by auto parts stores, as:

cleaning liquids and sprays, tools for cleaning posts, battery lift straps, and protective gear such as goggles, gloves, and drop cloths.

Steps in getting ready to clean:

(1) Put on protective eyewear and gloves, to prevent acid injury.

(2) Assemble tools needed, and protective drop cloth.

(3) Turn power switch to off.

(4) Remove cover, unclip any caps on battery posts.

(5) Examine cables while they are still connected so you can reconnect each one to the right terminal (battery post). A mix-up in reconnecting can severely damage motors and module. Cables may be color-coded. Usually one terminal will be labelled with a plus sign (+) or the letters POS for "positive." The other will be marked with a minus (-) sign, or NEG for negative. One way to be certain is to tag one post and its cable with tape before disconnecting.

(6) Disconnect negative (NEG, or - sign) cable first. This can be done with adjustable wrench or box wrench of the right size. If screwdriver is used for prying clamp off post, do so carefully. Some cables have wing nuts and do not require tools.

(7) Disconnect positive (+ sign or POS) cable last.

(8) If there are two batteries, disconnect short jumper cable between them.

(9) Swing battery cables out of way.

(10) Remove batteries from case.

CAUTION: This can be dangerous because batteries are heavy and battery fluid causes injury. Avoid tipping or dropping. It may be desirable to use a battery lift strap.

(11) Put battery on surface that cleaning process won't harm. A plastic drop cloth may be used.

SPECIAL NOTE: It may be possible to clean a battery in the wheelchair if rags or towels are used to catch drips. (Dispose of them later.)

Steps in cleaning a battery:

(1) Be certain vent caps are on tight, because cleaning paste or cleaners could harm battery.

(2) Wipe off battery top and posts with paper towels.

(3) Mix thin paste using baking soda and water. Use this to scrub top, posts, and as much of the rest of the battery as can be reached. Also clean clamps on cables with paste. An old toothbrush is a good scrubber.

NOTE: Cleaning liquids and sprays may also be available for battery cleaning.

(4) Rinse battery and battery cable with plain water, then wipe dry.

Steps in reinstalling battery:

(1) Put battery back in case, in the **same position** it was in before. Be certain it is not turned around.

(2) Reconnect cables in **reverse** order to that used to disconnect. Attach **positive** (POS, or +) cable **first**. Then attach negative (NEG, or -) cable last.

(3) If there is a short jumper cable, reconnect from positive (POS, or +) post of one battery to negative (NEG, -) post of the other.

(4) Hand-tighten wingnuts, or push cable clamps firmly onto posts and tighten clamp nuts securely with a wrench.

(5) Coat battery posts and cable clamps with petroleum jelly, for corrosion protection.

(6) Reclip any caps and replace battery cover; latch or strap down tight.

Wire inspection, every three months

Turn power switch off.

Check all wires and cables.

Look for worn or cracked insulation.

Plastic electrical tape can be used for temporary repair, but wire or cable should be replaced soon.

Find cause of damage and protect new wire against it.

Motor brush inspection, every six months

Each motor has two carbon brushes, in small cylinders that stick out from motor near top.

Remove cap on brush assembly, then spring and brush behind it.

Face, or curved side, of brush should be clean and shiny.

Motor needs service by dealer or repairer if face is deeply scratched or rough and burned looking.

Brushes can be worn down too thin. Check with dealer for when to replace.

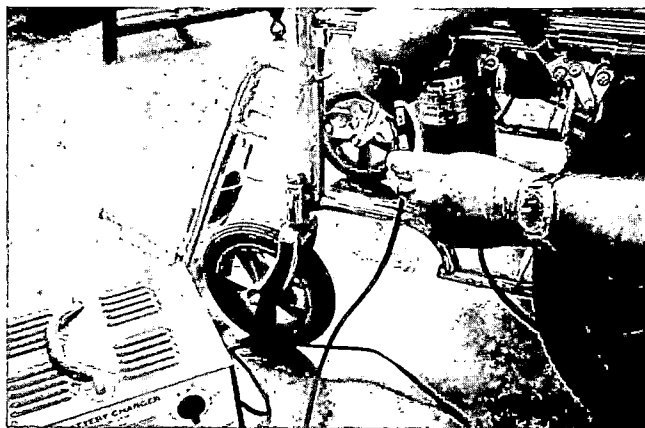
If brush is in good condition, replace brush, spring, and cap in original positions.

Module relays, yearly inspection

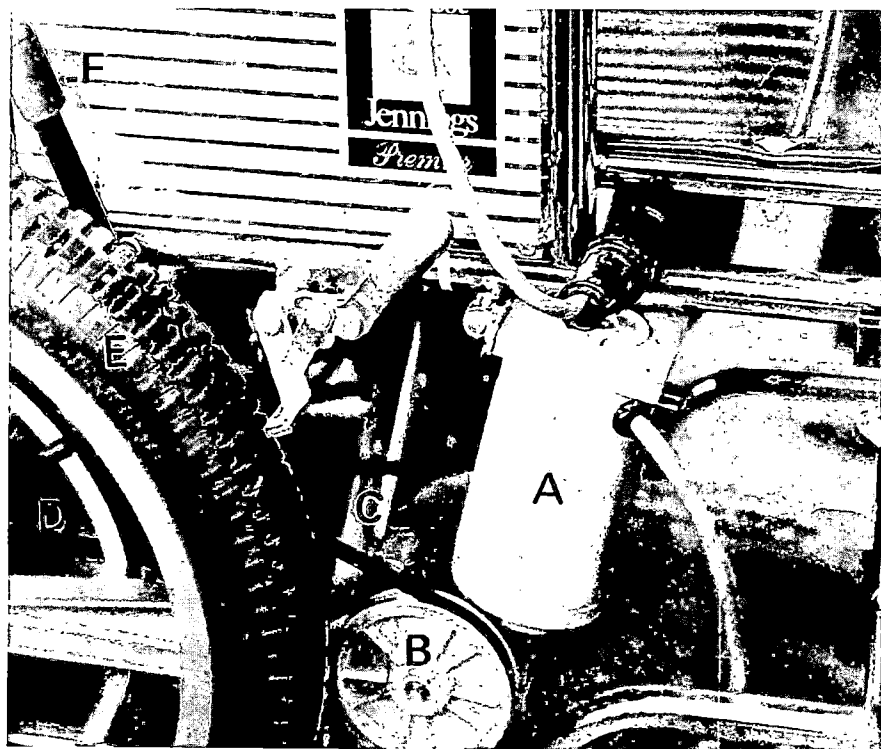
The four electric relays in the electronic circuitry module need inspection, cleaning, and possible replacement once a year. This is difficult to do, and usually should be done by an experienced repairer. If you decide to try it, consult owner's manual on servicing relays.



At least every three months, inspect the batteries for cleanliness. Tools for cleaning include a toothbrush, baking soda or other cleanser, gloves, goggles, drop cloths, and other things.



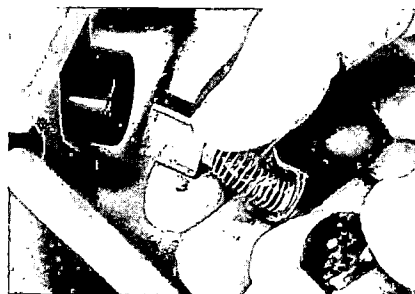
Batteries should be recharged each day, following steps on page 13 and instructions with the charger.



Electrical and mechanical components that power a chair include (A) electric motors, (B) pulleys driven by motors, (C) belts that connect (B) to (D) pulleys on (E) the main wheels. At F is a clutch lever.



It is important to connect battery cables to the right terminals, and in the right sequence. Pay attention to markings on terminals.



Every six months, inspect brushes on motors.



WHEELCHAIR

**maintenance
and repair**

a stitch in time



"A Stitch in Time"

Wheelchair Maintenance and Repair

By
Jere Gandolf Burrus

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Preface

When I approached OCD with a proposal to write this manual, the first question was, "Who is the typical person using a wheelchair?"

The reply was, "There are no typical persons in wheelchairs." Some people grow up using wheelchairs; others begin later in life after accident or illness. Some spend only parts of the day in their wheelchairs, while others spend all their mobile hours in them. Wheelchair users have no typical age, occupation, education, or skill level. Wheelchair people come in all sizes, colors, and shapes. There is only one common characteristic—their mobility depends on the wheelchair.

Without that mobility, the ability to move or be moved, a person is confined and limited. Mobility can provide a chance of meeting new friends, seeing new sights, pursuing a career, or continuing an education. Without that mobility, the world can seem very small and boring.

Being confined to a wheelchair is a nuisance; it is not the end of the world. The person has not lost the right to travel, work, or move about freely. The person has not lost the right to an education, or to a rewarding career. All rights are intact—but a right unexercised is no right at all. To have those rights, the person must use them. The key to using the rights is mobility.

This manual is about a means of mobility, the wheelchair as a transportation device. Being confined to a wheelchair is handicap enough without the chair breaking down every few months. Except in large cities, shops that provide competent wheelchair repair promptly are few and far between. Wheelchair users have to rely on general "fix-it" shops, waiting in line behind broken toasters or lawn mowers. A second major cause for delay is the lack of readily available spare parts.

The wheelchair user has only two alternatives to sacrificing mobility every time the chair needs some repair. The first option, purchasing a second chair, can be too expensive. The second option is to learn to inspect, maintain, and make minor repairs on a chair.

The manual's title, "A Stitch in Time," gives an indication of the basic approach required for maintenance. A problem that is left untreated can expand throughout the chair. For example, suppose the right wheel strikes a curb and is knocked out of alignment. This can throw the entire chair out of alignment. The effects on the wheel will be obvious right away. Effects on the other parts may take weeks to become apparent. The other wheel will absorb extra stress. That stress can warp and unbalance the chair frame. Extra stress is placed on the welds and brazes. A long and costly trip to the repair shop may follow.

There can be other consequences. A chair that is knocked, bent, or warped out of normal alignment will wiggle unsteadily under the user when in motion. It will be harder to push and awkward to turn and maneuver. Movement within the chair can cause unusual stress or friction. If these problems continue, they can lead to pressure sores (decubitus ulcers). These are painful and can require sustained bed rest and loss of mobility. There is a direct connection between a misaligned wheelchair and the formation of pressure sores.

No matter how well constructed and how carefully operated the wheelchair is, it still must be maintained or it will break down. This manual tells how to inspect for and recognize problems. It describes routine maintenance procedures, such as inspecting tires. The information can be used to detect problems while they are still small enough for simple repair.

Repair procedures are also covered in the manual, with the steps and key points needed to do specific tasks. The manual includes other necessary facts, such as lists of tools and materials needed, and what tasks require the special abilities and equipment of a repair shop. Information is provided on how to identify and order replacement parts. That makes it possible to spot which parts are wearing out through use, and to have their replacements on hand *before* they are needed.

As we have seen, there is no "typical" person who uses a wheelchair. Therefore, this manual is aimed at a wide group of potential users. This includes people in wheelchairs and their friends and relatives. It also includes people who might enter the occupation of wheelchair repairer. The manual, and audiovisual material related to it, could be useful in a wheelchair repair course. It can also serve as a reference during maintenance. The material has been simply written, so it can be used by people with many different levels of education. It is well illustrated, because many things are best understood when they can be seen. As author, I have attempted to make the manual useful in helping to fulfill a wide variety of personal goals.

Jere Gandolf Burrus

Introduction

"A Stitch in Time" is based on the idea that some simple inspection and maintenance tasks can reduce the number of repairs that must be done on a wheelchair. For that reason, certain chapters have two types of material, called sections. These are Section A and Section B materials. The A section of a chapter covers inspection and maintenance. It tells how to recognize problems, and what to do to correct them and prevent them from getting worse. Section B material is on repair, and tells what to do if conditions have become bad enough to require repair work.

Most chapters are organized in terms of parts or groups of parts. For example, Chapter 5 is on bearings, and Chapter 6 is on caster wheels.

In addition, the book has five special-purpose chapters. The first, Chapter 1, Maintenance References, covers information which is necessary for using the other chapters. So, Chapter 1 should be read and mastered first. There are also chapters on fitting the wheelchair, rust, wheelchair safety, and skin maintenance. Special material on motorized wheelchairs is presented in an Appendix at the end of this manual.

Audiovisual materials have been developed to cover the inspection and maintenance aspects of wheelchair maintenance. The material includes tape cassettes, slide or videotape visuals, an instructor's guide, and a participant's manual. Although the material is for group presentation, it could also be helpful to an individual. In particular, the *Participant's Manual* summarizes information presented by the A/Vs, and is excellent for review. The A/V material is titled *Wheelchair Maintenance—A Stitch in Time*. It is also available from the Center for Occupational Curriculum Development, Division of Continuing Education, Post Office Box 7218, The University of Texas at Austin, Austin, TX 78712.

Jack E. Robertson, PhD
Director, Center for Occupational Curriculum Development

You should master this chapter first because it contains basic reference information you will need when following procedures in this manual.

If you are in a wheelchair, you will have to decide which tasks to attempt. They do vary in how difficult they are. A reading of a task description will help you judge whether to try it. You may also wish to get some advice from other people. Often, it would be a good safety procedure to have an assistant present for a task. Some tasks might better be done by a friend, relative, or repair shop person.

You will need a sturdy couch or chair that will support you securely. Tools and supplies should be within easy reach. The floor should be protected against spills or drips. Some work can be more conveniently done if the wheelchair has been raised above the floor.

You will also need specific knowledge such as that in this manual and

in an audiovisual show designed to go with this manual. Bicycle repair manuals offer some useful information. So do publications provided with some wheelchairs. Dealers may also offer helpful information.

It is important to follow schedules for monthly, quarterly, semiannual, and annual maintenance. Some easy tasks done at the right time can avoid difficult and expensive repairs later on.

Finally, you will need to know how to identify and use specific tools, small parts, supplies, and items of safety equipment. These are shown and discussed in this chapter.

"A Stitch in Time" Maintenance Schedule

I. Monthly Maintenance

1. Check and adjust pressure in pneumatic tires.

2. Inspect wheel lock adjustments.
3. Inspect and adjust loose spokes.

II. Quarterly Maintenance

1. Clean and wax all chromed components.
2. Adjust main wheels.
3. Adjust caster wheels.
4. Adjust fork stem bearing nut.
5. Grease main wheel bearings.

III. Semiannual Maintenance

1. Repack all bearings.
2. Lubricate center pin.
3. Oil bottom rails.

IV. Annual Maintenance

1. Return chair to dealer for complete frame cleaning and rust stripping.
2. Have all rusted, bent, or otherwise damaged spokes replaced and the wheels returned to true roundness.

Tools

Wrenches

In wheelchair repair, a wrench is the tool that's used most often. The two main types of wrenches are *adjustable* and *nonadjustable*.

One type of nonadjustable wrench is the open-end wrench. This wrench has two open jaws that fit over bolts and nuts. Most wrenches of this type have an opening on both ends. These openings differ by one size. Thus one wrench really serves as two wrenches. Wrench sizes are given as fractions of an inch. Typical wrench sizes are

1/2 inch, 7/16 inch, and 11/32 inch.

Take your chair to the hardware store when you purchase your wrenches. All wheelchairs use a different combination of sizes of bolts. It is important that you purchase wrenches that exactly fit the nuts and bolts on your chair.

To test the fit, slip the end of the wrench over the bolt head. The wrench should be slightly larger than the bolt but fit snugly. If the wrench is too large, the fit will be loose. Loosely fitting wrenches will strip and ruin bolt heads.

The second type of nonadjustable wrench is called the *box wrench*. The end of a box wrench completely surrounds the nut or bolt. And it is less likely to slip off. This is important to remember when you are trying to

break loose a tight bolt. You can put more force on the box wrench because it is less likely to slip off. Box wrenches may need to be completely lifted off the nut after each turn. This makes them slower to use when tightening or loosening nuts.

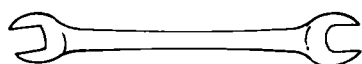


Figure 1. Open-end Wrench

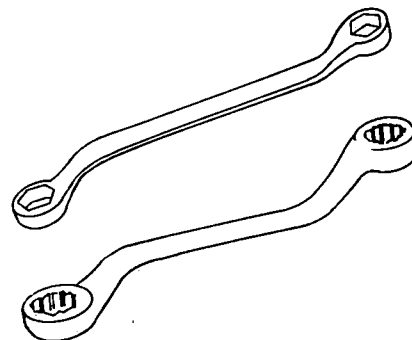


Figure 2. Box Wrenches

Another commonly used wrench in wheelchair repair is the *adjustable wrench*. This wrench should only be used when you do not have a box or open-end wrench that precisely fits a bolt or nut.

The adjustable wrench should be opened until it is slightly larger than the nut you want to adjust. Slip the open end of the wrench over the nut. Using your thumb, move the adjusting wheel until the wrench is tight on the nut.

The main use for adjustable wrenches is to hold a nut or bolt securely while the other end is turned with another wrench. Use the wrench as the holding wrench. Use the box or open-end wrench as the turning wrench.



Figure 3. Adjustable Wrench

The final type of nonadjustable wrench is called a *combination wrench*. It has an open-end wrench on one end and a box wrench on the other. Both openings are the same size. With this wrench, you can use the box end to break the bolts loose safely. Then you use the open end for speedy removal.

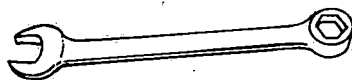


Figure 4. Combination Wrench

Screwdrivers

There are many different types and styles of screwdrivers. Each is designed to fit special job requirements. Figure 5 shows the most common type of screwdriver.

The handle of the screwdriver can be metal, plastic, or wood. Any type of handle that fits your hand comfortably is sufficient for wheelchair repair.

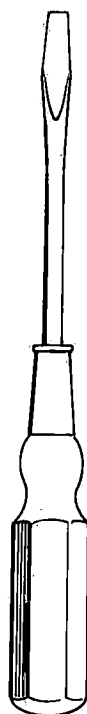


Figure 5. Screwdriver

The tip of the screwdriver is the part that engages the screwhead. There are two types of screwdriver tips needed for general wheelchair repair. The flange tip is also called the flat-bladed tip. This type fits into slotted screws. The Phillips tip has an X-shaped tip to fit Phillips-head screws.

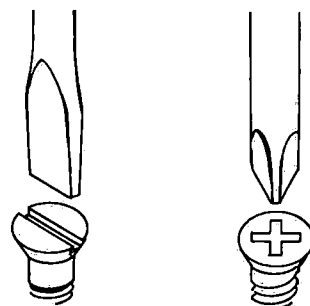


Figure 6. Screwdriver Tips

Both types of screwdriver tips come in several different sizes. You should select a screwdriver that tightly fits the screwheads on your wheelchair. To test the fit, put the screwdriver tip into the screwhead. It should fit snugly. If the tip will not fit, you need a smaller screwdriver. If the tip fits loosely, you need a larger screwdriver.

Hammer

Removing and replacing bearings will require the use of a hammer. This is the only task in the manual that requires a hammer. You should buy an all-purpose hammer that can be used for many more tasks than bearing removal. The most common type of hammer is the ball peen type (see figure 8). It can be used for wood-working and masonry as well as wheelchair repair. The most common ball peen hammer size is 16 ounces.

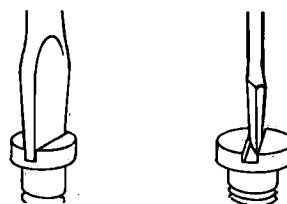


Figure 7. A screwdriver should fit the screw slot as shown in A. B shows a poor fit, which will damage the screwdriver and screwhead.



Figure 8. Ball Peen Hammer

Pliers

(Warning)

Pliers are the most abused of all the hand tools. Improperly used, they may mar work, damage parts, or injure the repairer. They are designed for no other purpose than holding or bending.

Pliers should never be used to loosen or tighten nuts or bolts. They almost always damage the bolt head or nut. No repair or maintenance task in this manual requires or recommends the use of pliers.



Figure 9. Pliers

Hand-held Air Pump

The hand-held air pump allows you to inflate pneumatic tires. All hand pumps have the same basic structure. The air only flows in one direction. This is necessary to keep air from coming out of the tire faster than you can put it in.

The main point in using a hand pump is to secure the nozzle to the valve-core stem. There are several types of connectors, some with mechanical closures.

Some nozzles must be held tightly against the valve core stem. The type of pump you purchase depends on your own level of coordination. The mechanical closing type is expensive. It is also easier to use since it can be locked into position.

You should check the air pressure in the tire after every three pumps. The tire can rupture or explode if overinflated.

Bolts

A bolt is a device used with a nut to fasten two parts together. The head of the bolt is either square (four-sided) or hexagonal (six-sided). Most bolts are sold with an attached nut. The nut is the same size as the bolt

head. Nuts and bolts are removed or tightened with wrenches.

Spoke Wrench

The spoke wrench is a small, grooved circle of metal that comes in several styles. The grooves fit the nipples on the end of wheel spokes. The wrench is used to tighten or loosen spokes. Spoke wrenches can be purchased at most hardware or bicycle shops.

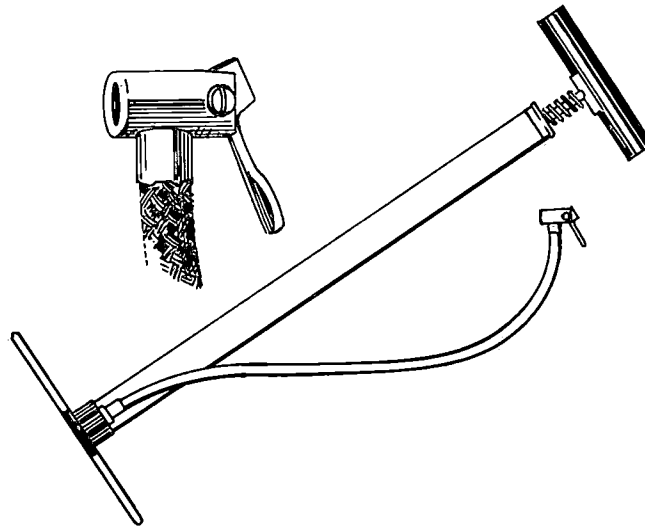


Figure 10. Hand-Held Air Pump

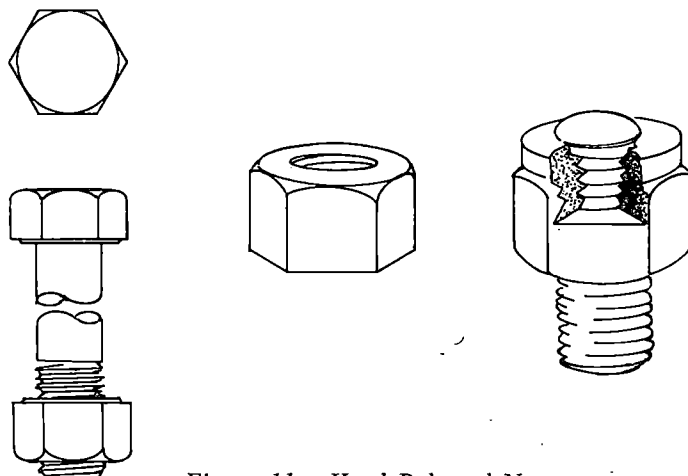


Figure 11. Head Bolt and Nut
Common Nuts

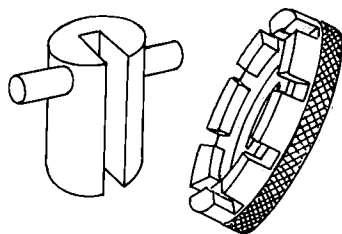


Figure 12. Spoke Wrenches

Materials

Sandpaper

Sandpaper is the generic term for a piece of tough, flexible paper with an abrasive called "grit" glued on one side. The original grit for abrasive paper was sand—thus, the term sandpaper.

Modern abrasive papers use a wide variety of materials for grit. There is a size and type of grit for nearly every sanding or smoothing job. No matter what type of grit an abrasive paper uses, it is still generally referred to as sandpaper.

Use a *silicon carbide* grit sandpaper for removing rust from metal. This type of sandpaper is identified by its shiny black color. When you go to a hardware store, ask the salesperson to help you find the right silicon carbide sandpaper. The following information will help the salesperson. You should purchase a silicon carbide paper with a "mesh number" between 240 and 400. The best size has a grit symbol of 10/0 or 9/0.

Aluminum oxide sandpaper is used to rough vinyl prior to gluing on a patch. This type of sandpaper is identified by its brown color. You should purchase a "coarse" or "very coarse" grit. The "mesh number" will be between 20 and 50. The grit symbol will be between 3½ and 1.

Commercial Solvent

This manual often suggests the use of a commercial solvent when cleaning metal pieces. The solvent breaks down the grease and grime, and makes them easier to remove with a cloth.

Check with your dealer to see which solvents are recommended for your

model of wheelchair. Solvents are available at hardware and auto parts stores. Many grocery stores also carry them.

Whichever solvent you use, read the label carefully. Have all the required first-aid materials on hand *before* you begin cleaning.

Spray Oils

The thickness of an oil is called *viscosity*. Axle grease has a very high viscosity. Most oils that are sprayed from aerosol cans have a low viscosity. This means that they are very light oils.

Light oil should never be used to lubricate an axle or bearing. Spray oil is normally used only to loosen locked nuts, bolts, or spokes. A locked piece is one that resists turning with a wrench.

A spray of light oil at the top of a locked piece will cause it to loosen. The light oil will run down into the piece and lubricate the threads.

Waterproof Grease

Waterproof grease is used to lubricate wheelchair bearings. The grease is heavy enough to stay on the metal parts even when they are in motion. It is waterproof to keep it from being washed off the parts. A service station attendant can help you find a grease suitable for your wheelchair. Several types are available in auto parts stores.

Steel Wool

Steel wool is used for rust removal and frame cleaning. It can be purchased at any grocery store or hardware store. Do not confuse it with commercial sink pads such as Brillo. These commercial pads are saturated with soap. And you do not need to perform wheelchair maintenance.

Steel wool is soft and gray when it is new. As it ages, it turns black and becomes brittle. These brittle pieces can pierce your fingers. Rubber gloves are a good precaution when using steel wool. Good grades of steel wool to use are 00 and 000.

Rubber Gloves

Rubber gloves protect the hands without restricting mobility or flexibility. They are useful whenever you are working with solvents or steel wool.

Rubber gloves can be purchased at any supermarket. The best rubber gloves for wheelchair repair have small treads imprinted on the fingers and palms. These treads help improve your gripping power. They are most useful when the gloves are wet.

Safety Gloves

Gloves are recommended as safety apparel whenever the wheelchair is operated outdoors. Cloth gloves are not good safety gloves. They do not disperse heat from friction. They are also prone to snag burs and thorns imbedded in the wheels. Gloves with leather palms are recommended.

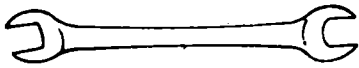
Sporting gloves make good wheelchair safety gloves. Raquetball and handball gloves have padded palms. They can be purchased either with or without fingers. A wide selection of gloves can be found at a sporting goods store or hardware store.

Safety Glasses and Goggles

Whenever you do maintenance or repair work on a wheelchair, it is a good idea to wear approved safety glasses or safety goggles, depending upon your personal preference. Both have shatterproof lenses to protect your eyes from accidental impact. They also keep small particles like rust or metal shavings out of your eyes. And they help prevent chemical liquids or fumes from irritating or injuring your eyes.

Safety glasses are worn like regular glasses. Safety goggles usually have an elastic band that goes around your head to hold them in place. Safety goggles can usually be worn over prescription eyeglasses and give greater protection around the sides of your eyes than safety glasses do. But they can fog up more easily when used in hot and humid conditions.

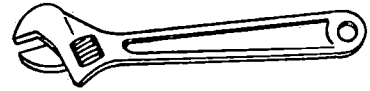
Tools



Open-end Wrench



Combination Wrench



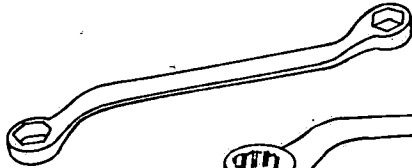
Adjustable Wrench



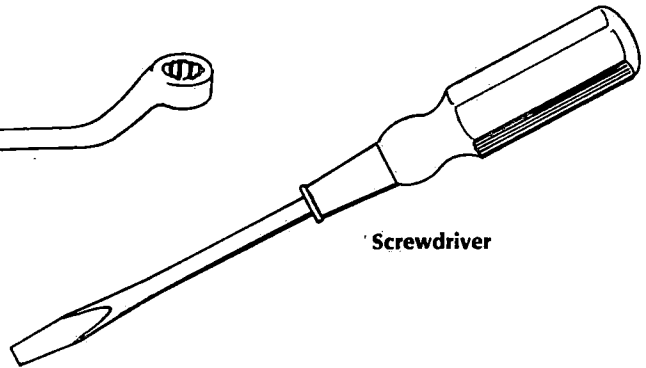
Pliers



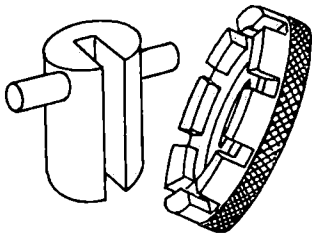
Ball Peen Hammer



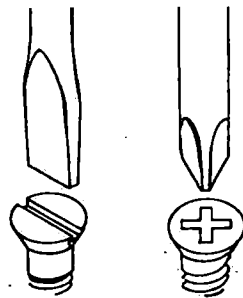
Box Wrenches



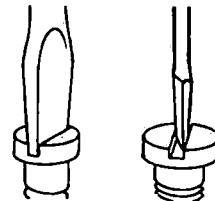
Screwdriver



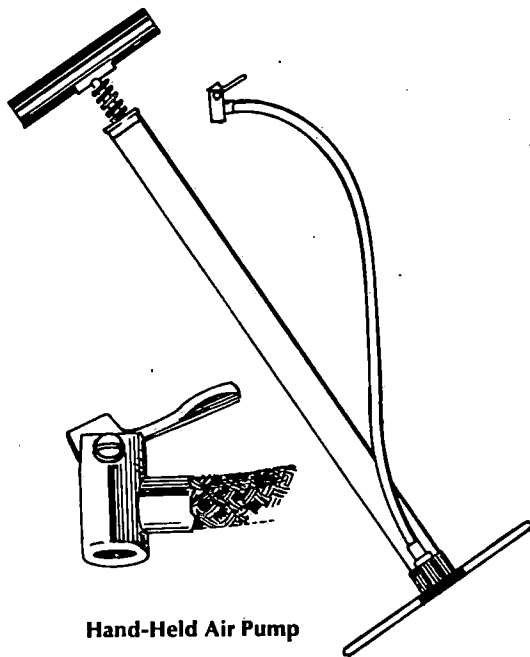
Spoke Wrenches



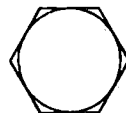
Screwdriver Tips



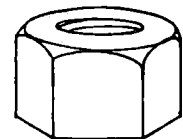
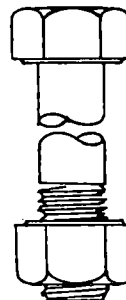
A screwdriver should fit the screw slot as shown in A. B shows a poor fit, which will damage the screwhead.



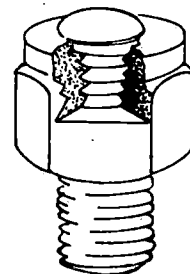
Hand-Held Air Pump



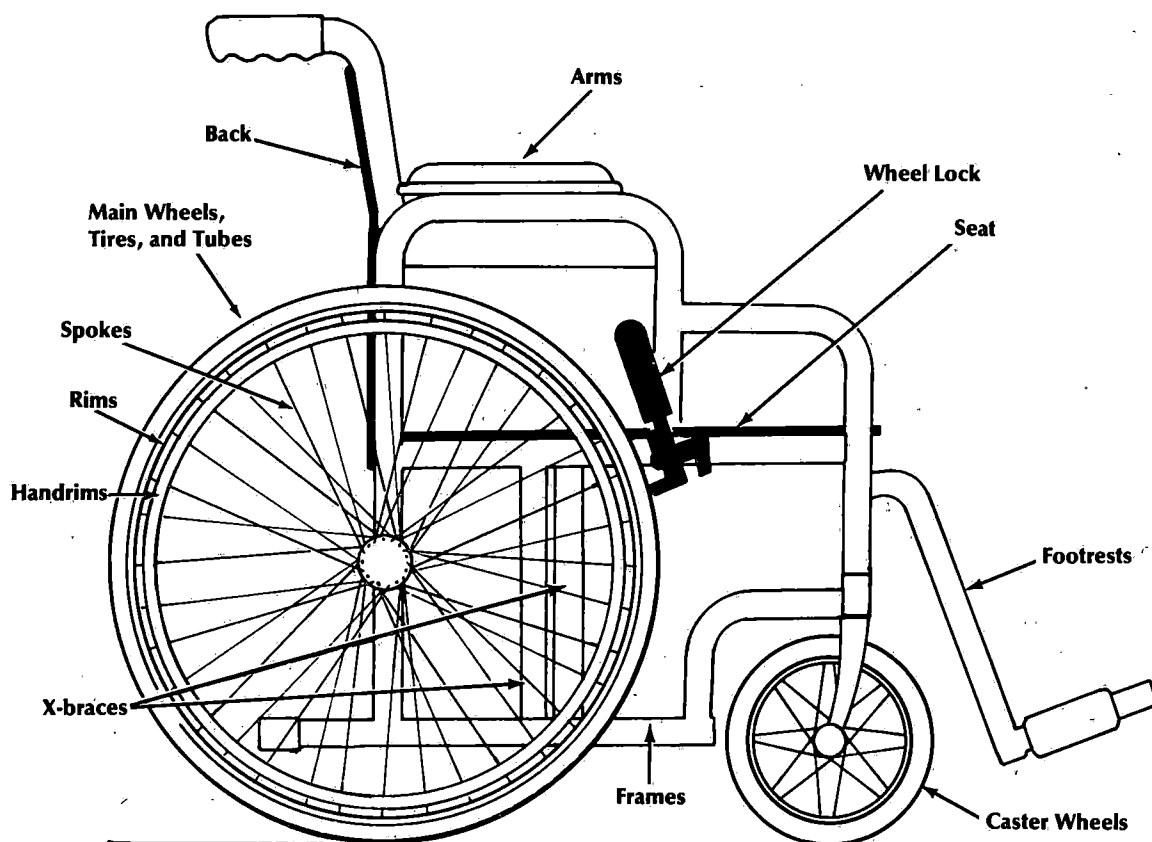
Head Bolt and Nut



Common Nuts



Parts of the Wheelchair



Objectives: *After completing this chapter, you will be able to—*

1. *describe two basic types of wheelchairs;*
2. *tell why a wheelchair is like a custom-tailored suit;*
3. *explain why a fitted wheelchair is necessary to the user's comfort;*
4. *state the three main questions a physical therapist must answer to fit a wheelchair;*
5. *describe the type of measurements that the physical therapist may take in fitting the wheelchair;*
6. *state the effects different environments might have on wheelchair selection;*
7. *explain why it is important to know the width of all doors in the user's immediate environment;*
8. *name two factors that determine wheelchair seat width;*
9. *give the formula for finding the width of the finished wheelchair;*
10. *describe changes affecting the wheelchair user that could make a previously well-fitted wheelchair inappropriate; and*
11. *name the possible sources for obtaining a first fitting or a refitting.*

Two basic types of wheelchairs, *standard* models and *fitted* models, are described in this chapter. First, differences between these two types of chairs and, then, the procedure for fitting a wheelchair are discussed. Persons who own a standard wheelchair should use this information to check the fit of their chair. This chapter concludes with information on obtaining a refitting.

An analogy can be drawn between fitting a garment and fitting a wheelchair. When most persons purchase a coat, they have two broad choices. The first is to check a clothing store's "ready-to-wear" section. Clothes in this section are sold in broad sizes. A size "42" jacket, for example, is intended to fit a wide range of people. The size "42" coat fits those persons who are a bit too large for a "40" and still too small for a "44." Generally, the customer tries on several coats and selects the one that fits best. This type of purchase gives the customer an approximate fit, not an exact one.

The second alternative in purchasing a coat is to find a professional tailor. The tailor is trained in measur-

ing the body and custom sewing a garment to fit. The tailor will also ask how the garment will be used, and selects proper material accordingly. A garment crafted in this manner is custom designed to fit an individual's needs.

There are two similar routes for obtaining a wheelchair. A person who needs a wheelchair may go to a medical supply shop or rental outlet to purchase the chair. At these shops, the person tries out a variety of wheelchairs. The chair that comes the closest to fulfilling the person's needs is selected.

An improperly fitted coat may be a nuisance. But it is not a hazard to health and mobility. A badly fitted wheelchair is difficult to maneuver, uncomfortable to sit in, and dangerous to operate. For these reasons, it is best to have the wheelchair custom fitted to the body by a physical therapist.

The physical therapist will ask three questions when fitting the wheelchair. These questions are "who," "where," and "why." The answer to the first question tells the physical therapist

who will be using the wheelchair. To the physical therapist, who you are refers to a description of your exact height and weight. Precise measurements are taken of each part of the body. Figure 1 shows the measurements that must be taken to ensure proper wheelchair "fit."

The answer to the "where" question tells the physical therapist about the environment in which the chair will be used. The physical therapist will generally conduct an interview to determine if the wheelchair is intended for indoor or outdoor use, or a combination of the two. It's also important to know how smooth and level the surfaces are upon which the chair will be used. These factors must be considered when deciding which type of wheels and tires are required.

Solid treadless tires are suitable for indoor use. Treaded pneumatic tires are needed for outdoor use. These tires also provide a smoother ride. The disadvantage is that they are subject to flats and require extra routine maintenance. A wheelchair intended for outdoor use must have a heavier-duty frame than the indoor models.

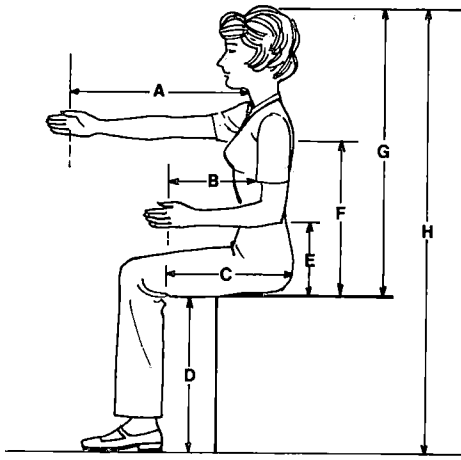


Figure 1. Measurements for Wheelchair

The major question that must be answered in the "where" phase is, "What is the width of the doorways through which the chair must pass?" If a wheelchair-bound person must pass through 37-inch-wide doorways, the chair must be less than 37 inches wide. For the wheelchair user, the door might as well not be there at all if it cannot be passed through. A chair that's too wide can create barriers where none existed before. Since the chair is a means to mobility, it is illogical to purchase a chair that restricts mobility because it's the wrong size.

Answers to the "why" question provide the physical therapist an overview of any specialized needs wheelchair users may have. These questions aim at finding the individual uses for which the chair is intended. Answers to these questions help determine which size and style of armrests will be installed. The nature and shape of the objects that the user wants to approach determine the length of the armrest. A person who intends to work at a desk or workbench needs short armrests to make close approach easier. Persons who intend to put the chair to a wide variety of uses may need detachable armrests.

Two factors that determine wheelchair width are the armrest style and

the width of the wheelchair seat. Wheelchair seats are sold in standard sizes ranging from 14-26 inches. Generally, the seat should be 2 inches wider than the user's hips. The hips should be measured straight across, while the user is seated. A seat more than 2 inches wider than the hips will fit loosely. A loose seat makes the chair harder to roll and steer. The fit is uncomfortable, like being in a bed with a sagging mattress. A seat less than 2 inches wider than the user's hips will place unnecessary pressure on the hips and thighs. This pressure is uncomfortable and could cause pressure sores.

To find the total width of the finished chair, the physical therapist adds the seat width to the armrest frame width. For wheelchairs with standard or offset arms, the total width will be $6\frac{1}{2}$ inches wider than the seat width. For wheelchairs with detachable arms, the total width will be $7\frac{3}{4}$ inches wider than the seat width.

Upholstery strength is determined by the weight of the wheelchair user. Frame strength is figured by analyzing both the user's weight and the purposes for which the chair will be used. The larger the user and the wider the variety of uses, the heavier the frame construction must be.

In time, a chair that was once fitted to a user's body can become unsuitable. Changes in the user's body size, physical abilities, or environment can render even a fitted chair unsuitable. Significant weight gain or loss is generally reflected in the hips. A gain or loss of more than 10 pounds can cause a wheelchair seat to fit improperly. A change in occupation or workplace could make it necessary to install different armrests. Changes in the environment of operation might require changes in the frame weight or tire type.

Persons whose bodies or lifestyles have distinctly changed should see a physical therapist for a refitting of the wheelchair. Persons currently using a nonfitted wheelchair could also benefit from having it refitted. Refitting does not necessarily mean another chair will be required. Since the chair is manufactured in com-

ponent parts, often the refitting will require changing only some of these parts. And the user's cost is a lot less than replacing the entire chair.

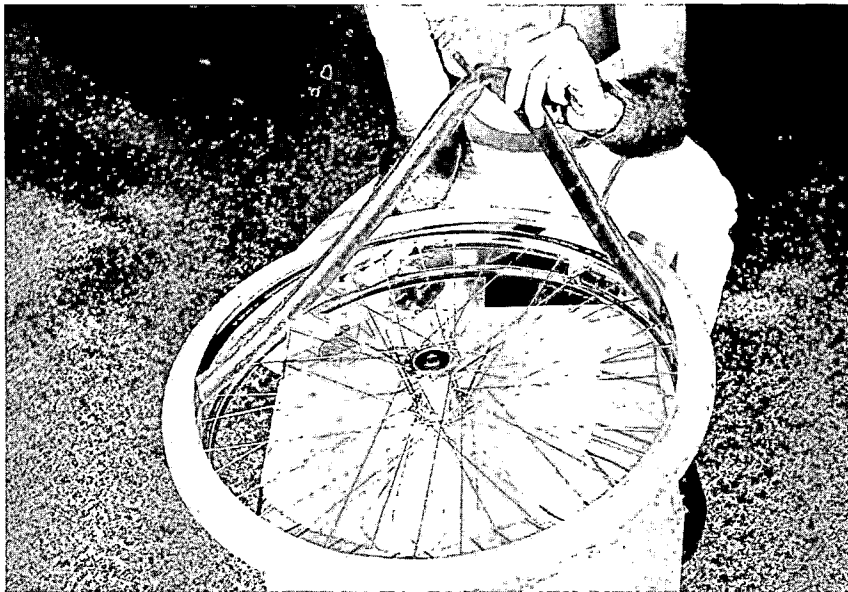
If the wheelchair user does not know a physical therapist, a physician should be contacted for referral. Another route would be to call the county office of the American Medical Association for the names of local licensed physical therapists.

Check Your Knowledge

- The two basic types of wheelchairs are _____ and _____ models.
- An improperly fitted wheelchair is _____ to maneuver.
 - easy
 - difficult
 - safe
- It is best to have the wheelchair custom fitted to the body by a _____.
 - bone specialist
 - repair person
 - physical therapist
- The three questions a physical therapist will ask when fitting the wheelchair are _____, _____, and _____.
- The answer to the "where" question tells the therapist about the _____ in which the chair will be used.
- Solid tires are suitable for _____ use.
 - outdoor
 - all-weather
 - indoor
- Pneumatic (new-mat'ik) tires give a _____ ride.
- A chair that is too wide can create _____ for the wheelchair user.
- The two factors which determine wheelchair width are the _____ and the width of the seat.
- A seat more than two inches wider than the user's hips will fit _____.

3

TIRES AND TUBES



Advisory: Tire and tube removal and replacement are unusually difficult tasks for anyone. For that reason, you may want to have another person present to assist. Or you may want to have the task done by someone else.

Section A

Inspecting and Maintaining Tires and Tubes

General Information: There are two main types of tires on wheelchairs. Solid rubber tires are found on chairs which are mainly used indoors. Inflatable pneumatic tires are found on wheelchairs that are used indoors and outdoors. Solid rubber tires must be taken to a dealer for replacement or repair. Pneumatic tires can be repaired and replaced at home.

Possible Problems: overinflated tire, underinflated tire, punctures, cuts and foreign objects imbedded in tires.

1. **Problem:** Overinflated tire.
To Inspect: Check air pressure with pressure gauge.

Maintenance Action: Press on valve core until some air escapes. You will hear the air hiss out. Check pressure again. Repeat until correct.

2. **Problem:** Underinflated tire.
To Inspect: Check air pressure with pressure gauge.
Maintenance Action: Add air with hand pump until the pressure is raised to desired level.

3. **Problem:** Punctures or cuts in tire body.
To Inspect: Look at the tire.

Remove the wheel from the frame by following the instructions in Section B of this chapter. A procedure for locating leaks is also given in Section B.

Maintenance Action: Follow the repair procedures in Section B.

4. **Problem:** Foreign objects imbedded in the tire tread.
To Inspect: Look at the whole tire. Wearing a glove, lightly rub the tire all over. You will feel any imbedded objects. Remove these.

Section B

Repairing and Replacing Tires and Tubes

Objective: After completing the step-by-step instructions in this chapter, you will be able to do tasks and provide information related to those tasks.

Task Objectives:

1. remove the main wheels from the wheelchair frame;
2. locate the source of any air leaks;
3. remove the tire from the rim;
4. remove the tube from the tire body;
5. repair the tube and/or tire;
6. repack the tube into the tire body;
7. check the airtightness of the repair; and
8. mount the wheel onto the wheelchair frame.

Information Objectives:

1. list the three main causes of air leakage from pneumatic tires;
2. identify the two main types of wheelchair tires;
3. explain how spokes can cause internal punctures;
4. tell how rust can cause an internal puncture; and
5. give examples of foreign objects that can cause external punctures.

Materials:

1. 3/8-inch box end wrench
 2. Adjustable wrench
 3. Hand-held air pump
 4. Grease pencil
 5. Commercial patch kit
 6. Large container of water*
 7. Pressure gauge
 8. Tire tools
 9. Electrical tape
- * You can use a bathtub or large sink for the container of water.

Parts (See figure 1):

1. Axle
2. Axle bolt
3. Hub cap
4. Spokes
5. Spoke nipples
6. Valve core stem
7. Tire bead
8. Tire
9. Inner tube
10. Receptacle groove

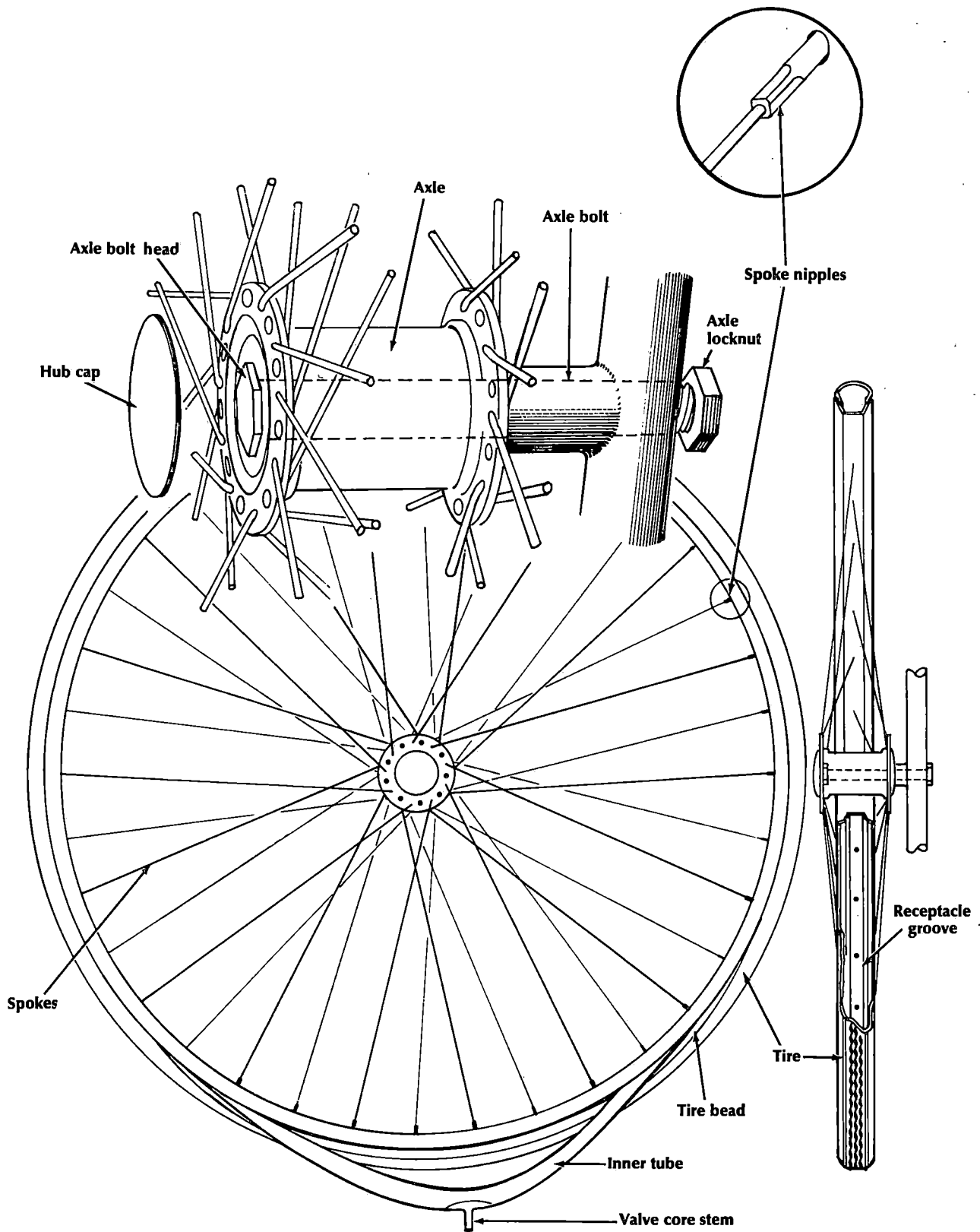


Figure 1. Tire and Tube

The two types of tires found on wheelchairs are the *solid* type and the *pneumatic* type. Both are usually made of rubber. Solid tires are installed by dealers. Special equipment is required to remove or install a solid tire. Any solid tires with serious defects must be taken to a dealer for replacement or repair. This chapter provides information for the repair of pneumatic tires.

Pneumatic (new-mat'ik) tires are inflatable. Most have inner tubes, but some pneumatic tires are tubeless or have plastic foam instead of air inside. All pneumatic tires can go flat. The three main causes of air loss from pneumatic tires are internal punctures, external punctures, and aging. External punctures occur when a foreign object pierces the tire from the outside. A foreign object is any sharp object such as glass, nails, or thorns.

Internal punctures occur when something sharp gets between the inner tube and the wheel rim. Spoke heads cause most internal punctures. If a spoke is allowed to loosen, the spoke head can push up through the wheel rim until it punctures the inner tube. Rust flakes also cause internal punctures, since they are sharp. Like an abrasive sandpaper, they can rub a hole in the tube. If rust is trapped in the receptacle groove, it will cut the inner tube.

Solid tires can only be installed or removed by a dealer. Removal and installation require special equipment not available to most home repair persons.

Tasks, Steps, and Key Points:

Task No. 1: Remove the wheel from the frame

1. Remove the hub cap. Not all wheelchairs have hub caps. If your wheelchair does not have a hub cap, you should purchase a replacement.
2. Insert a flat-blade screwdriver under the edge of the hub cap. Twist it right and left until the cap comes free. The wheel is attached to the frame with an axle bolt and a locknut. The locknut is first removed; then the axle is withdrawn. See figure 2.

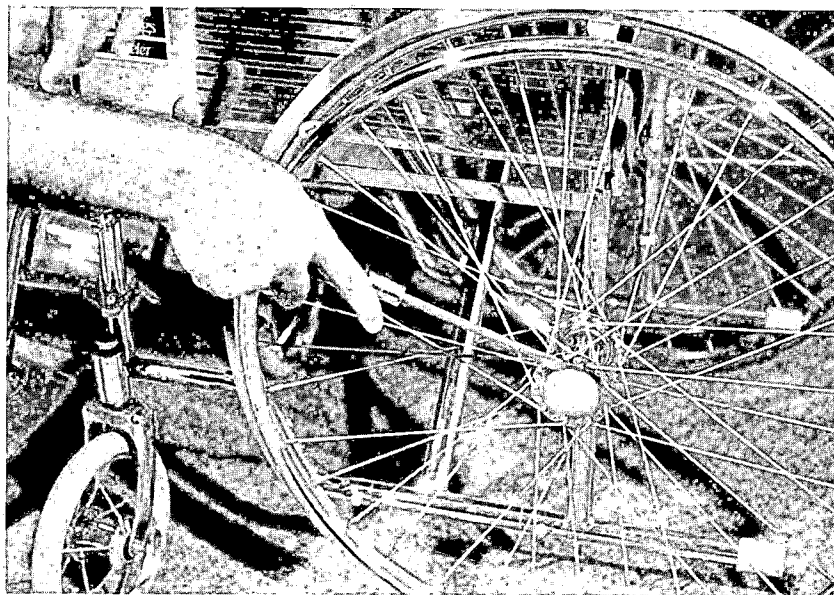


Figure 2

3. Place your wrenches on the axle bolt and the locknut. Most axle bolts are the $\frac{3}{4}$ -inch size. Use the adjustable wrench to hold the locknut.
4. Loosen the locknut by twisting it counterclockwise.
5. Remove the locknut, using your fingers.
6. Using a wrench, turn the axle bolt head counterclockwise until the axle bolt clears the threads cut in the frame tube. Then use your fingers to pull the axle bolt toward you. The wheel is now free of the frame.

Task No. 2: Remove the tire from the rim.

The inner tube must be fully deflated before the tire is taken off the rim. Press in on the little button in the center of the valve until no more air hisses out. Unscrewing the valve core and removing it from the valve stem will exhaust the last traces of air, but is normally not necessary.

1. Place the adjustable wrench on the valve stem retaining the nut next to the rim. Adjust the wrench until it fits the nut snugly, and turn it counterclockwise.
2. Remove the valve stem nut. (See figure 1, under "Parts")
3. Set these parts aside for use in reassembly.

To complete removing the tire from the rim, you must break the bead. All tires are different. Some are very easy to remove from the rim. Others are very difficult. You must use both hands to keep a steady grip on the wheel. Any slipping at this stage could cause the tire tools to puncture the tube.

4. Insert the first tire tool under the bead (see figure 3A).
5. Rock the tool gently left and right to loosen the bead.
6. Insert the second tire tool into the gap you have created at the bead.
7. Gently twist the second tire tool to expand the opening you are creating between the tire and the rim (see figure 3B).
8. Repeat this process until one side of the tire comes clear of the rim.

Key Point: If you are having difficulty inserting the tire tools, use a lubricant. Water is the best lubricant for tire removal. Place a few drops of water at the bead where you intend to begin levering. Gently push the tip of the tire tool under the tire edge. The water will seep under the edge and help you slide your tire tools along. Never use oil as a tire lubricant. The tire tools will become too slippery to handle safely, and they decompose the tire rubber.

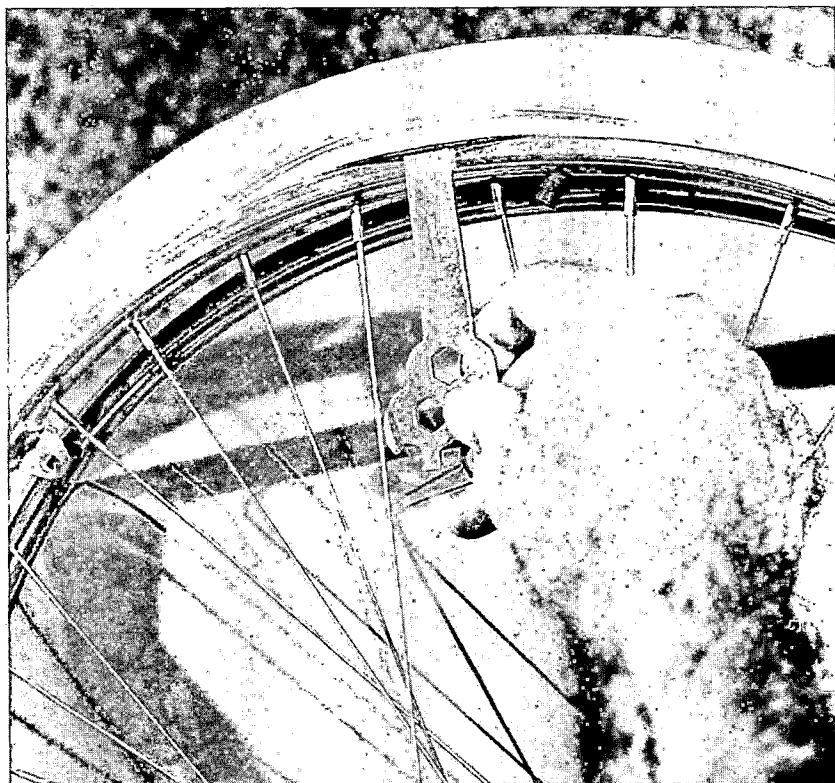


Figure 3A. Insert the tire tool under the bead.

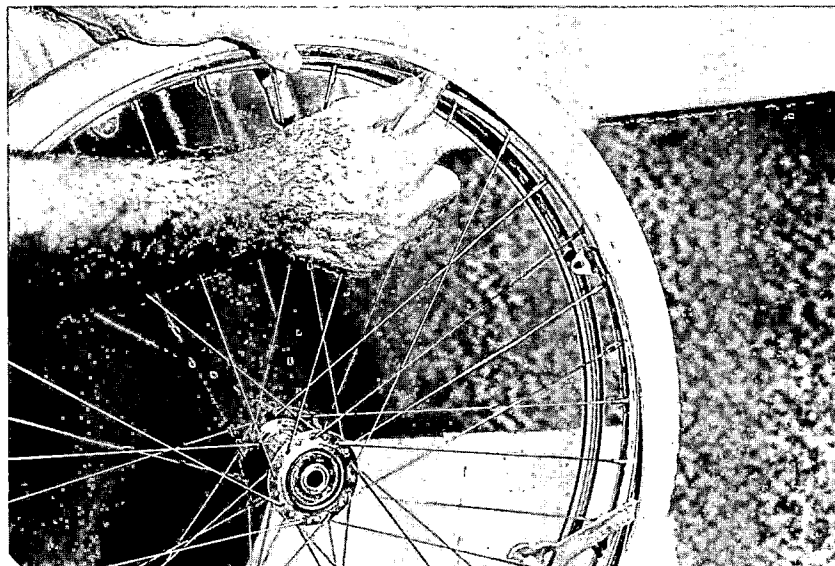


Figure 3B. Expand the opening between the tire and the rim.

The tube must be removed from the tire body *before* you remove the wheel completely from the rim. Removing the tube first protects the tube from further damage. Push the valve stem up through the rim into the tire body. Be careful not to twist it, since a twisted valve stem will leak air.

Task No. 3: Locate the source of any air leaks.

Leaks are found by holding the inner tube under water and watching for rising air bubbles. You can use a large container of water, a sink, or a bathtub to immerse the tube.

1. Inflate the tube with the hand pump. The tube must be inflated to reveal air leaks.
2. Immerse the tube in water one section at a time. If you see a steady stream of bubbles rising, you have found a leak.
3. Continue the underwater check, marking each leak with a grease pencil.

Task No. 4: Repair the tube.

Commercial patch kits have all the materials needed for home tube repair. Each kit will have its own set of instructions. For best results, follow these instructions carefully. Commercial kits are readily available, safe, and efficient. Whichever kit you use, give the glue plenty of time to dry. Inflating a tube before the patch is fully dried will weaken the patch. To test the repair, inflate the tube and reimmerse in the water to check for bubbles.

Task No. 5: Repair the tire.

Commercial tire repair kits have all the materials you will need for at-home tire repair. You do not need to repair minor punctures on tubed tires. You must be sure that there are no sharp objects penetrating the tire.

Task No. 6: Inspect the receptacle groove of the wheel rim (see fig. 4).

1. Remove foreign matter. Any object trapped under the tube will press and cut when the tire is inflated.
2. Remove rust from the receptacle groove. Rust is made up of metal flakes. Each flake has sharp edges that can wear through a tube. Follow the steps for rust removal to clean the receptacle groove.
3. Line the receptacle groove. Electrical tape can be used to protect the tube from rust and spoke heads. If you line the receptacle, use no more than two wraps with the electrical tape. The tube needs to be seated in the receptacle groove. Too many tape wraps will fill the groove and make installing the tire very difficult. Punch a hole for the valve stem in the tape (see fig. 5).

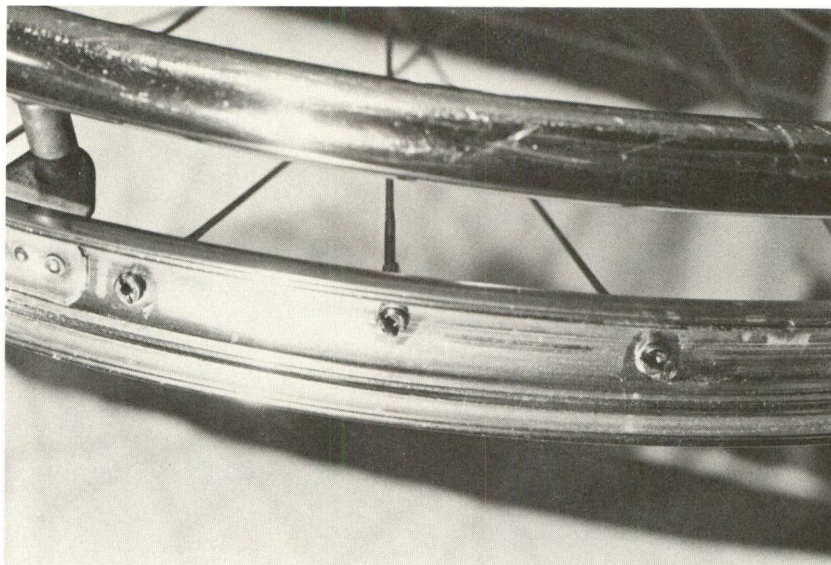


Figure 4

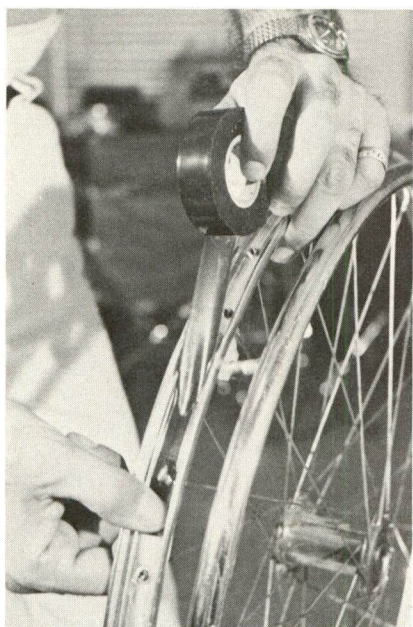


Figure 5

Task No. 7: Reassemble the tire unit.

Again, you will need to work slowly, keeping a firm grip on the wheel.

1. Slip one side of the tire back on the rim. The first side inserted on the rim will be called the *down*

side. This side will slide on easily without the use of any tools (see fig. 6).

2. Insert the tube into the tire body beginning with the valve stem through the valve opening in the rim (see fig. 7).
3. Using your hands, begin working the *up side* of the tire back onto the rim. Use your hands until the tire is too tight to make any more progress without tools (see fig. 8).

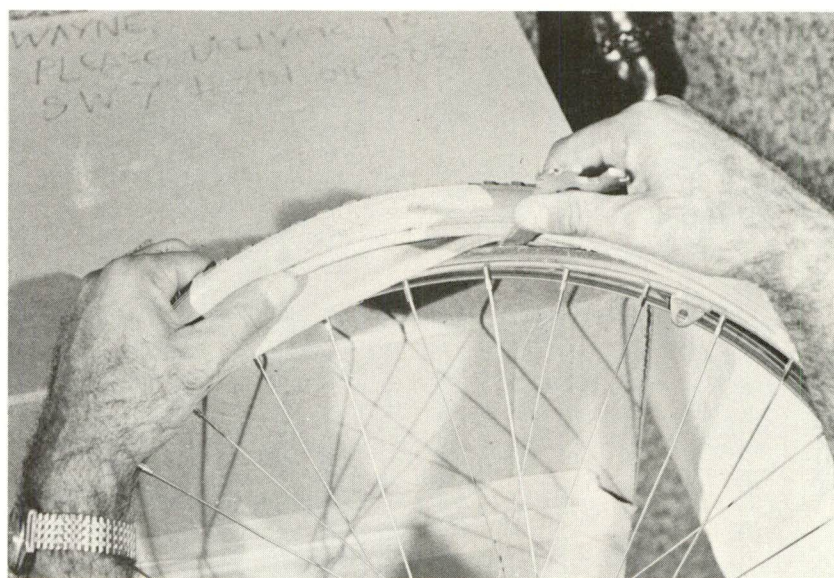


Figure 6

Key Point: Most of the errors in tire installation are made at the valve stem. If the stem is allowed to twist or become crooked in the hole, it can tear and the air will leak out.

4. Insert the tube evenly under the tire, using your hands and fingers.
5. Once the tube is under the tire, work the tire back onto the rim. Again, use your hands as long as possible. When the tire is too tight for hand levering, insert the first tire tool under the tire. Following the steps shown in the illustrations, gently lever the tire back onto the rim. Water can again be used as a lubricant if the tire is difficult to reinstall (see figs. 9 and 10).

Key Point: Most of the rest of the mistakes that occur in tire reassembly happen at this point. If the tire tools are pushed too far under the tire, they will cut or pinch the tube. If the tube was not smoothly placed under the tire, the tire tools can pinch and puncture the tube. Work slowly and carefully. Inflate the inner tube (see fig. 11).

Task No. 8: Attach the repaired wheel to the frame.

1. Hold the wheel against the frame.
2. Insert the axle through the wheel



Figure 7

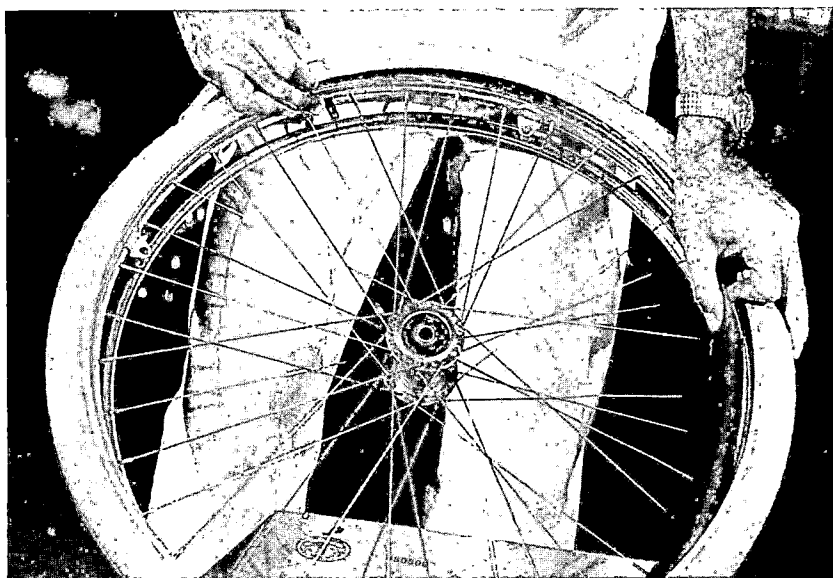


Figure 8

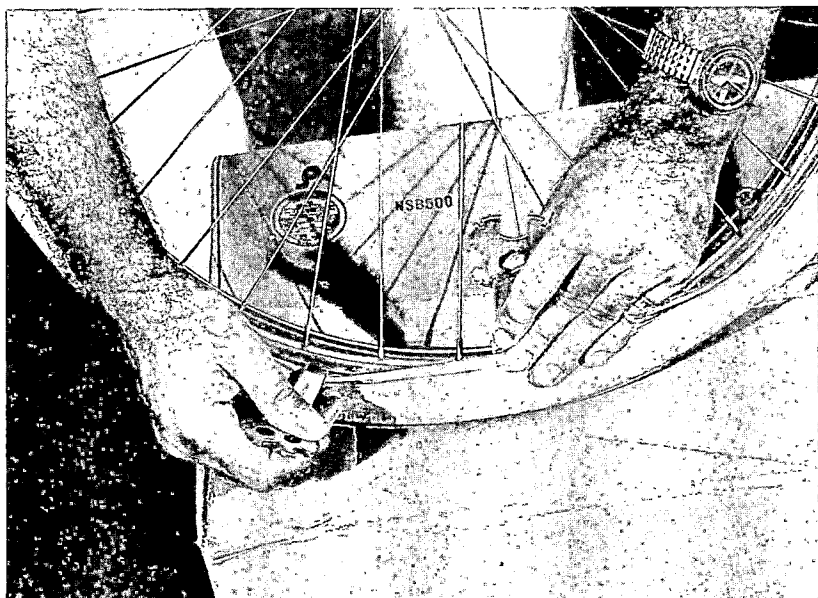


Figure 9

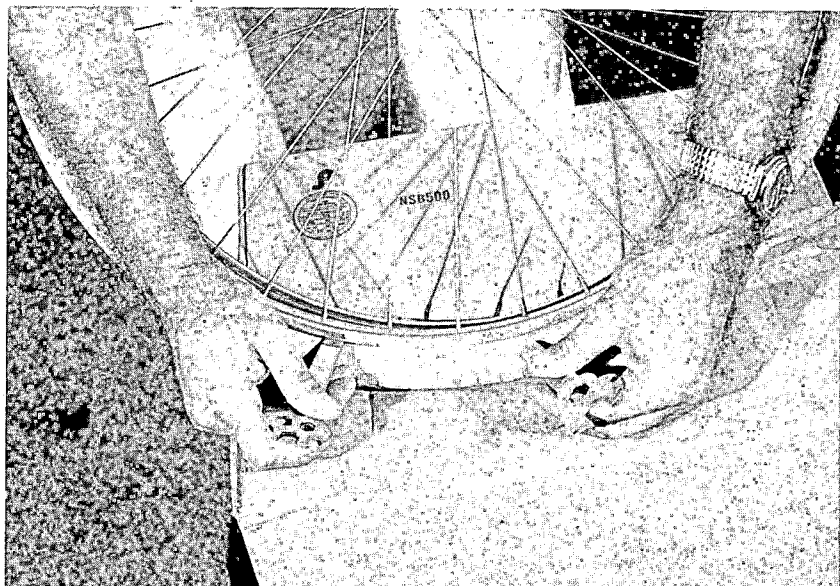


Figure 10

3. Most internal punctures are caused by _____.
 - a. thorns
 - b. spoke heads
 - c. nails
 - d. glass
4. Any solid rubber tires with defects must be taken to a _____ for repair.
5. The three main causes of air loss on pneumatic tires are _____, _____, and _____.
6. Leaks are found by holding the tire under _____.
7. Mark damaged areas on the tube with a _____.

and into the receptacle on the frame. With your fingers or a wrench, turn the axle bolt clockwise until it is almost fully tight.

3. Place the locknut on the inner end of the axle bolt, turning it with your fingers.
4. Tighten the locknut. Rotate it clockwise, while holding the axle bolt with the adjustable wrench.
5. Replace the dust cap. Center it with your fingers, and tap it firmly into place with a hammer or mallet.

Check Your Knowledge

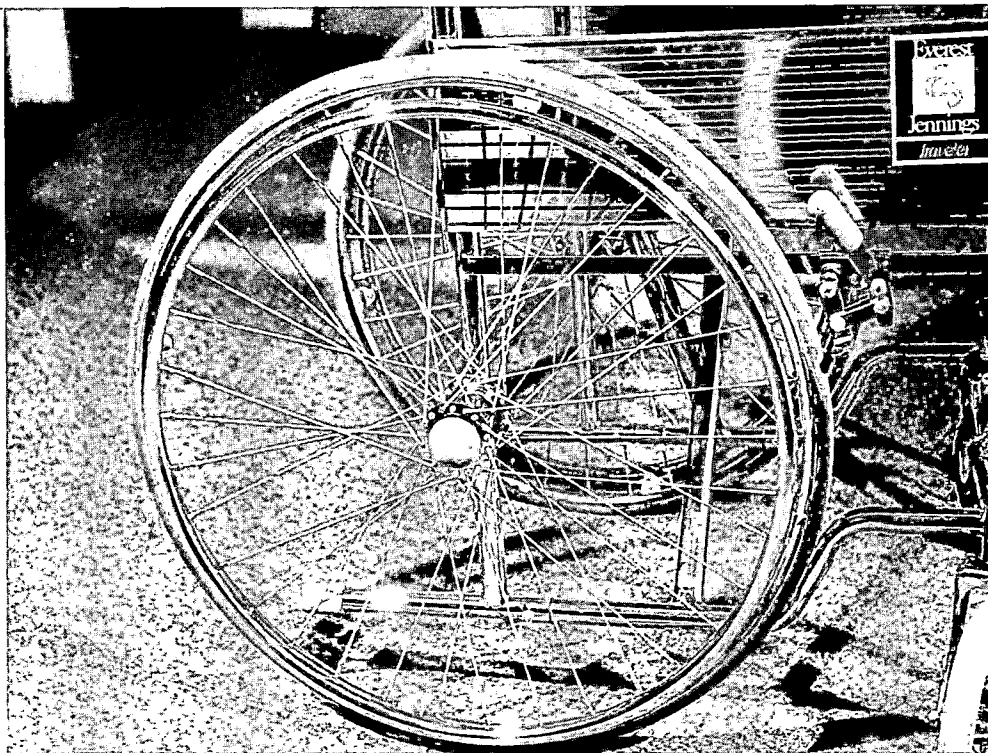
1. _____ tires are inflatable.
2. Solid tires are made of _____.
 - a. metal
 - b. vinyl
 - c. rubber



Figure 11

4

SPOKES AND RIMS



Section A

Inspecting and Maintaining Spokes and Rims

General Information: Spokes act as a shock absorber for the wheelchair. They must all be equally tightened in order to work properly. A single broken or loose spoke could damage the entire wheel. A spoke that is too tight could puncture the wheel rim and the tire.

Possible Problems: Unequally tightened spokes, rust formation, bent or twisted wheel

1. **Problem:** Unequally tightened spokes.

To Inspect: Strum the spokes as if they were guitar strings, us-

ing a flat-blade screwdriver. Listen for any variations in tone as you strum the spokes. (See Section B.)

Maintenance Action: Tighten or loosen any spokes that have an odd sound. (See Section B of this chapter for procedures.)

2. **Problem:** Rust forming on the spokes or rim.

To Inspect: Look closely at the spokes and the wheel rim. Pay particular attention to the areas where the spokes join the rim and hub. Lightly rub each

spoke. Any rough spots probably indicate the formation of rust.

Maintenance Action: Remove rust from the rim and spokes. (See Chapter 12 of this manual for detailed instructions.)

3. **Problem:** Bent or twisted wheel.
To Inspect: See Section B of this chapter for step-by-step instructions.

Maintenance Action: Take the wheel to a repair shop for wheel truing.

Section B

Repairing Spokes and Rims

Objectives: After completing this chapter, you will be able to perform actual tasks and provide information related to those tasks.

Task Objectives:

1. inspect the rim and spokes for rust formations;
2. remove the rust from the rim and spokes;
3. check the spokes for equal tightness;
4. adjust the tightness of the spokes; and
5. check the wheel for trueness.

Information Objectives:

1. tell what determines the roundness or trueness of a wheel;
2. explain why the services of a repair person are needed to repair a bent rim; and
3. describe the condition which spokes must be in to effectively absorb shocks and impacts.

A wheel that is perfectly round is called "true." *Trueness* is the word used to describe the degree of roundness in a particular wheel. Returning a bent wheel to roundness is called "truing the wheel."

When we think about the roundness or trueness of a wheel, we usually think about the tire. The tire is the rubber outer edge of the wheel. But the tire does not determine the trueness of the wheel. The tire only

reflects the shape of the rim upon which it is mounted.

As an illustration, picture a rubber band around an object of any shape and it will conform to that shape. Wheelchair tires are like large rubber bands. They are mounted on a rim and will conform to that shape. If the wheel is bent or out of round, the problem lies beneath the tire.

The roundness or trueness of a wheel is determined by the rim and its supporting spokes. The rim itself is only a circle of metal, less than 1/4 inch thick. If the rim alone received a severe impact, it would bend or twist. The rim must be supported by a network of spokes. These spokes support and protect the rim by distributing stress from impacts. If the spokes are not adjusted to equal tightness, individual spokes will absorb too much stress. And they will be damaged. The spokes must be of equal tightness to work effectively as a shock absorber.

The rim and spokes are susceptible to the following types of problems. The rims and spokes can chip and rust. The rims can be bent and twisted by impacts and misuse of the wheelchair. If the spokes are unequally tightened, two other problems can arise. If they are too loose, the rim loses equal support and can be easily bent, and pierce the tube. If any spokes are too tight, they can also pierce the rim from below and puncture the tire.

Replacing bent rims and respoking the wheel are very difficult tasks. They require a lot of time and special equipment. This chapter will present procedures for inspecting the rims and spokes. And instructions will be given for helping to prevent rim or spoke damage.

If you do find badly damaged spokes or rims, take the wheel to a professional repair person. If you have the tools and skills to undertake major repair in your home, see any complete bicycle repair manual for instructions on spoke and rim repair.

Two main topics are covered in the repair section of this chapter. First, procedures for finding and removing rust formations on the spokes and rim are presented. Next, a procedure for keeping the spokes equally tightened is given. Carefully following these two procedures will prevent most major damage to your wheels.

Materials:

1. Spoke wrench
2. Flat-blade screwdriver
3. Grease pencil
4. Machine oil
5. The materials needed for rust removal are listed at the beginning of Chapter 12.

Parts (See fig. 1):

- | | |
|--------------|----------------|
| 1. Wheel rim | 3. Spokes |
| 2. Hub | 4. Nipple ends |

Tasks, Steps, and Key Points:

Task No. 1: Inspect the rim and spokes for rust formations.

Note: Spokes are often bumped and chipped during the daily

operation of the wheelchair. Each impact can chip off the rust-proof coating on the metal. Exposed metal will rust and weaken. Spokes should be checked for rust twice weekly.

1. Look carefully at the rim. Pay particular attention to the receptacles where the spokes join the rim.
2. Use your fingers to lightly rub the entire rim. Any rough spots are probably rust formations.
3. Mark the area with the grease pencil and continue inspecting.
4. Look carefully at each of the spokes. Mark any rust spots you observe.
5. Use your fingers to lightly rub each spoke. Any rough spots are rust formations.
6. Mark these spots with the grease pencil.

Task No. 2: Remove the rust from the and spokes.

See Chapter 12 of this manual for step-by-step instructions for rust removal.

Task No. 3: Check the spokes for equal tightness.

1. Strum the spokes lightly like guitar strings.
2. Use a flat-blade screwdriver or other metal piece for strumming.
3. Listen for variations in tone as the spokes are strummed.

Note: There is not one "correct" tone for the spokes. The important fact is that they must all sound about the same.

4. Mark any spoke that has a different sound with a grease pencil.

Task No. 4: Adjust the tightness of the spokes.

1. Place the spoke wrench on the spoke nipple of any spoke you have marked. If the spoke's tone was too low, it is loose. If the spoke's tone was too high, it is too tight.
2. Tighten spokes by turning the nipple clockwise.
3. Loosen spokes by turning the nipple counterclockwise.

4. After you have turned a spoke nipple one half revolution, restrum the area. If the spoke and its neighbors sound the same, the adjustment is complete.
5. If the spokes do not sound the same, continue the adjustment process.

Task No. 5: Check the wheel for trueness.

Note: This procedure will tell you if you have corrected the problem. If you have adjusted the spokes equally and the wheel is still not trued, you have a bent rim. Bent rims must be taken to a dealer for repair.

1. Lay the wheelchair on one side.
2. Select any spot on the wheelchair frame that is near the edge of the tire.
3. Spin the wheel. Closely observe the distance between the spinning tire and the reference point on the chair. If the wheel appears to move up and down in relation to the reference point, the rim is warped.
4. Tilt the wheelchair to the other side so that a wheel can spin freely.
5. Again, choose a reference mark on the wheelchair frame.
6. Spin the wheel.
7. Closely observe the distance between the edge of the spinning tire and the reference mark. If the wheel appears to dip away from the rim, it is bent.

Note: Bent or warped wheels should be taken to a dealer for repair.

Check Your Knowledge

1. A wheel that is perfectly round is called _____.
2. Returning a wheel to roundness is called _____.
3. The _____ reflects the shape of the rim.
4. If the wheel is bent or out of round, the problem lies with the _____ and the _____.

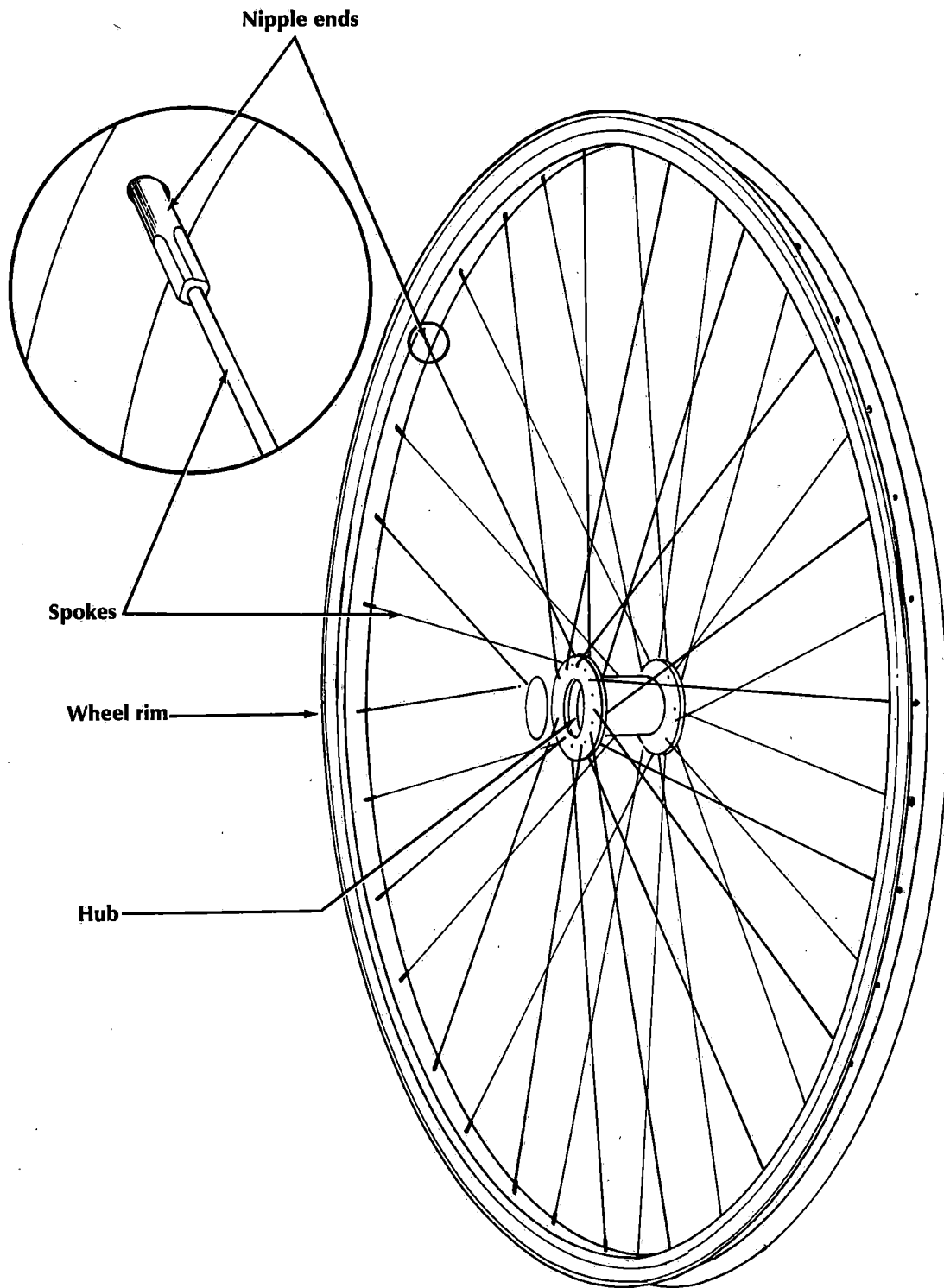


Figure 1. Wheel Rim and Spokes, Parts

5. The rim is _____ inches thick.
- a. more than one
 - b. more than $\frac{1}{2}$
 - c. more than $\frac{1}{4}$
 - d. less than $\frac{1}{4}$
6. The rim is supported by a network of _____.
- a. braces
 - b. spokes
 - c. rubber
 - d. tubular steel
7. Which of the following is *not* a cause of rim problems? _____
- a. spokes too tight
 - b. spokes too loose
 - c. underinflated tire
 - d. unequally tightened spokes

5

BEARINGS



Repairing Bearings

Objectives: *After completing this chapter, you will be able to do actual tasks and provide information related to those tasks.*

Task Objectives:

1. *remove the bearing;*
2. *clean it;*
3. *inspect it;*
4. *lubricate it; and*
5. *replace it on the wheel.*

Information Objectives:

1. *tell why early wheels were not efficient;*
2. *tell how a bearing attaches an axle to a frame receptacle; and*
3. *give reasons why you should always keep a replacement bearing in your tool kit.*

A wheel cannot be used unless it has an axle. The first functional wheels used solid axles inserted into simple receptacles. The problem with these early wheels was the axle. Turning in a receptacle quickly wore down the axle, and it would wobble and break. The axle and the frame were in direct contact. The more weight the wheel carried, the more pressure was put on the axle.

Modern wheels use bearings for stability and reduced friction. Figure 1 shows the typical wheelchair bearing. When the bearing is inserted in a receptacle, the outer ring attaches to the wheel hub and the inner ring attaches to the axle. The bearings sandwiched in the middle allow the inner ring to rotate while the outer ring is held rigid.

During the life of your wheelchair, the bearings will need servicing several times a year.

If any of the bearings make a grinding noise, this indicates that you probably need to replace them. Keep a spare bearing in your tool kit. Also you should never attempt to remove a bearing from the wheelchair unless you already have the replacement

bearing on hand. There is always a chance that you will damage the bearing while removing it from the frame. And without the replacement, you could find yourself immobilized.

If you have a bearing in your tool kit, familiarize yourself with it before trying to remove a bearing from the wheelchair. Each bearing is a tiny bit smaller than the receptacle tube. This size difference allows the

bearing to be snugly inserted inside the tube. This is known as "seating the bearing." A replacement bearing must be *exactly* the same size as the original. You can find the size number of the bearing stamped on its side.

There are 12 bearings on a manual wheelchair. Each of these bearings comes in sets of two, totaling six sets of bearings per wheelchair. Figure 1

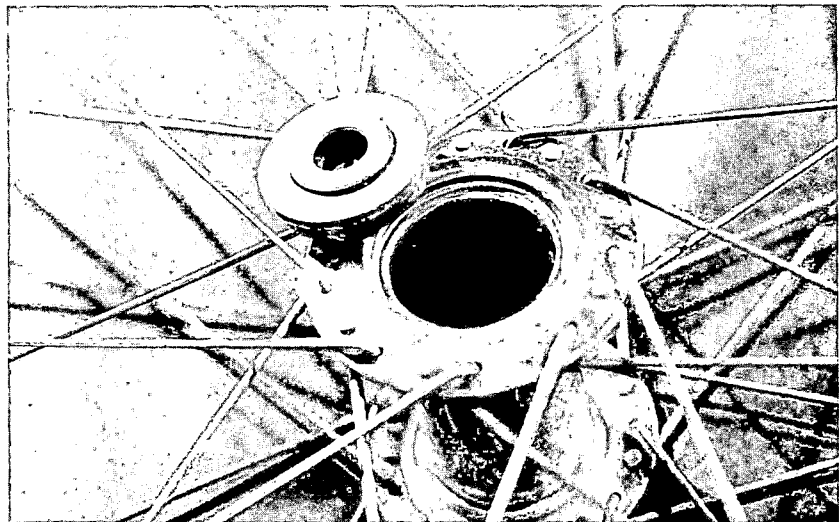


Figure 1. Main wheel hub with bearing removed. The bearing is resting next to the wheel hub.

shows the location of these bearings on the chair.

The same procedure is used to remove all bearings, no matter where they are located on the chair. The same procedures also apply to inspecting, cleaning, lubricating, and installing all bearings. If any other chapter of this manual refers to bearings removal, you will be referred to this chapter.

Materials:

1. Flat-blade screwdriver
2. Hammer
3. Cleaning rag
4. Commercial solvent
5. Waterproof grease

Parts (See fig. 2):

1. Bearings
2. Inner bearing ring
3. Outer bearing ring
4. Ball bearings
5. Frame receptacle
6. Axle

Note: All removal instructions given in this chapter assume that you already removed the wheels or casters. Once the wheel or caster is removed, the bearing can be removed. These instructions stop at the point where the bearing is replaced in the sleeve or wheel. Return to the chapter on casters or tires for instructions on reassembly of that part group.

Tasks, Steps, and Key Points:

Task No. 1: Remove the bearing.

Key Note: Be sure to brace the wheelchair frame or wheels securely before attempting to remove bearings.

1. Place the tip of a flat-blade screwdriver at an angle against the outer ring of the bearing. See figure 3 before you proceed.
2. Using the hammer, tap the screwdriver gently.
3. Move the screwdriver tip to the other side of the bearing, and repeat the process.

Note: Do not pound on the screwdriver. If the bearing is struck too hard, it will bend or break. Bearing removal requires a delicate touch and patience.

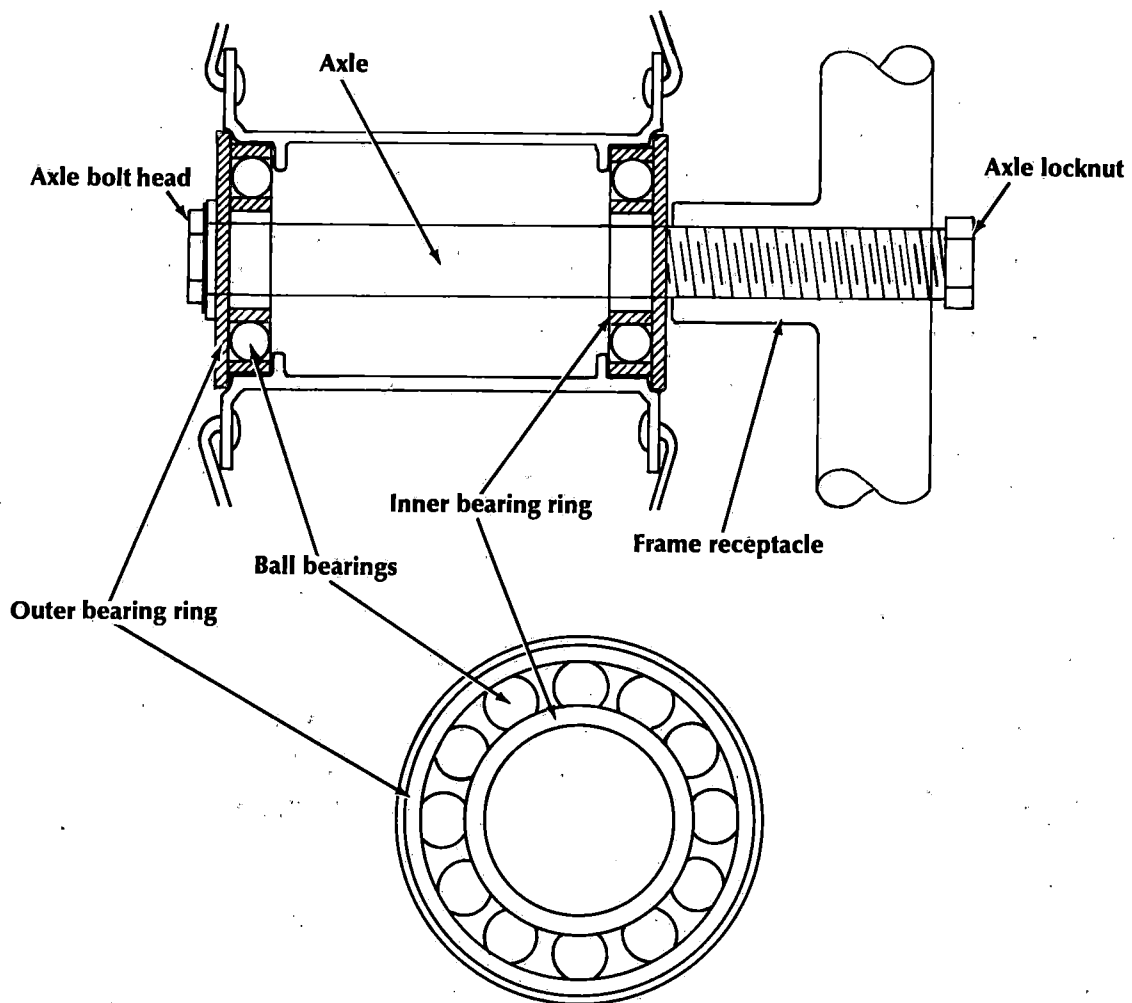


Figure 2. Bearings Parts

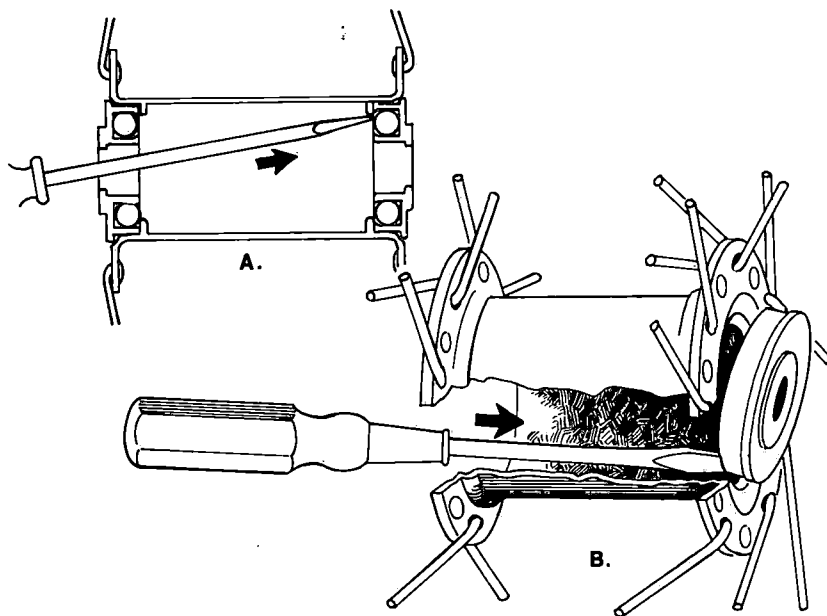


Figure 3

4. Continue moving the tip of the screwdriver followed by two taps with the hammer.
5. Repeat this process until the bearing comes free of the sleeve or wheel.

Task No. 2: Clean the bearing.

1. Dip the bearing in the commercial solvent.
2. Rub it with a cleaning rag.

Task No. 3: Inspect the bearing.

1. Inspect your bearing by first comparing it to the figures 4A and 4B.
2. After looking over the bearing, check to see how it operates.
3. Hold it with your thumb and forefinger pressing the inner ring.
4. Use your other hand to spin the outer ring. The bearing should spin freely. If you hear grating noises, the internal ball bearings are pitted. If the bearing resists spinning, it is defective and can-

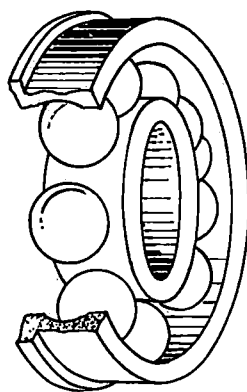


Figure 4A. Bearing in good condition.

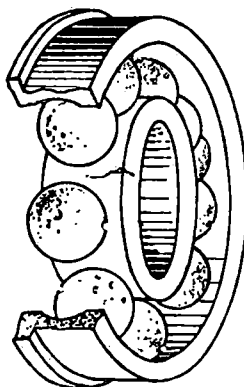


Figure 4B. Bearing in poor condition, with rough surfaces.

not be repaired. In either case, if the bearing is defective, throw it away and use a replacement bearing.

Task No. 4: Lubricate the bearing.

Note: This is a messy job. Have cleaning materials handy.

1. Hold the bearing in the palm of one hand.
2. Place a large amount of waterproof grease on it.
3. Be sure to work grease into the internal ball bearings.
4. Turn the bearing rings often to ensure that the grease spreads.
5. Wipe off any excess grease with the cleaning rag.

Task No. 5: Replace the bearing.

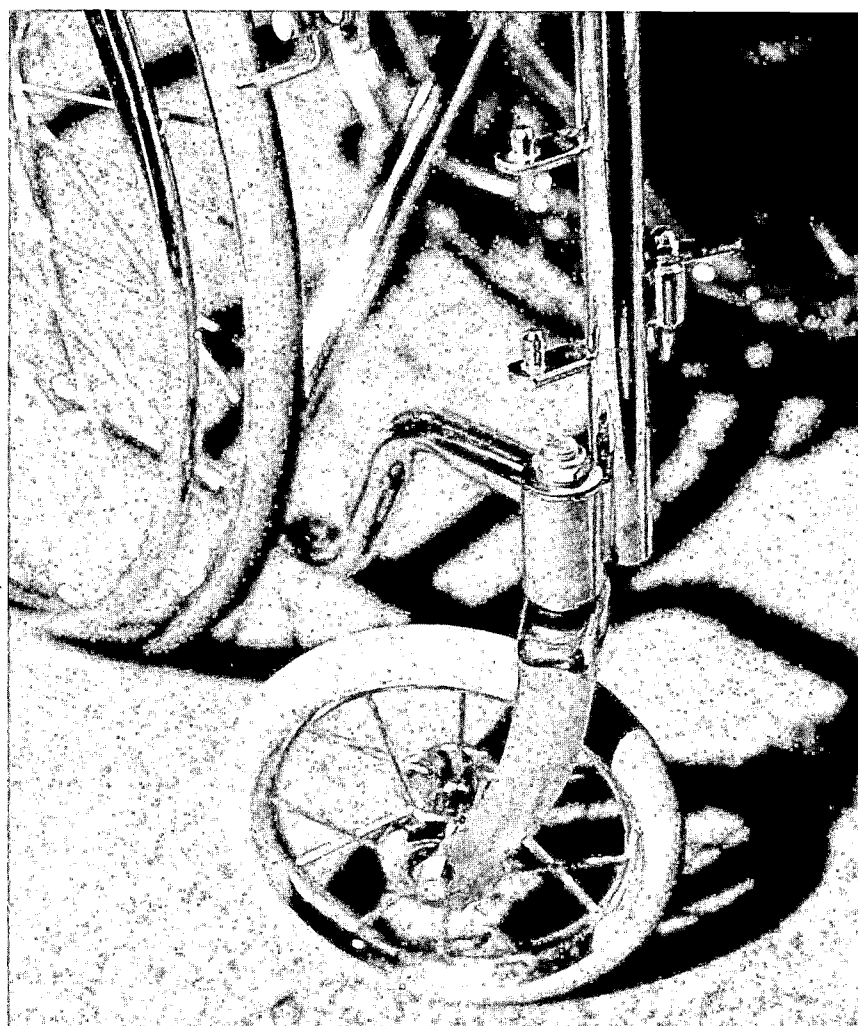
1. Slip the bearing into the sleeve or axle. Use your fingers.
2. Push down on each side until the bearing will go no farther.
3. Place the tip of a flat-blade screwdriver against the outer ring and tap lightly.
4. Continue moving the screwdriver and tapping until the entire ring has been pushed down evenly. The bearing is now seated.

Check Your Knowledge

1. The first functional wheels used solid axles inserted in _____.
2. A wheel must have an _____ to be useful.
3. When a bearing is inserted in a receptacle, the _____ attaches to the frame or wheel hub.
4. The inner ring attaches to the _____.
5. A replacement bearing must be _____ as the original.
6. Inserting a bearing into a receptacle is called _____ the bearing.

6

CASTER WHEELS



Section A

Inspecting and Maintaining Caster Wheels

General Inspection: Tilt the wheelchair so the casters can freely rotate. Observe any rust formations, and check the condition of the tires. Make sure the casters rotate smoothly. Check the wheel to see that it spins freely.

Possible Problems: Rust formation, defective bearings, worn tires

1. **Problem:** Rust formation on the caster.
To Inspect: Look carefully at each caster. Lightly rub your hand over the entire assembly. Any rough spots are probably rust formations. See Chapter 12

for instructions on rust removal.

2. **Problem:** Caster will not spin on the horizontal plane.
To Inspect: Check the tightness of the upper locknut.
Maintenance Action: If the caster is spinning too freely, tighten the upper locknut with an adjustable wrench by turning it clockwise. If the caster is not spinning freely enough, loosen the locknut, turning it counter-clockwise.
3. **Problem:** Caster wheel will not spin properly.
To Inspect: Spin the wheel. If

you hear a grinding noise, or if the wheel will not spin freely, the bearings are defective.

Maintenance Action: Remove the bearings by following the instructions given in Chapter 5 of this manual.

4. **Problem:** Worn tires.
To Inspect: Look at the wheel. If it appears too worn, it could be a safety hazard.
Maintenance Action: Remove the wheel and order a replacement. Following the step-by-step instructions given in Section B of this chapter.

Section B

Repairing Caster Wheels

Objectives: After completing the step-by-step instructions in this chapter, you will be able to do actual tasks and provide information related to those tasks.

Task Objectives:

1. remove the caster wheel assembly from the frame;
2. remove, inspect, lubricate, and replace bearings;
3. detach the caster wheel from the caster fork;
4. remove, inspect, lubricate, and replace wheel bearings;
5. attach the wheel to the caster fork; and
6. attach the caster fork assembly to the frame.

Information Objectives:

1. locate the component parts of the caster assembly on a diagram;
2. define a caster wheel and give its function;
3. describe movements on the horizontal plane;
4. tell which locknut controls each plane of motion;
5. give a consequence of an overly tightened axle locknut; and
6. explain why caster adjustment requires a trial-and-error approach.

There are two sets of wheels on the wheelchair. The larger *main wheels* are used for propelling the chair. They are rigidly mounted to the frame. This means that they will only rotate on one plane of motion, forward and backward. This is the

vertical plane of motion. The main wheels will not turn to the right or the left in the *horizontal plane of motion*.

The front wheels are called *caster wheels*. A caster wheel is one that can move in two planes of motion

at once. The caster has an extra set of bearings mounted on the frame that allows this extra range of motion. Figure 1 shows these two planes of motion.

Caster wheels make the wheelchair easier to steer and maneuver. There are two main locknuts in the caster assembly. The upper locknut controls the horizontal plane. If this nut is too tight, the wheelchair will be difficult to steer. If it is too loose, the chair will wiggle or wobble when it moves. The casters on most grocery carts are almost always too loose. You can picture a grocery cart vibrating down the aisles as each caster moves in a different direction.

The axle locknut affects the ability of the caster wheel to spin freely. If this nut is too tight, the chair will be difficult to push forward or backward.

Loosening and tightening the locknuts is a matter of trial and error. The degree of tightness on a caster wheel is a matter of individual preference. You need to keep loosening and tightening the locknut until the unit becomes comfortable for your own use.

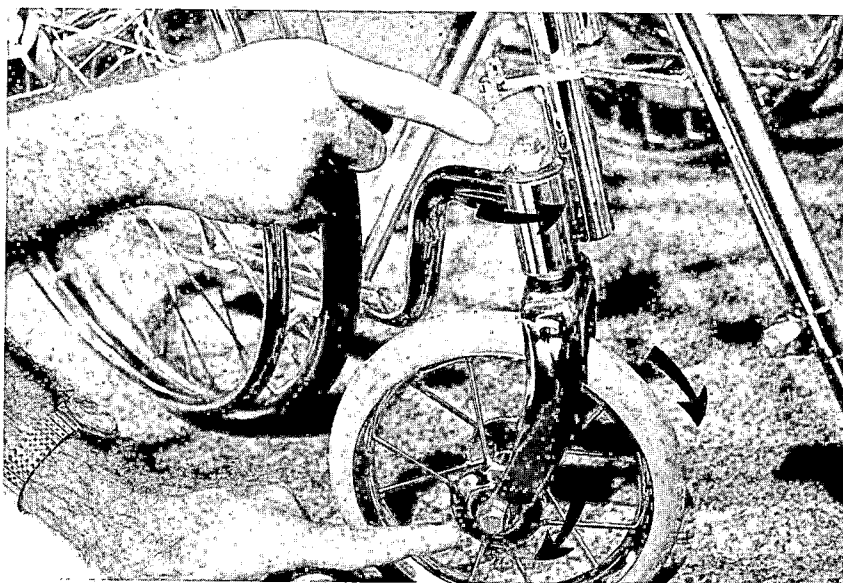


Figure 1. Caster Assembly

This chapter will provide step-by-step instructions for adjusting the horizontal spin of the caster. If your repair problem involves removing bearings, you will be referred to Chapter 5 of this manual. There you will find step-by-step procedures for removing, inspecting, lubricating, and installing replacement bearings. This chapter gives instructions for removing the caster fork from the wheelchair frame. It concludes with instructions for removing and replacing the caster wheel.

Tools and Materials:

1. Flat-blade screwdriver
2. $\frac{3}{4}$ -inch box end wrench
3. Adjustable wrench
4. Cleaning rag
5. Commercial solvent (see Chapter 1)
6. Axle grease (see Chapter 1)

Parts (See fig. 2):

1. Stem nut (for adjusting horizontal rotation)
2. Frame sleeve
3. Caster bearings
4. Caster fork

5. Caster stem
6. Wheel
7. Axle
8. Axle locknut (for adjusting vertical rotation)
9. Wheel bearings

Tasks, Steps, and Key Points:

Task No. 1: Remove the caster wheel assembly from the frame.

1. Place a wrench on the upper locknut. Most chairs use a $\frac{3}{4}$ -inch nut. If yours is different, use the adjustable wrench.
2. Remove the upper locknut by rotating it counterclockwise. Complete the removal with your fingers. The caster assembly will drop clear of the frame once this upper locknut is removed.

Task No. 2: Remove the caster bearings.

Key Point: Complete step-by-step instructions for removing and servicing bearings are given in Chapter 5 of this manual.

Task No. 3: Detach the caster wheel from the caster assembly.

Key Point: The caster assembly does not need to be removed from the frame to service the wheel.

1. Place a wrench on the axle locknut. Most wheelchairs use a $\frac{1}{2}$ -inch locknut. If yours is a different size, use the adjustable wrench.
2. Remove the axle locknut, while holding the head of the axle bolt with another wrench. Rotate the wrench counterclockwise to loosen it. Complete removal of the axle locknut with your fingers.
3. Withdraw the axle from the wheel by pulling it with your fingers. The wheel will drop free of the caster fork.

Task No. 4: Remove the wheel bearings.

See Chapter 5 of this manual for complete step-by-step instructions.

Task No. 5: Attach the wheel to the caster fork assembly.

1. Hold the wheel between the two halves of the fork.
2. Insert the axle. The axle must pass straight through the receptacles in the fork.
3. Attach the axle locknut. Using your fingers to start the locknut, turn it clockwise to tighten.
4. Using the $\frac{1}{2}$ -inch box end wrench or the adjustable wrench, continue rotating clockwise until the axle locknut is tight. Hold the head of the axle bolt with another wrench.
5. Spin the wheel. If it will not spin freely, loosen the axle locknut. If the wheel will still not spin freely, you have a problem with your wheel bearings. See Chapter 5 of this manual for instructions on bearing repair.

Key Note: The caster wheel picks up a lot of grime and grease. The parts will be very dirty when removed from the frame. Have a cleaning cloth handy. Dip it lightly in solvent; and clean each piece as it is removed.

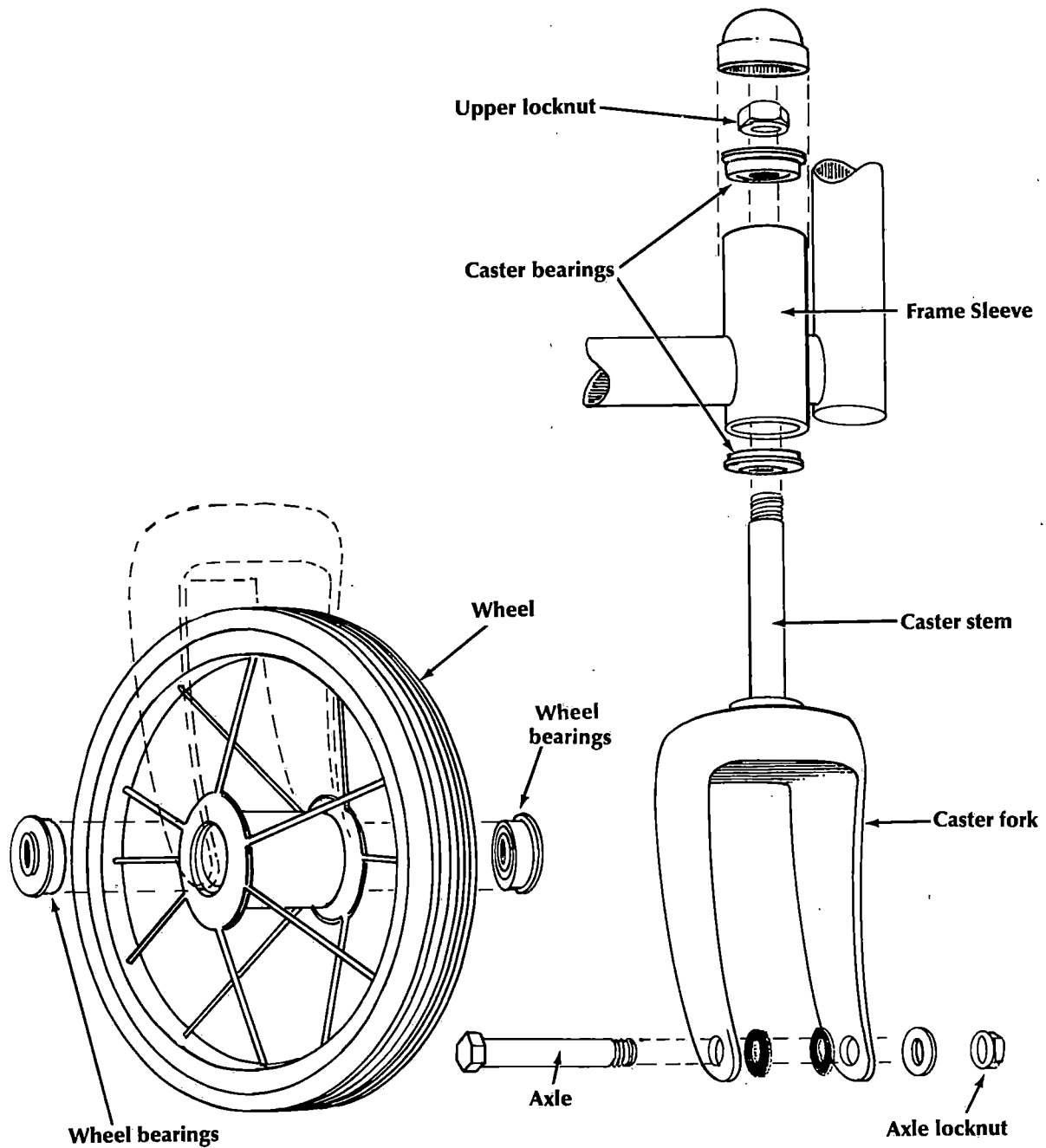
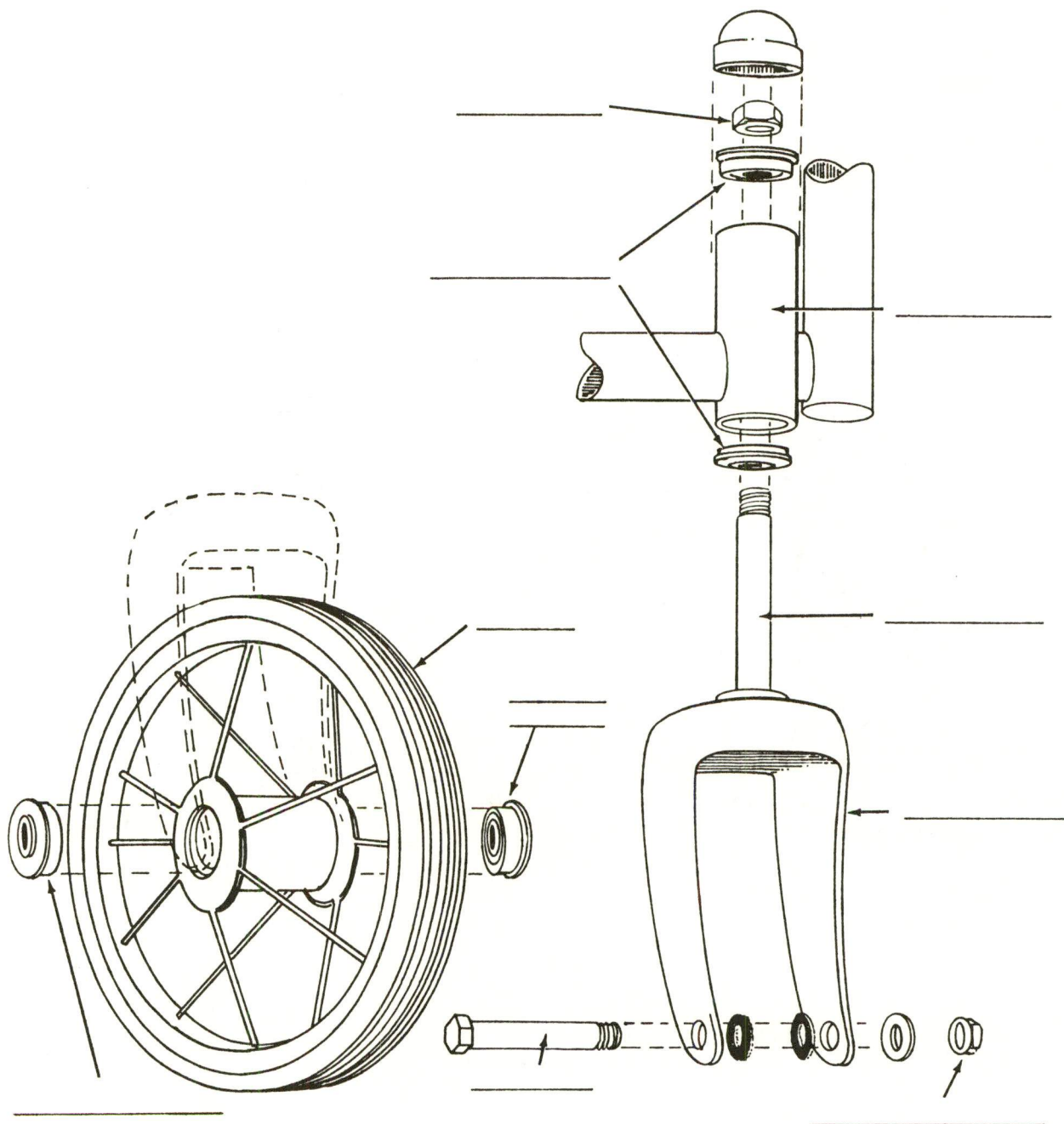


Figure 2. Caster Assembly Parts

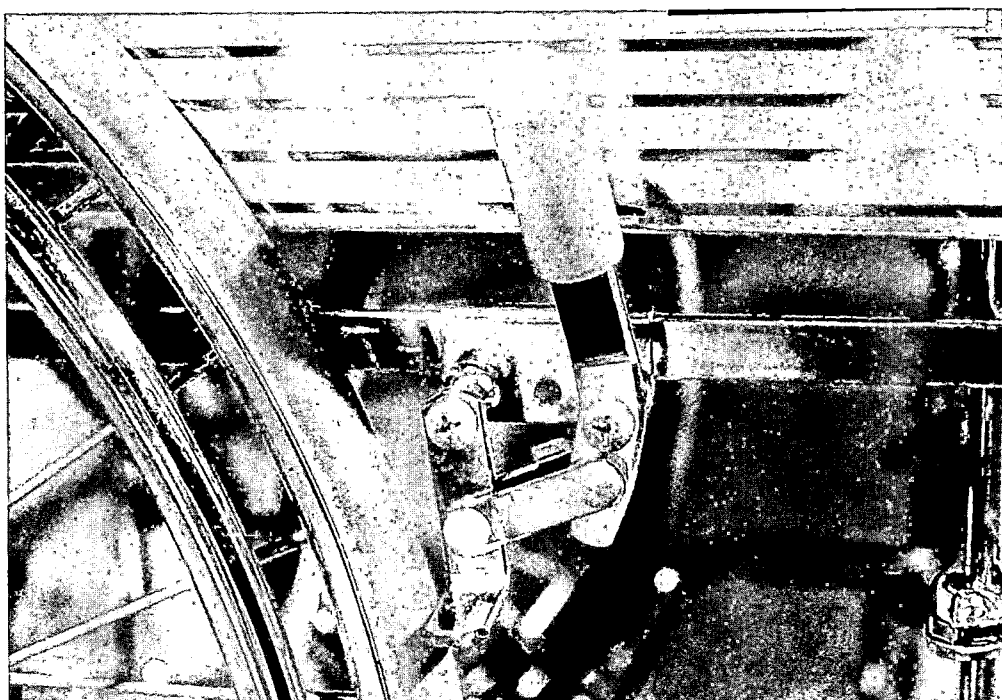
Check Your Knowledge

1. What are the directions of movement on the vertical plane? These are _____ and _____.
2. What are the directions of movement on the horizontal plane? These are _____ and _____.
3. What is the distinctive characteristic of a caster wheel?
 - a. It has shock absorbers.
 - b. It can move in two planes of motion at once.
- c. It moves in only one plane of motion at a time.
4. The stem nut controls movement on the _____ plane.
 - a. horizontal
 - b. vertical
 - c. ordinary
 - d. inclined
5. There are _____ sets of wheels on the wheelchair.
6. The larger wheels are used for _____ the wheelchair.
7. Caster wheels make the chair easier to _____ and _____.
8. The caster has an extra set of _____ mounted on the frame.
9. If the upper locknut is too tight, the wheelchair will be _____ to steer.
10. Locate and name the component parts of the caster assembly on the following diagram.



7

WHEEL LOCKS



Section A

Inspecting and Maintaining Wheel Locks

General Information: Wheel locks hold the wheelchair in place. They firmly lock the main wheels so that they cannot turn.

Possible Problems: Wheel locks slip or will not hold, broken wheel lock

1. **Problem:** Wheel lock slips or will not hold.

To Inspect: Check the condition of the tires. The wheel lock must firmly press against the tire to hold the chair in place.

If you have solid tires, check to see if they are badly worn. If you have pneumatic tires, check to see that they are fully inflated.

Maintenance Action: Inflate pneumatic tires to their proper pressure. If it does not solve the problem, see Section B of this chapter (Task No. 1, Steps 1, 2, and 3, for loosening and

Task No. 3, Steps 5, 6, 7, and 8 for adjustment).

2. **Problem:** Broken wheel lock.
To Inspect: Look over each part of the wheel lock.

Maintenance Action: Broken wheel locks cannot be repaired. See Section B of this chapter for instructions on removing the broken wheel lock and installing a replacement.

Section B

Replacing Wheel Locks

Objectives: After completing this chapter, you will be able to perform actual tasks and provide information related to those tasks.

Task Objectives:

1. remove the wheel lock from the frame;
2. order a replacement wheel lock; and
3. install the replacement wheel lock.

Information Objectives:

1. tell what wheel locks do for the wheelchair;
2. name the most efficient type of wheel lock; and
3. tell why it's important to measure the distance between the receptacles in the mounting bracket.

The term *wheel lock* tells exactly what this device does for the wheelchair. *Wheel locks* lock the main wheel of the chair firmly into place, and they prevent the wheel from rolling. This greatly increases the stability of the wheelchair.

There are two basic types of wheel locks. Almost all wheelchairs now use the toggle-type wheel locks. Figures 1A and 1B show the position and "knee action" of the wheel lock. The knee action provides a firm, slip-proof lock.

Some older or custom-made wheelchairs occasionally use lever-type wheel locks. This style of lock is less efficient than the toggle type. It will not hold the wheelchair as firmly in one place. Figure 2 shows a lever-type wheel lock removed from the chair.

Wheel locks are made of solid pieces of heavy metal. The home repair person cannot repair a broken wheel lock. However, you can adjust or remove a wheel lock and install another of the same design.

Because there are few lever-type wheel locks currently in use, this manual will only describe procedures for toggle-type wheel locks.

Materials:

1. Flat-blade and Phillips screwdrivers
2. Adjustable wrench
3. Air-pressure gauge
4. Hand-held air pump

Parts (See fig. 3):

1. Mounting bracket
2. Screws
3. Locknuts
4. Rubber cap

Tasks, Steps, and Key Points:

Task No. 1: Remove the wheel lock from the frame.

1. Select a screwdriver that matches the screwheads on the mounting bracket.
2. Place a $\frac{3}{8}$ -inch box wrench or an adjustable wrench on the locknut, and adjust the wrench to fit it. (See Chapter 5 for instructions on adjusting the wrench.

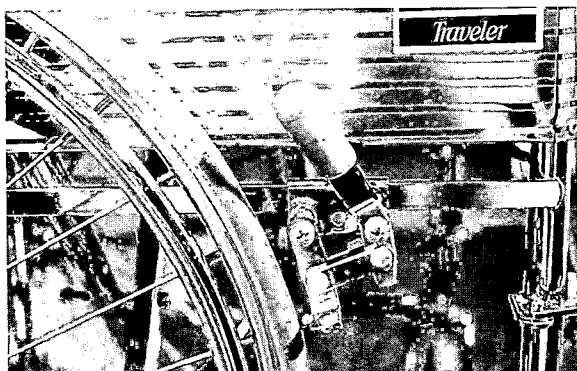


Figure 1A. Wheel lock in off position.

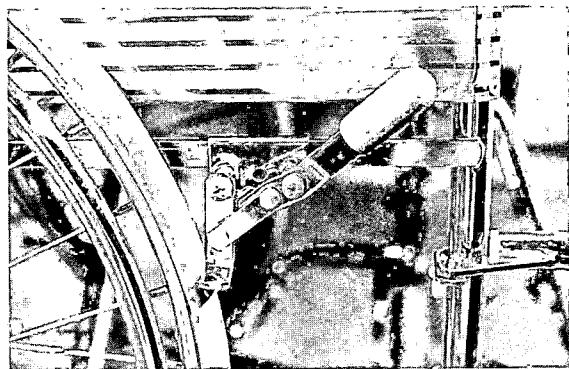


Figure 1B. Wheel lock, engaged.

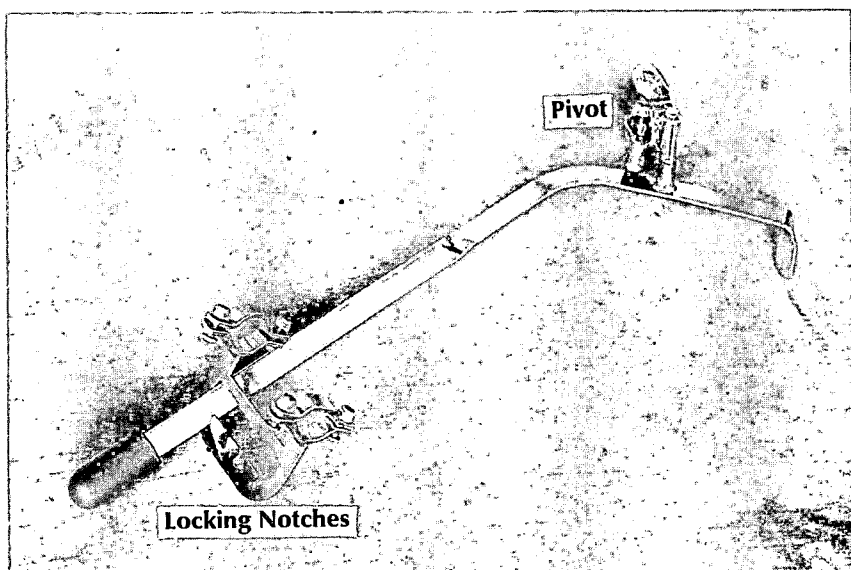


Figure 2. Lever-type wheel lock removed from the chair, showing pivot and locking notches.

3. Remove the locknut by turning it counterclockwise while firmly holding the screw.
4. Inspect the screw and locknut by comparing them to the references in Chapter 5. If they are in good condition, save them. If they are stripped or burred, throw them away.
5. Be prepared to catch the wheel lock when the last screw is removed.

Task No. 2: Order a replacement wheel lock.

Count the number of receptacles drilled through the mounting bracket. Measure the distance between these receptacles. Give the parts shop this information along with the manufacturer and model number of your wheelchair. The following is an example of a clear request for parts. "I need a left-side wheel lock for an Everest and Jennings 'Sportsman.' The wheel lock has two receptacles $1\frac{1}{2}$ inches apart." You would then continue with any special information such as the type of tires on your chair.

Key Note: Wheel locks are not interchangeable from one side of the chair to the other. A left-side wheel lock will only work on the left side of the wheelchair.

Task No. 3: Attach the replacement wheel lock to the wheelchair.

1. Place the replacement wheel lock on the frame where the original was located.
2. Align the receptacles in the wheel lock with the receptacles in the mounting bracket.
3. Insert the screws with your fingers. The screws should pass *straight through* both pieces. If this is not the case, the replacement wheel lock will not fit. Call the wheelchair shop for assistance if you purchase a wheel lock that does not fit your frame properly.
4. Attach the locknuts to the ends of the screws. Using your fingers, turn them clockwise to tighten.
5. Set the wheel lock to the "on" position.

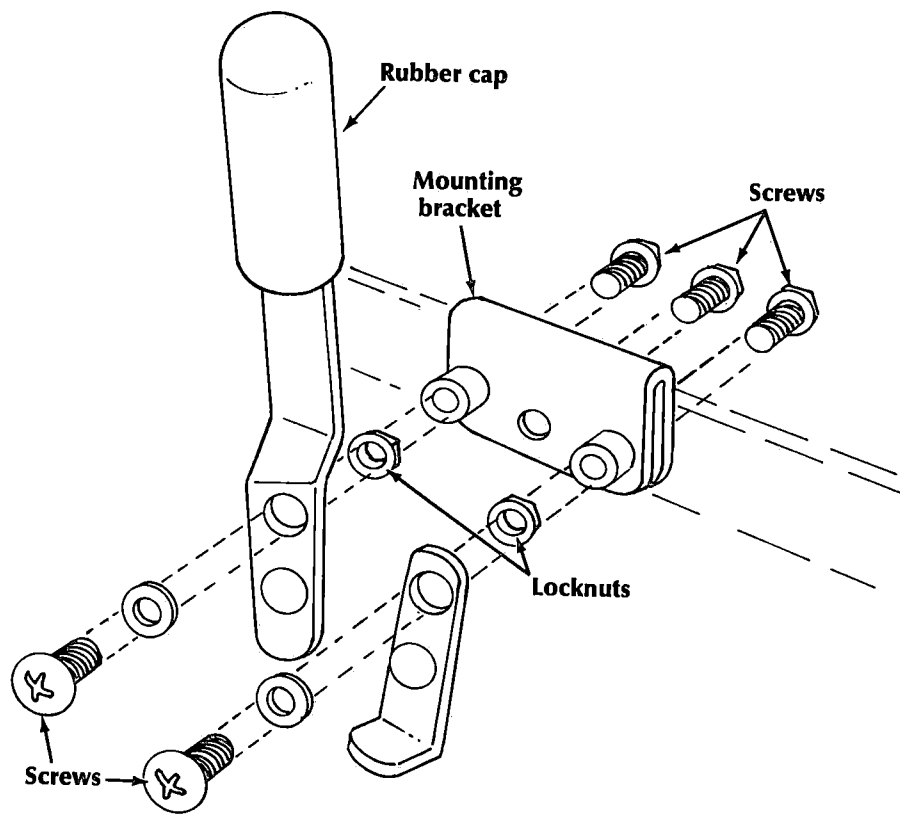


Figure 3. Wheel Lock Parts

6. Twist the wheel lock and the mounting bracket so that the lock shoe touches the tire.
7. Set the wheel lock to the "off" position.
8. Slide the wheel lock and mounting bracket $\frac{1}{4}$ inch closer to the tire.
9. Tighten the nuts to hold the wheel lock assembly firmly in place.
10. Move the lever to the "on" position. The metal bar should press firmly into the tire. If the bar is not tight on the tire, loosen the nuts. Move the wheel lock

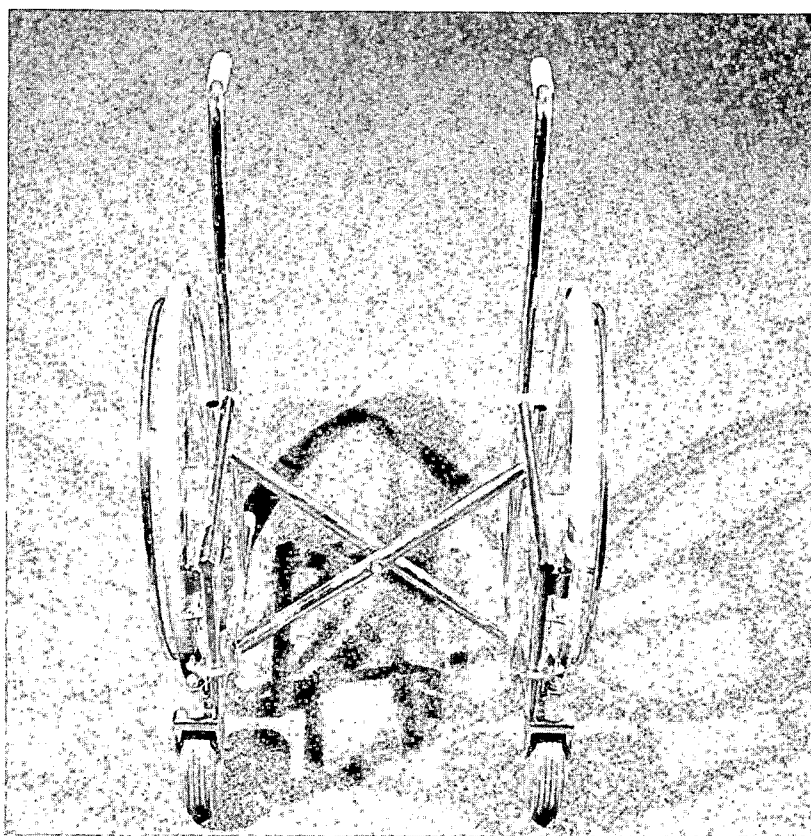
closer to the tire, and test again.

Check Your Knowledge

1. Wheel locks lock the _____ wheels into place.
 - a. main
 - b. caster
 - c. front
2. The two basic types of wheel locks are _____ and _____.
3. The toggle-type wheel lock has a _____ locking device.
4. Some older or custom-made wheelchairs occasionally have _____ wheel locks.
5. Lever-type wheel locks are _____ efficient than (as) the toggle type.
 - a. equally
 - b. less
 - c. more
6. Wheel locks are made of solid pieces of heavy _____.
 - a. rubber
 - b. plastic
 - c. metal

8

FRAME PIECES



Section A

Inspecting and Maintaining Frame Pieces

General Information: All frame pieces and sections are made of tubular metal that has been coated with a rustproof plating. This plating is very thin, and it can chip or break in daily use. Any cracks or breaks are dangerous to the wheelchair frame because they provide an entry for rust. And metal, weakened by rust, will eventually break and possibly cause injury to a wheelchair user.

Burred heads on screws or bolts attached to the frame also present a problem. A user could severely cut a hand or arm on a burr. Burred screws and bolts are also likely to rust. And the rust can spread from the screwhead to the tubular metal. You should inspect your wheelchair frame for rust or burred heads weekly (see fig. 1A and B).

The frame itself could also be bent. A bent frame makes the wheelchair more difficult to propel and turn. And it cannot absorb shocks effectively.

A visual inspection will reveal problems with a bent frame. You will need to take your wheelchair to a professional wheelchair repair person or metalworker to straighten or repair bent frame sections.

Possible Problems: rusting and corrosion, burred screws or bolt heads, broken or cracked frame pieces, bent or twisted frame pieces, chair won't collapse properly.

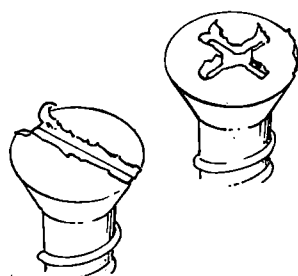
1. **Problem:** Rust or corrosion deposits on the frame pieces.

Maintenance Action: Inspect the frame by lightly passing your hand over each frame sec-

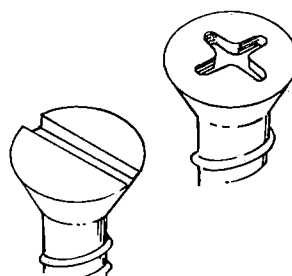
tion. Mark any rough spots with a grease pencil. Remove the rust at once following the step-by-step instructions given in Chapter 12 of this manual. After rust is removed, coat the area of metal with a thin layer of clear nail polish. Make a note on your maintenance and inspection schedule. Give special attention to this area each time you inspect the frame. Replace the cover of nail polish weekly, or each time it is removed or wears off.

2. **Problem:** Screws or bolts with rusted or burred heads.

Maintenance Action: Locate any screw or bolt with burred or rusted heads by touching the entire frame. Mark these

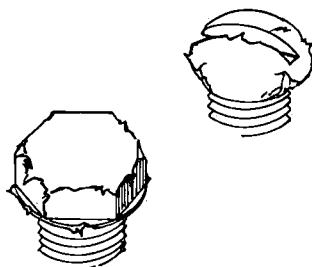


Burred Screwheads

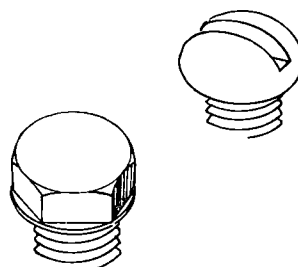


Screwheads in good condition

Figure 1A



Burred bolt heads



Bolt heads in good condition

Figure 1B

with a grease pencil. Remove and replace any rusted or burred screws or bolt heads. Replace with screws or bolts of exactly the same size.

3. *Problem:* Broken or cracked frame pieces.

Maintenance Action: Locate any breaks or cracks while inspecting with your hands. Mark any of these with the grease pencil. Make arrangements with a professional wheelchair shop

or metalworker to have the damage repaired.

4. *Problem:* bent or twisted frame.

Maintenance Action: View the wheelchair from a distance of at least five feet. See if both sides of the chair are equally level. Then see if the wheels are even. Make arrangements with a professional wheelchair repair shop or metalworker to

repair any damage.

5. *Problem:* Wheelchair will not collapse on "X" frame.

Maintenance Action: Make sure the "X" frame lockpin is present. Make sure the locknut is present on the lockpin. Check the slides where the "X" frame rides up the inside of the armrests. Make sure there are no foreign objects trapped in these. Remove any dirt or foreign objects.

Section B

Repairing Frame Pieces

Objectives: *After completing this chapter, you will be able to—*

1. *cite the importance of wheelchair safety and mobility;*
2. *give the advantages of tubular steel frames by comparing them to solid steel frames;*
3. *give the meaning of plasticity;*
4. *describe how the frame acts as a shock absorber;*
5. *cite two main reasons why users twist their frames out of shape; and*
6. *tell why prevention is the best solution to the problem of wheelchair frame twisting.*

A wheelchair must offer its owner both safety and mobility. The chair must be strong enough to safely support the user. It must also be lightweight enough for easy user mobility. A wheelchair made of solid steel rods would offer maximum stability. But a solid steel wheelchair would be so heavy that it would severely restrict mobility. To ensure safety and mobility, most wheelchairs are made of tubular steel.

Tubular steel is lightweight, but strong. The steel tubes are hollow, like straw. You can picture a steel tube as a solid rod with the center removed. The tube weighs less than 20 percent of the rod. Yet it is as strong and will support as much weight as the rod. A wheelchair frame made of tubular steel weighs about 40 pounds. The same frame would weigh more than 160 pounds if it were made of solid steel rods. Lightweight and strong tubular steel allows

for the construction of wheelchairs that are both structurally safe and easy to operate.

Tubular steel offers another major advantage for wheelchair construction. It has the property of *plasticity*. This means that it can resume its original shape after being bent. Since a wheelchair does not have shock absorbers, this property of plasticity is very important.

When you hit a bump, the impact is distributed throughout the wheelchair. The tires and spokes, as well as the seat and back upholstery, absorb some of the shock. And the frame pieces also absorb part of the impact. They do this by bending slightly, then returning to their original shape. They cushion the user like springs.

The main problem areas with tubular steel are *tolerance* and *fatigue*. Tolerance refers to the amount of bending a tube can withstand and still return to its original shape.

A wheelchair used on rough ground encounters hundreds of bumps daily. Average bumps and impacts are within the tolerance of most tubular steel. Large bumps hit at full speed, such as rocks or curbs, are beyond its tolerance. If you hit a bump hard enough, you can bend the frame beyond its tolerance. And it will remain bent.

For the wheelchair frame to absorb shocks efficiently, it must be balanced. *Balancing* means that all frame pieces are in their original shape to ensure equal distribution of stress. A bent part will prevent the wheelchair frame from working efficiently. It should be removed and replaced by a professional repair person.

The second source of problems with tubular steel comes from *fatigue*. Simply put, *fatigue* means that the metal "tires" of bending and regaining its shape. Fatigue occurs when the same metal piece is bent in the same way over and over again. All metal will fatigue from age and repeated use. But a user's bad habits will speed up this process.

Most wheelchair users have regular patterns of applying stress to their wheelchairs. The main habits are (1) taking bumps and curbs with the same wheel and (2) reaching over the same side of the chair. Most persons will use the same wheel for climbing or going off curbs. Whether this is the left or the right wheel, the problem is always using the *same*

wheel. Habitually handling curbs with the same wheel will twist the wheelchair frame out of shape. A twisted frame loses value as a shock absorber. And it will finally bend or break, endangering the user's safety and mobility.

The best solution to the twisted frame problem is *prevention*. It is easier to keep the frame from becoming twisted than it is to straighten a twisted or bent frame. Try to remember to change wheels when you take a curb or a bump. Using both wheels equally will eliminate most of the causes of frame twisting.

The other bad habit that results in twisted frames is always reaching over the same wheel. This places great stress on the side you habitually lean over (see fig. 2).

If you always reach over the same side, you will eventually twist the frame on that side. Again, *prevention is the best solution to the problem*. Try to remember to reach over both sides of the wheelchair equally.

Wheelchair frames are made of pieces of tubular steel bolted or welded together. The amount of weight the chair will carry and the user's size determine the size of the steel tubes used in construction. An

outdoor chair for a heavy person has thicker steel tubes than an indoor chair for a lighter person.

Each piece of the chair's frame is formed and plated at the factory with a rustproof material. Receptacle holes are drilled into the frame pieces. All wheels, upholstery, and accessories are attached to the frame by screwing or bolting into these receptacles.

Bending or straightening the tubular steel frame pieces is beyond the range of most home repair persons. These tasks require the use of specialized heavy equipment. Any time you find a bent piece, you should consult your dealer. You can avoid loss of mobility by ordering the part in advance. This way, you can be sure that the part has arrived before you send your chair in for repair.

Check Your Knowledge

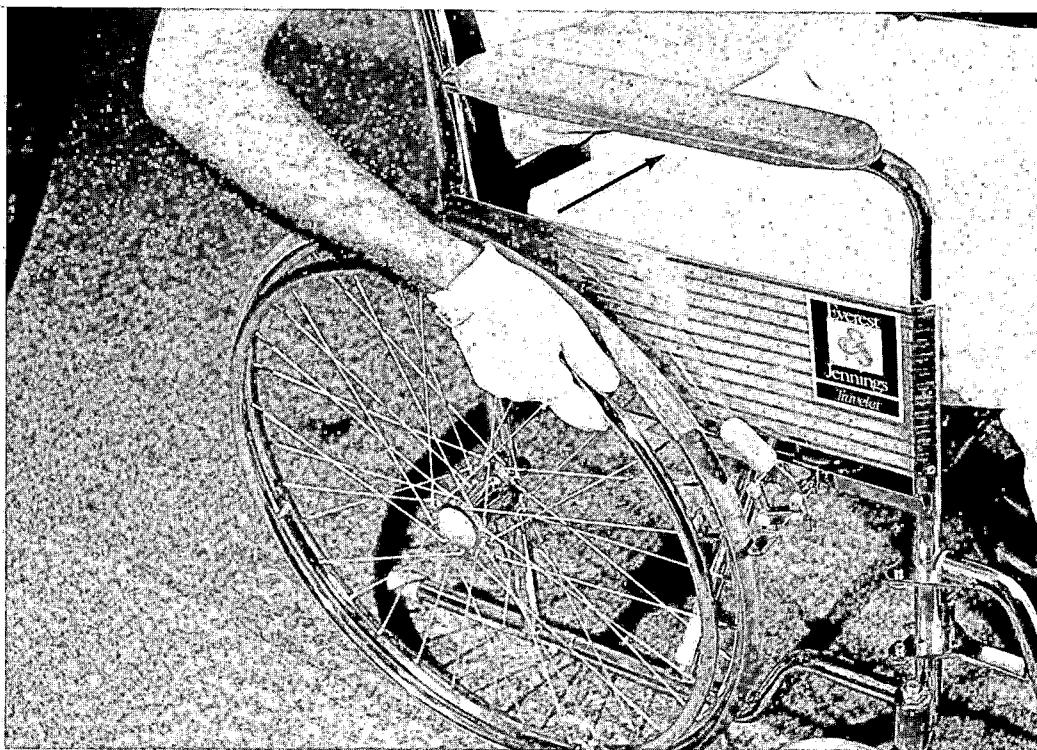
1. A wheelchair must offer its user both _____ and _____.
2. A solid steel wheelchair would be so heavy that it would severely restrict _____.
3. Steel tubes will support _____ weight than (as) solid rods.
 - a. more
 - b. less
 - c. the same
4. The ability of a steel tube to retain its original shape after being bent is called _____.
5. Plasticity is important because a wheelchair has no _____.
6. The amount of bending that a piece of tubular steel can withstand and still retain its original shape is called its _____.
 - a. weight
 - b. clearance
 - c. tolerance
 - d. mobility
7. The wheelchair frame must be _____ to provide efficient shock absorption.
8. All metal will eventually _____ from age and repeated use.
9. The best solution to the twisting frame problem is _____.
10. Most persons use the _____ wheel every time they go over a curb.



Figure 2

9

ARMRESTS



Section A

Inspecting and Maintaining Armrests

General Information: If your chair has armrests, they must be firmly attached to the frame. Their upholstery must be free of tears or rips. And attaching screws should not have burred heads.

Possible Problems: Loosely attached armrests, torn upholstery, burred screwheads

1. **Problem:** Loosely attached armrest.

To Inspect: Wiggle the armrest with your hand. If it is not tightly attached to the frame, it must be adjusted.

Maintenance Action: Tighten all screws or bolts attaching the armrest to the wheelchair

frame. Rotate them clockwise.

2. **Problem:** Torn or ripped upholstery.

To Inspect: Look at the armrests. Run your hand over each to detect rips or tears.

Maintenance Action: Patch the tear or rip by following the instructions given in Section B of this chapter.

Section B

Repairing and Replacing Armrests

Objectives: After completing the step-by-step instructions in this chapter, you should be able to do actual tasks and provide information related to those tasks.

Task Objectives:

1. remove the armrest from the wheelchair frame;
2. repair small tears in the upholstery with a commercial patch kit; and
3. attach the armrest to the wheelchair frame.

Information Objectives:

1. give the major advantage of armrests on a wheelchair;
2. cite the major disadvantage of armrests on a wheelchair;
3. tell how a person loses mobility by using a wheelchair with a cracked armrest;
4. explain why you must count the number of receptacle holes and measure their spacing before ordering a replacement part;
5. tell how much each armrest adds to the total width of the wheelchair; and
6. tell what could happen if you use replacement screws with longer shanks than the original screws.

Not all wheelchairs have armrests. Adding armrests to a wheelchair has advantages and disadvantages. The advantages are extra frame strength and stability and added comfort for the wheelchair user. The disadvantages are reduced mobility and access.

Armrests allow the wheelchair user to be more comfortable in the chair. They provide extra support for the arms and back. Shifting your weight in the chair is easier if you can brace

your elbows on the armrests. Armrests also give extra structural support to the wheelchair frame.

The major disadvantage of armrests is that they slightly reduce the potential for movement. Armrests add an extra 3 inches to the width of the wheelchair.

You should measure a new wheelchair to determine exactly how much width will be added with armrests. This extra width may reduce the

number of doorways that the chair can pass through. The armrest length also limits your ability to closely approach some objects like desks or workbenches.

Armrests come in a wide variety of sizes, shapes, and lengths. You can find an armrest that is just right for your own lifestyle and needs. These armrests are usually interchangeable. That means any wheelchair frame will accept almost any style of armrest.

This chapter presents information on how to remove and install armrests. It also tells you how to figure out which replacement armrests your chair will accept. The chapter concludes with information on how to repair tears on upholstery armrests.

Materials:

1. Flat-blade screwdriver or
2. Phillips screwdriver
3. Ruler or tape measure
4. Upholstery patch kit

Parts (See fig. 1):

1. Screws
2. Receptacle holes
3. Armrest

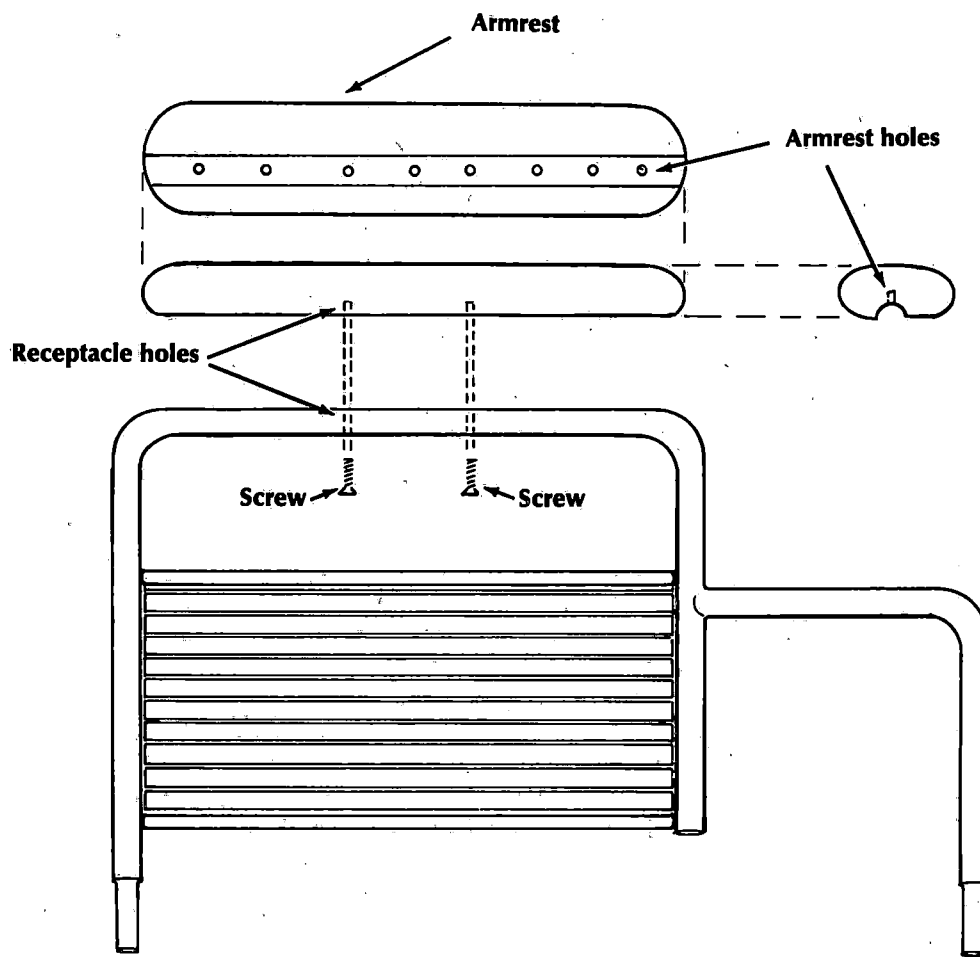


Figure 1. Armrest Parts

Tasks, Steps, and Key Points:

Task No. 1: Remove the armrest from the frame.

First, check to see what type of screw is holding the armrest to the frame. If the screwheads look like figure 2A, you will need a flat-blade screwdriver. If the screwheads look like figure 2B, you will need a Phillips screwdriver. A “stubby” or offset screwdriver may be necessary for adequate clearance.

1. Using the proper screwdriver, remove the screws by turning the screwheads counterclockwise. When they are loose enough, use your fingers to finish unscrewing them. Before you use these screws again, check their condition.
2. Compare the screwheads and threads to figures 1A and B in Chapter 8. If they are not in good condition, throw them away. Then use new screws to reattach the armrest.

Task No. 2: Repair the armrest, if possible.

If the armrest is covered with upholstery, check it for tears or cracks. Bare skin rests on and rubs over the armrests daily. Any cracks or tears on the upholstery can irritate or cut the user's skin. These cracks can make wheelchair use very uncomfortable. If these irritations become serious enough, they can form sores. This could restrict your ability to use the wheelchair. Because this might restrict your overall mobility, you must exercise care.

Any small tears or cracks can be repaired with a commercial patch kit. These kits are available at most hardware stores. Each kit contains a set of instructions. Please follow these carefully for the best results. Also, a strip of electrical tape will make a good temporary patch.

Many armrests are made of wood or plastic. These armrests cannot tear, but they may crack or break. You should replace a cracked or broken armrest.

Task No. 3: Replace the armrest.

Most wheelchair shops carry a wide variety of replacement armrests. You

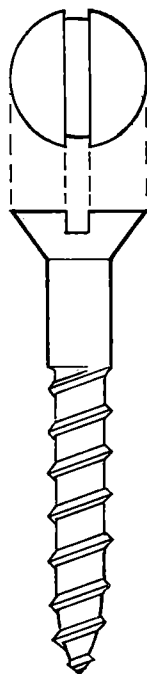


Figure 2A. Slotted Screw

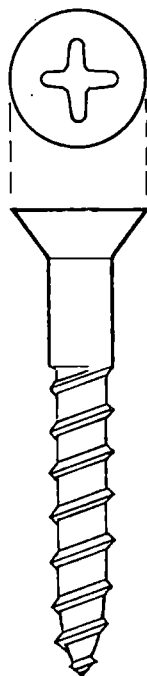


Figure 2B. Phillips Screw

will need the following information to order one. You must know the manufacturer and model of your wheelchair. For example, you might have an Everest and Jennings “Sportsman” model. You then count and measure the distance between the receptacle holes on the wheelchair frame.

Key Note: There are more screw receptacle holes on the bottom of the armrest than there are receptacle holes in the frame. This is because one armrest will fit many wheelchair frame sizes and styles. Not all of the screw receptacles on the armrest will be used at one time. *All* of the frame receptacles must have screws for a proper mounting. A replacement armrest must have *at least as many* receptacles as the wheelchair frame.

The following is an example of a clear request for a replacement part. “I need a left armrest for an Everest and Jennings ‘Desk’ model. The frame has three receptacles spaced two inches apart.” The requester would then go on to specify the color and finish for the replacement.

1. Place the replacement armrest on the wheelchair frame.
2. Insert the screws with your fingers. Make sure the screws pass straight through the frame and into the armrest. Tighten the screws with your fingers as far as they will turn.
3. Then use your screwdriver to tighten them. Rotate them clockwise.

Key Note: The replacement armrest will come with its own set of mounting screws. These screws may or may not have the same head type that was on the original armrest. If the screwheads are different, you must use another screwdriver for tightening. There is no difference in holding power between Phillips-head screws and slotted screws.

The replacement screws must be exactly the same length as the original screws. If they are shorter, the replacement armrest cannot be firmly attached to the frame. If they are longer, they could push up through the armrest. And screw tips sticking through an armrest are dangerous. The screwheads can be different (either Phillips or slotted), but the shank must match exactly.

Check your work:

1. Are the screws all completely tightened?

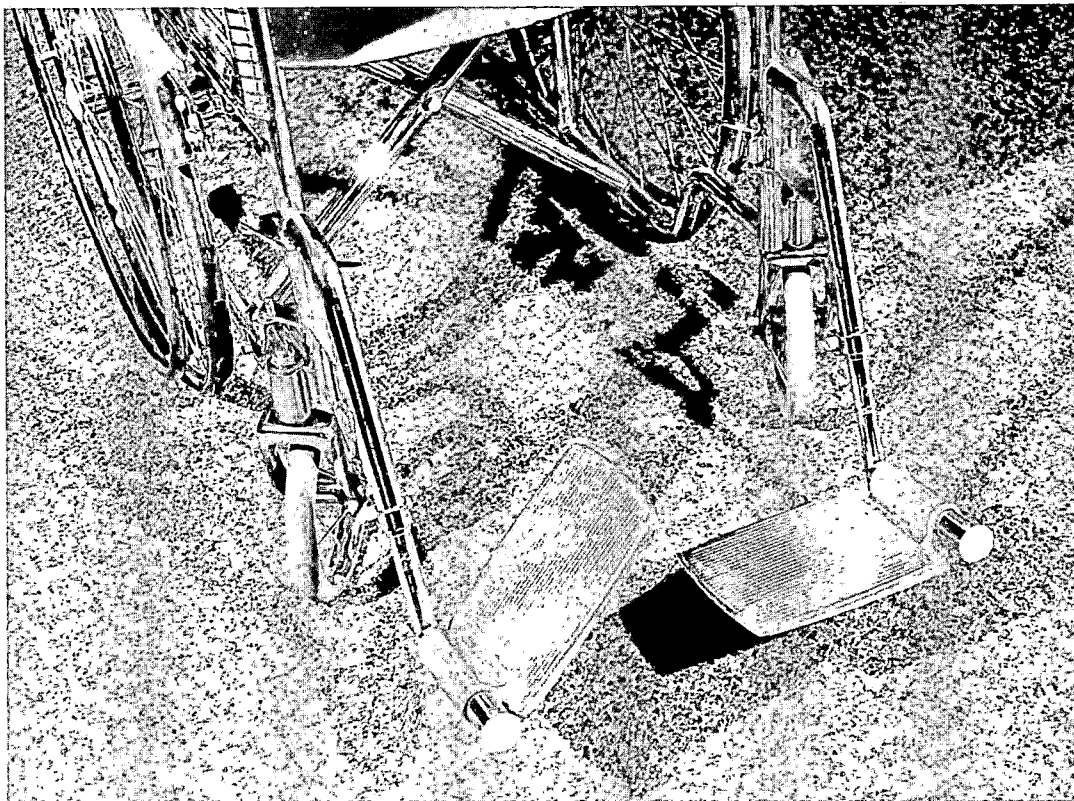
2. Is the armrest firmly attached to the wheelchair frame?
3. Are there any screwtips sticking through the armrest?
4. Have all tears and cracks been covered with a patch?
5. Are the edges of the patch firmly attached to the upholstery?
2. Armrests provide extra support for the arms and the _____ .
 - a. neck
 - b. legs
 - c. torso
 - d. back

Check Your Knowledge

1. Two advantages of having armrests on a wheelchair are extra _____ and added _____ .
3. Shifting your weight in the chair is easier if you can _____ your elbows on the armrest.
 - a. slide
 - b. brace
 - c. push
4. The major disadvantage of armrests is that they slightly reduce the potential for _____ .
 - a. leaning
 - b. sitting
 - c. movement
5. The _____ of the armrest limits your ability to closely approach some objects like desks.
6. Armrests are usually _____ .
 - a. uncomfortable
 - b. interchangeable
 - c. fixed
 - d. damaged
7. Any wheelchair frame will accept almost any _____ of armrest.

10

FOOTRESTS



Section A

Inspecting and Maintaining Footrests

General Information: The footrests are intended to comfortably support the weight of a user's legs and feet. First, footrests must be stable. The user enters and exits the wheelchair from the front. The footrests must swivel out of the way for easy access. When the wheelchair is in motion, the footrests must be extended forward. When the user wishes to approach an object, the footrests are swiveled to the side for easier and closer access.

Possible Problems: Footrest will not

support user's weight, is not at the right height, or will not stay in an elevated position.

1. **Problem:** Footrest will not support user's weight.

Maintenance Action: Tighten the footrest adjusting bolt.

2. **Problem:** Footrest is not at the right height.

Maintenance Action: See repair section of this chapter for step-by-step instructions for adjusting footrest height.

3. **Problem:** Footplate will not

stay in an elevated position.

Maintenance Action: Replace footplate holding spring. See repair section of this chapter for step-by-step instructions for replacing this spring.

Note: Some wheelchairs have footplates equipped with heel loops. If these heel loops are worn or frayed, they should be replaced. As heel loop attachment systems vary, consult your dealer for exact replacement methods.

Section B

Repairing Footrests

Objectives: After completing the step-by-step instructions in this chapter, you should be able to do actual tasks and provide information related to those tasks.

Task Objectives:

1. remove the footrest unit from the frame;
2. adjust the elevation of the footplate;
3. remove the footplate;
4. replace the holding spring; and
5. attach the footrest unit to the frame.

Information Objectives:

1. give the purpose of footrests;
2. tell why the footplate height adjustment bolt must be tight;
3. state the two functions of the rubber cap at the end of the footplate; and
4. tell why the footplate holding spring should be replaced when necessary.

Not all wheelchairs have footrests, which provide added comfort and safety. Footrests take pressure off the back of the thighs. They also protect the user's feet and ankles. They prevent the feet from catching on obstacles and being turned under when the chair is in motion.

One disadvantage of footrests is that they add extra width and length to the wheelchair frame. The major disadvantage is that they limit the

number of objects that you can closely approach. A pair of footrests adds about a foot to the wheelchair's overall length. It also puts an extra 12 inches between you and objects that you wish to approach.

Most footrests swivel to the side by releasing a lockpin. This adds an extra six inches to each side of the wheelchair. This extra width could severely limit the number of doorways that are accessible to the user.

In normal use, the footrests are locked forward when the chair is in motion. And they are unlocked and swiveled to the side whenever the user wishes to closely approach an object (see figs. 1-3).

Special attention must be paid to the adjusting bolt which controls the footrest elevation. After adjustments, this bolt must be completely tightened. Wheelchair users often place their entire weight on the footrests. If the bolt is loose, the footrest will not support this weight. So a loose adjusting bolt could cause a person to fall or stumble.

There should be a rubber cap at the end of the footplate frame. This cap performs two important functions. First, it serves as a bumper. In normal usage, the front of the wheelchair often collides with objects. This cap allows for a soft impact. If the cap is missing, the sharp edge of the frame tube will strike objects first. This could injure both the object and the metal frame.

The second function of the cap is to keep water and dirt out of the tubular frame sections. If water enters the frame, it could cause rust. Since you cannot see rust forming inside a frame tube, it can quickly and

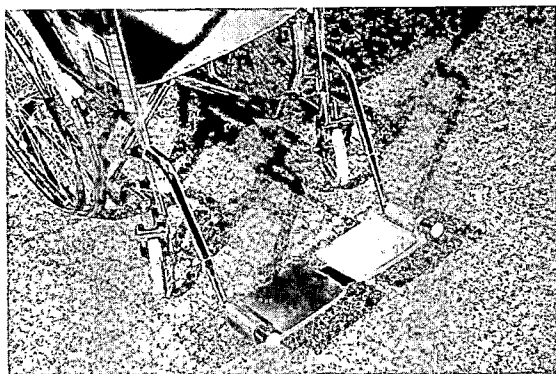


Figure 1. Footrest, forward

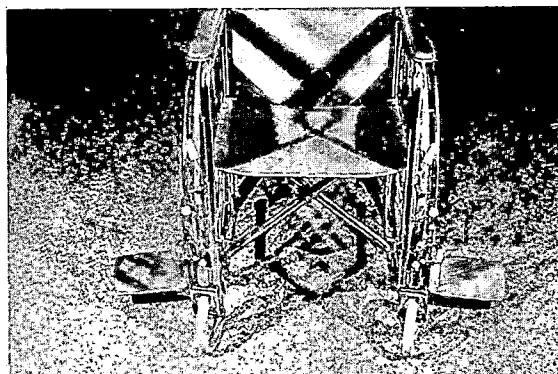


Figure 2. Footrest, swiveled

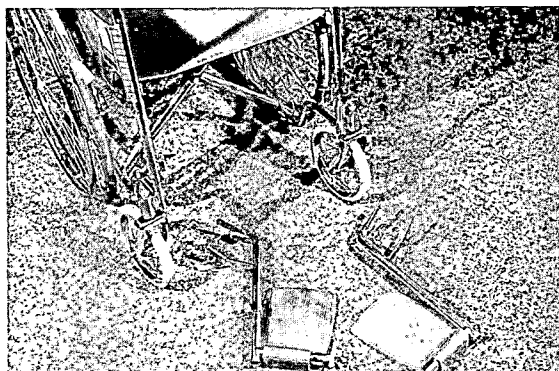


Figure 3. Chair with no footrest

easily become widespread. This cap does not keep all water out of the frame tube, but it helps.

Materials:

1. Adjustable wrench
2. 1/4-inch box end wrench
3. Flat-blade screwdriver
4. Phillips screwdriver
5. Commercial solvent
6. Cleaning rag
7. Replacement footplate holding spring

Note: Do not remove this spring unless you have a replacement spring on hand.

Parts (See fig. 4):

1. Swivel lock
2. Swivel posts
3. Footrest frame
4. Height adjustment bolt
5. Footplate
6. Holding screw
7. Metal sleeve
8. Rubber bumper
9. Footplate spring

Tasks, Steps, and Key Points:

Task No. 1: Remove the footrest unit from the frame.

Most footrests are attached to the frame with a lock and a pair of swivels. These swivels are usually "naked posts." This means that there is no bolt or cap on top of the posts. Removing or replacing the footrest on the wheelchair frame is very easy. The entire procedure takes only a few seconds.

1. Remove or loosen the lockpin. This usually only requires that you lift the pin with your fingers.
2. Swivel the unit to the side. If there are any nuts or caps on top of your swivel posts, they must be removed.
3. Use your hands to lift the footrest unit off the frame.

Task No. 2: Adjust the elevation of the footplate.

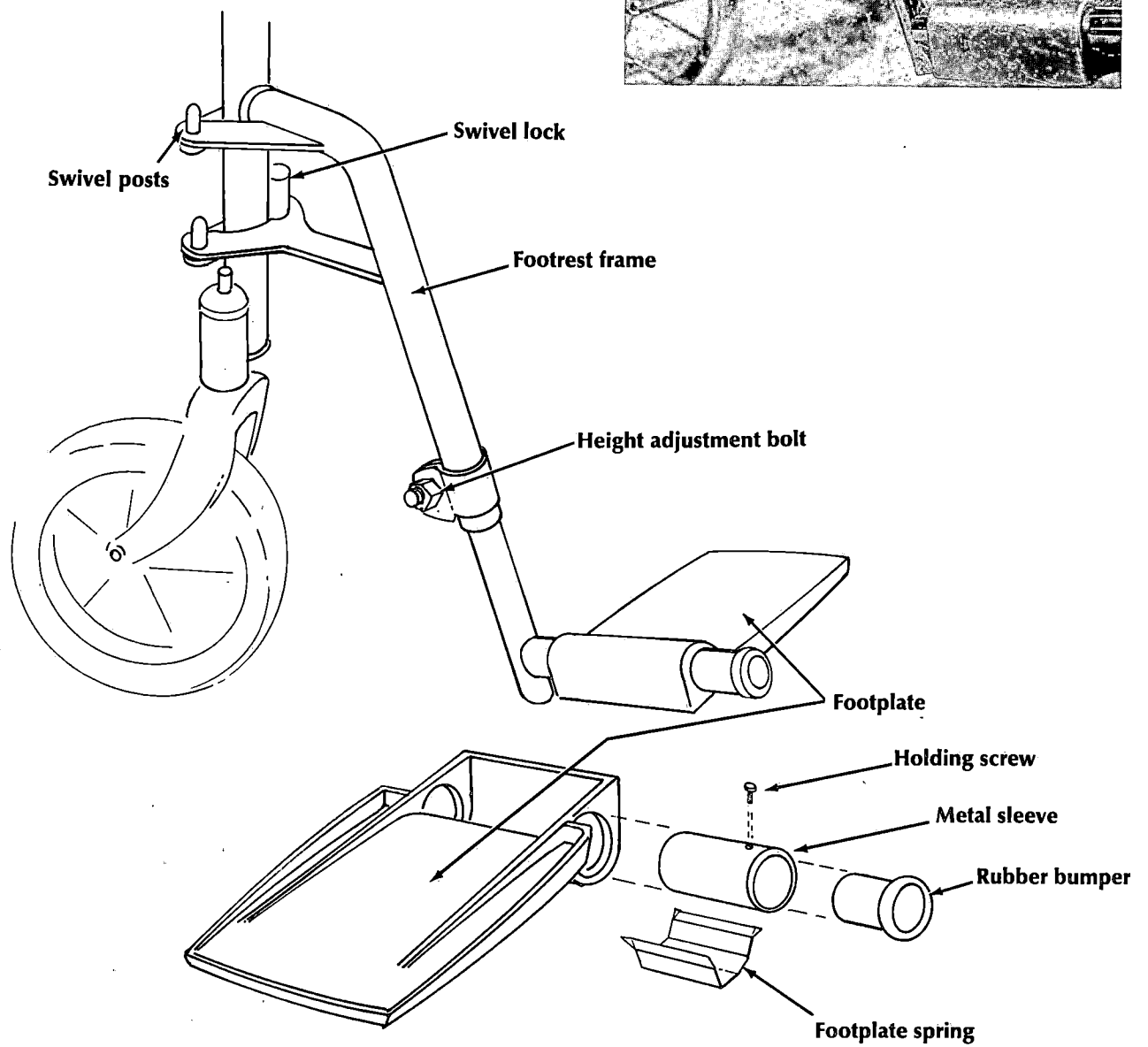


Figure 4. Footrest Parts

The footrest frame is made up of two pieces of tubular steel. The lower piece slides into the upper piece. The further the lower tube is pushed into the upper tube, the higher the footplate will be raised. The ability of the tubes to slide into each other is controlled by the adjusting bolt.

1. Select a wrench for the adjusting bolt. If you do not have a box end wrench that exactly fits the bolt, use the adjustable wrench.
2. Turn the bolt counterclockwise, but do not remove it. It only needs to be loosened.
3. Adjust the elevation of the footplate. Use your hands to push the steel tubes together or pull them apart. Pulling the tubes apart lowers the footplate.
4. Tighten the adjusting bolt. When you have adjusted the elevation as desired, the adjusting bolt *must* be retightened. A loose adjusting bolt is dangerous to the user.

Task No. 3: Remove the footplate.

The footrest unit does not need to be removed from the frame before the footplate is removed. The footplate can be turned on its frame. It is turned up to permit the user an easy entry and exit from the wheelchair. And it is turned down when the user wishes to place weight on it. It is essential for the footplate to stay in whatever position it is placed. It is held in place by a metal clip called a footplate holding spring. This spring wears out quickly and should be replaced when necessary.

1. Select a screwdriver for the holding screw. Use a screwdriver tip that matches the screwhead.
2. Remove the screw, rotating it counterclockwise.
3. Remove the rubber bumper. A flat-blade screwdriver can be used to pry off the bumper.
4. Remove the metal sleeve. Use your hands to pull it off the frame.
5. Remove the footplate. Using your hands, twist it right and left while pulling away from the frame.
6. Clean the removed parts and the frame, which will be covered by a layer of grease and grime. A cleaning rag lightly dipped in solvent should be used for cleaning.

Task No. 4: Replace the footplate holding spring.

The footplate spring should be replaced each time it is removed. Do not remove the spring unless you have a replacement part on hand.

1. Loosen the footplate holding spring. Insert a flat-blade screwdriver under any edge of the spring. Gently twist the screwdriver until the spring loosens. Notice the direction the spring faces and how it fits into the footplate.
2. Remove the spring, using your cleaning cloth. It will be covered with grime and grease.
3. Install a replacement spring. Make sure it faces the same direction as the old spring. It should snap into place. Compare your spring to the one shown in figure 5.
4. Press the spring into the footplate groove. Use your fingers. The spring should snap into place.

Task No. 5: Assemble the footplate unit and attach it to the frame.

1. Attach the footplate. Using your hands, twist it back onto the frame.
2. Replace the metal sleeve. Make sure the hole in the sleeve is directly above the hole in the frame.
3. Insert the holding screw and start turning it with your fingers.
4. Insert the bumper. Push it back onto the frame with your fingers.
5. Tighten the holding screw with

a screwdriver, rotating it clockwise.

6. Place the reassembled unit back onto the wheelchair frame.

Check Your Knowledge

1. Some wheelchair users rely on footrests for added _____ and _____.
2. Footrests take some of the pressure off _____ and _____.
3. Footrests prevent the user's feet from being _____ when the wheelchair is in motion.
4. The main disadvantage of footrests is that they add extra _____ and _____ to the wheelchair frame.
5. A pair of footrests adds about _____ to the wheelchair frame.
 - a. 4 inches
 - b. 8 inches
 - c. 12 inches
 - d. 16 inches
6. The extra width of the wheelchair could severely limit the number of accessible _____ the user can pass through.
7. Footrests are locked _____ when the wheelchair is in motion.
 - a. sideways
 - b. backwards
 - c. forward
 - d. down

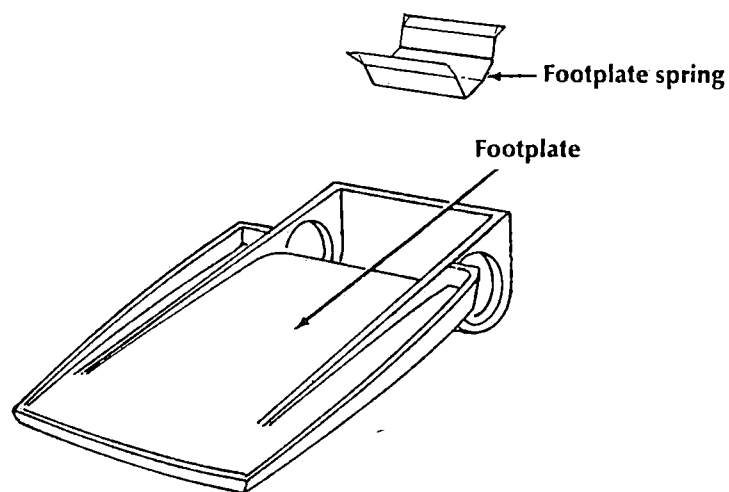


Figure 5

11

UPHOLSTERY



Section A

Inspecting and Maintaining Upholstery

General Information: The seat and back of the wheelchair must support the user's weight comfortably. Any tears or rips in the upholstery could be dangerous to the user. Rips or tears could also irritate the user's skin and promote the formation of a pressure sore.

1. **Problem:** Torn or ripped up-

holstery.

To Inspect: Look at the seat and back. Be sure to check the underside of the seat.

Maintenance Action: Repair the upholstery by following the step-by-step instructions in the B Section of this chapter.

Section B

Repairing and Replacing Upholstery

Objectives: *After completing the step-by-step instructions in this chapter, you will be able to do actual tasks and provide information related to those tasks.*

Task Objectives:

1. *attach a patch to torn or ripped vinyl;*
2. *remove the upholstery from the wheelchair frame; and*
3. *attach the upholstery to the wheelchair frame.*

Information Objectives:

1. *describe the physical characteristics of vinyl;*
2. *tell where vinyl is most likely to tear or crack;*
3. *explain why a canvas inner liner must be taken to an upholstery shop for repair;*
4. *name the parts usually found in a commercial vinyl patch kit; and*
5. *give the information needed to successfully order a replacement backrest or seat.*

Almost all wheelchairs use vinyl as a covering for seats and backrests. Vinyl is a very tough and durable man-made material. It is used as an upholstery material because it combines the durability of leather with the flexibility and water resistance of rubber. It resists scuffs and dirt as well as water.

Vinyl is supple. This means that it can be bent or folded without breaking. This property of suppleness is

necessary for wheelchairs that fold or collapse. Supple seats and backs provide a comfortable support for a person using the chair.

Even though vinyl is tough and durable, it is not permanent. Age and regular use will eventually wear it down. It can crack and tear. When the wheelchair is collapsed, the vinyl folds. After a period of time, the line where it folds will become a crease. You can see this crease even

when the seat and back are unfolded. Along this crease, the vinyl is most likely to tear or crack.

Inside the vinyl liner, there is a sheet of heavy canvas. This canvas actually supports your weight in the wheelchair. The vinyl cover protects it from tears and stains. This cover also makes sitting in the wheelchair more comfortable for the user. The canvas can sometimes rip or tear. If this happens, the seat or backrest should be replaced.

Repairing tears in canvas requires a commercial-strength sewing machine and special thread. Most home repair persons do not have access to this special equipment. If your canvas rips, you might take it to an upholstery shop for repair. You can save money on the cost of repair by removing the upholstery from the frame yourself. After the seat is repaired, you can also attach it to the frame yourself.

Replacement upholstery is readily available through most wheelchair outlets. Simple replacement is the most common way of dealing with canvas upholstery tears. Tears in the vinyl liner are generally repaired with glue and a patch from a commercial repair kit.

This chapter gives instructions for removing upholstery from the wheel-

chair frame. These instructions apply equally to both backrests and seats. Instructions for patching the vinyl cover are also given. Directions for reassembly conclude the chapter.

Materials:

1. Commercial vinyl patch kit
2. Scissors
3. Screwdriver (Phillips or flat-blade to match the screws that are on your wheelchair)
4. Adjustable wrench

Parts (See fig. 1):

Key Note: Seats and backrests are made in the same way. The instructions given below apply to both seats and backrests. When you see the word "upholstery" in this chapter, it can apply to either the backrest or seat.

1. Grommets
2. Screws
3. Locknuts
4. Front
5. Back

Tasks, Steps, and Key Points:

Task No. 1: Apply a patch to the torn vinyl cover.

Key Note: The upholstery does not need to be removed from the wheelchair frame for the application of vinyl patches.

1. Inspect the patch kit and read the enclosed instructions. Most patch kits contain glue, patches, sandpaper, and an instruction sheet. Read the instructions to see if your patch kit has any special precautions or steps.
2. Select a patch. The patches may or may not be pre-cut. If they are not pre-cut, you will need to use a pair of scissors to cut your patch.
3. Place the patch over the tear to check if it is the proper size.

Key Note: The patch should be $\frac{1}{2}$ inch larger than the tear on all sides.

4. Rough the area to be glued with sandpaper. This helps the glue to form a tighter bond.

Key Note: To rough an area, rub a piece of sandpaper over it briskly. Apply steady downward pressure on the sandpaper for 20 seconds.

5. Apply the glue to the roughed area. Spread a thin, even coat of glue for the best results.
6. Press the patch onto the glued area.

Key Note: A flatly and smoothly applied patch will last a long time. Use your fingers to press out any wrinkles. Work from the center of the patch toward the edges (see fig. 2).

7. Press the patch firmly to the vinyl until it bonds.

Key Note: Check the instruction sheet in the commercial patch kit to find out how long you should press. Different types of glues require different amounts of time for bonding.

Task No. 2: Remove the upholstery from the wheelchair frame.

1. Inspect the heads of the screws holding the upholstery to the wheelchair frame.

Key Point: Always use the screwdriver blade tip that matches the type of screwhead.

2. If locknuts are present, hold them securely with an adjustable wrench.
3. Loosen the screws by rotating the screwdriver counterclockwise.
4. Remove the screws using your fingers.
5. Inspect them.

Key Note: See Chapter 8 of this manual for comparison charts of screws and nuts. If the screws or nuts are damaged, throw them away.

6. Remove the upholstery from the wheelchair frame with your hands. The upholstery will come free when the last screw is removed.

Key Point: The main factor that determines if a piece of upholstery fits is the location and spac-

ing of its grommets. The grommets and the receptacles drilled in the wheelchair frame must exactly match for a proper fit.

Task No. 3: Attach the upholstery to the wheelchair frame.

1. Determine which end is the front and which is the back.

Key Point: The front of a piece of upholstery has a folded edge. The back has a stitched or heat-sealed edge (see fig. 3).

2. Make sure the upholstery fits the wheelchair frame.
3. Insert the screws. Use your fingers to start threading the screws.
4. Attach the locknuts to the bottom of the screws. (Not all wheelchairs have locknuts on the upholstery.)
5. Hold the locknuts (if present) with an adjustable wrench.
6. Tighten the screws, rotating the screwdriver clockwise.

Check Your Knowledge

1. _____ is a tough man-made material.
2. The most common upholstery material for wheelchairs is _____.
 - a. aluminum
 - b. vinyl
 - c. steel
 - d. cotton
3. Supply seats and backrests provide extra _____ for the user.
4. The inner liner is made of _____.
 - a. vinyl
 - b. aluminum
 - c. steel
 - d. canvas
5. You should take a torn inner liner to an _____ shop for repair.
6. Wheelchair upholstery can be attached to the frame with _____ and _____.
7. Seats and _____ are made from the same material.
 - a. armrests

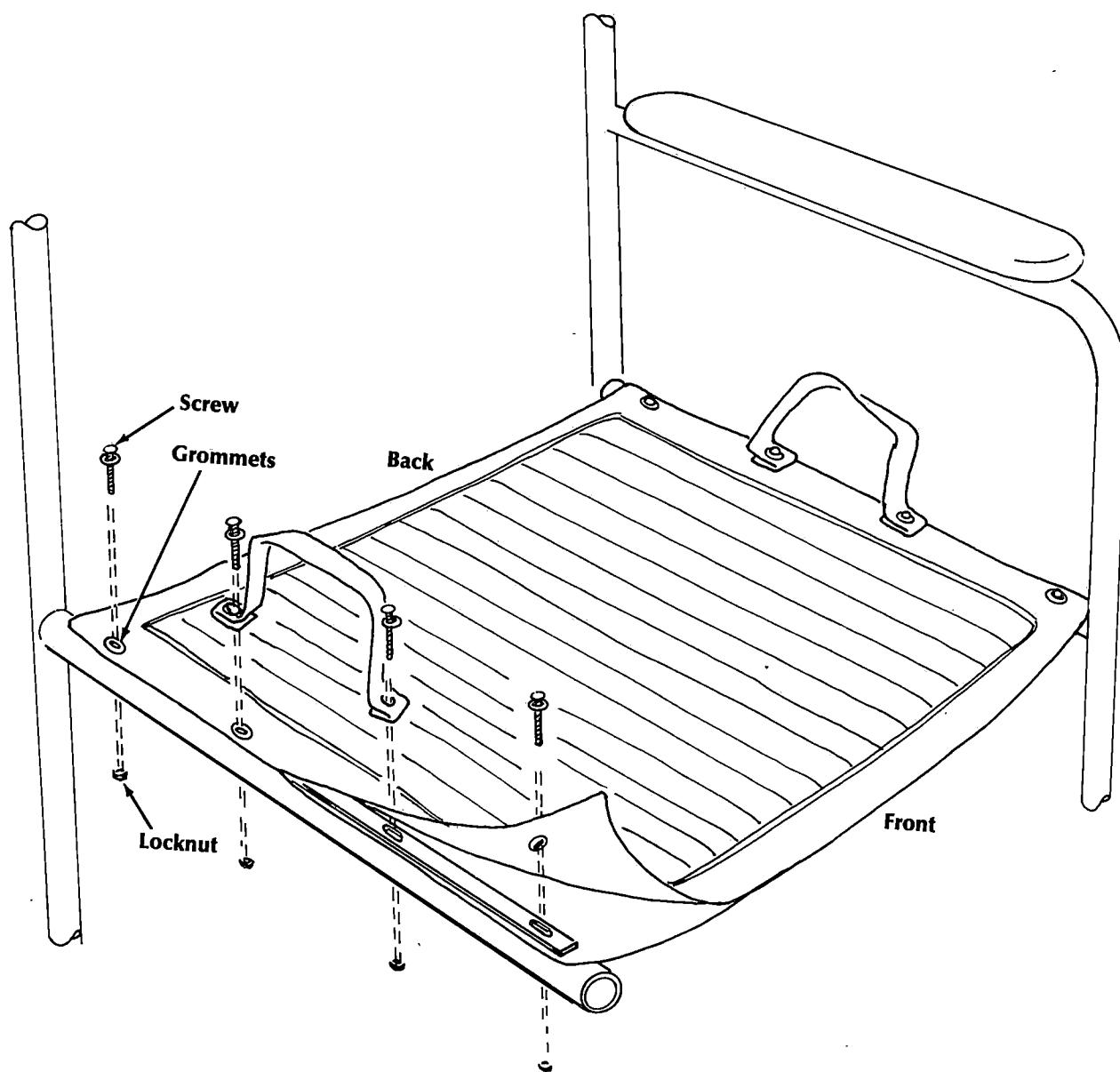


Figure 1. Upholstery

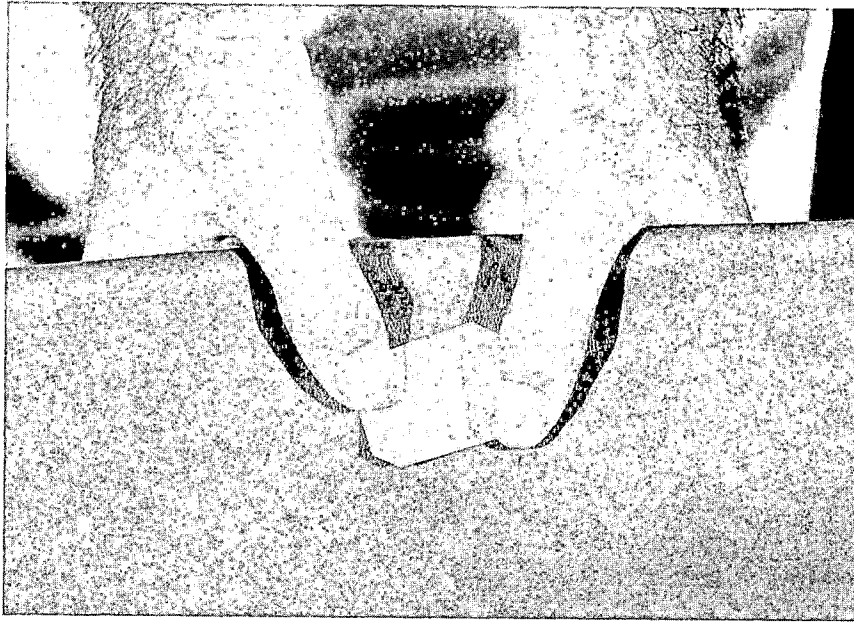


Figure 2

- b. backrests
 - c. caster wheels
 - d. footrests
8. Most commercial patch kits contain an _____ sheet.
 9. A patch should be _____ larger than the tear on all sides.
 - a. $\frac{1}{4}$ inch
 - b. 1 inch
 - c. $\frac{1}{2}$ inch
 - d. $\frac{1}{8}$ inch
 10. To rough the area, you rub the vinyl with a piece of _____.

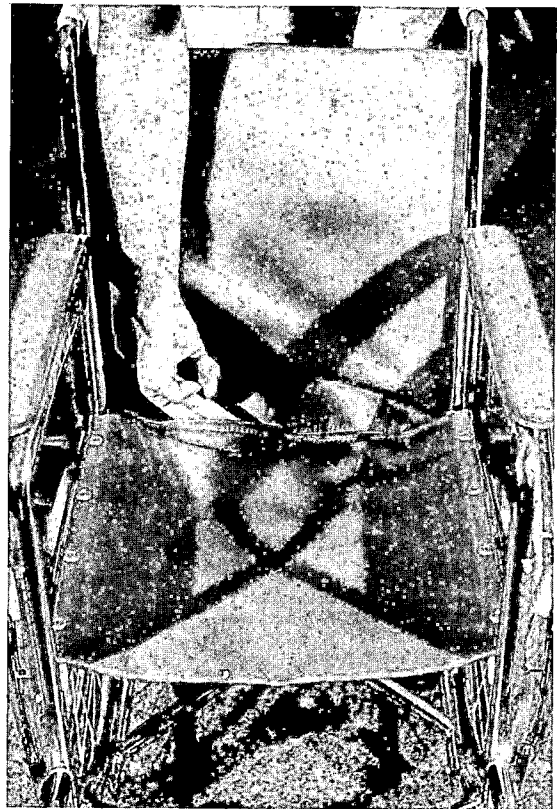


Figure 3

Section A

Protecting Your Chair
from Rust

General Information: Rust will weaken any ferrous metal it attacks. It can enter through any crack or chip in the rustproof coating. And it must be removed before it spreads. A chair that is kept clean and dry will resist rust effectively.

Possible Problems: The spread of rust, rust prevention, rust removal

1. **Problem:** The chair is damp from outdoor use.

To Inspect: Rub your hand over

each part of the frame. If you feel any moisture it must be removed.

Maintenance Action: Dry and clean the chair with a soft cloth.

2. **Problem:** Preventing rust.

To Inspect: Rust must be prevented long before you can see it or feel it.

Maintenance Action: Once a month, polish the wheelchair frame sections with chrome

polish. This will help the chair resist rust.

3. **Problem:** Removing rust.

To Inspect: Look over each part of the wheelchair frame at least once a month. Rub your hand over the entire frame. Any rough spots are indications of rust formation.

Maintenance Action: See Section B of this chapter for detailed instructions on rust removal.

Section B

Removing Rust

Objectives: After completing this chapter, you will be able to remove rust from metal parts and provide information about rust formation and removal.

Task Objectives:

1. remove rust from metal parts.

Information Objectives:

1. describe rust;
2. explain how rust spreads from one metal part to another;
3. describe the electroplating process;
4. name the materials most commonly used for rustproof coatings;
5. give three reasons why wheelchairs are electroplated;
6. tell why chips in the rustproof coating must be treated quickly;
7. describe the special rust prevention steps necessary in snowy areas;
8. state the precautions for working with solvents;
9. tell why clear nail polish works as a temporary seal for cracks in the rustproof coating;
10. tell how often the wheelchair should be completely rust stripped;
11. describe how rust can threaten your mobility; and
12. explain what unremoved rust can do to the wheelchair.

Rust is the reddish coating that can form on any ferrous metal. If this brittle coating is disturbed, it will break up into a fine powder. And this powder can spread like dust to other metal parts. If rust touches a piece of unprotected metal, that metal will probably rust also. In this sense, rust is like a contagious disease. It can quickly spread from one part to another. Rust must be removed from metal immediately. Otherwise, the metal will break down and need to be replaced.

Rust is formed by a process called *oxidation* (ox-e-dá-shun). Oxidation is the interaction of moisture and air on a metal to break down the metal surface. The reddish coating of rust that forms was once part of the metal surface. This rust coating can now spread to other metal parts causing them to rust as well.

The surface of most wheelchairs is made of one or more plated metals. The most common plating for wheel-

chairs is chrome. These coatings are applied to the base metal by the *electroplating* (e-lék-tro-plat-ing) process.

A *base metal* is any metal which receives a coating. The base metal is submerged in a tank of liquid that contains tiny flakes of the coating material. Then electricity is passed through the base metal, and the metal is magnetized. Tiny particles of the coating material are bonded to the base metal. Though this thin coating is thick enough to resist air and moisture, it can become chipped or cracked.

All wheelchair users should be aware that the rustproof coating on their chairs is very thin. Rough impacts or collisions can crack or chip it. Any cracks will expose the base metal to air and moisture which will cause it to rust. This rust will spread to other metal under the rustproof coating. And before long, the coating itself will begin to flake off as the base metal rusts (see fig. 1).

Wheelchairs are metal plated for three main reasons. First, this process prevents rust formation on the base metal. Second, the coating prevents

abrasions where metal rubs directly against other metal. And finally, it improves a metal's appearance by giving it a lustrous finish.

Whenever the wheelchair is used in foul weather, it should be wiped dry with a clean cloth. If you live in a snowy area, you must take two extra precautions. Snow is, of course, frozen water. If it is not brushed from the chair often, rust will form. You must also be careful with ice-melting chemicals. These chemicals, as well as salt, are often used to spread over ice to speed up its melting. As ice melts, these chemicals are dissolved into the water. If this liquid touches the base metal, it will cause rust to form quickly. The best defense against this extra danger of rust formation is frequent rinsing with clear water. Then, carefully dry the chair.

Pushing the chair into walls or curbs can crack or break the rustproof coating. If you find any breaks or cracks on your wheelchair, you must keep them under observation. They should be added to your regular maintenance schedule. Rust will form on any exposed metal.

If you find a crack, you must first remove any rust present. Next, you should prevent any rust from forming on the exposed metal. The best way to remove rust is with a pad of "00" or "000" steel wool, available at most hardware and grocery stores. Rubbing steel wool over the rusted area will remove most of the flakes.

Some persons use clear fingernail polish to seal cracks in the rustproof coating. This seal is both airtight and moistureproof. And it protects against rust formations. Inspect the condition of the original polish often to make sure it's continuing to protect the metal. Remove old polish with nailpolish remover and apply a new coat of polish.

Rust can threaten your potential mobility. We have seen that rust is the end product of oxidation. The reddish flakes called rust are the result of air and moisture destroying metal. As rust spreads throughout the chair, the metal is weakened. Metal that once supported your full weight could bend or break.

No matter where rust forms on your wheelchair, it must be removed at once. Unremoved rust will do two

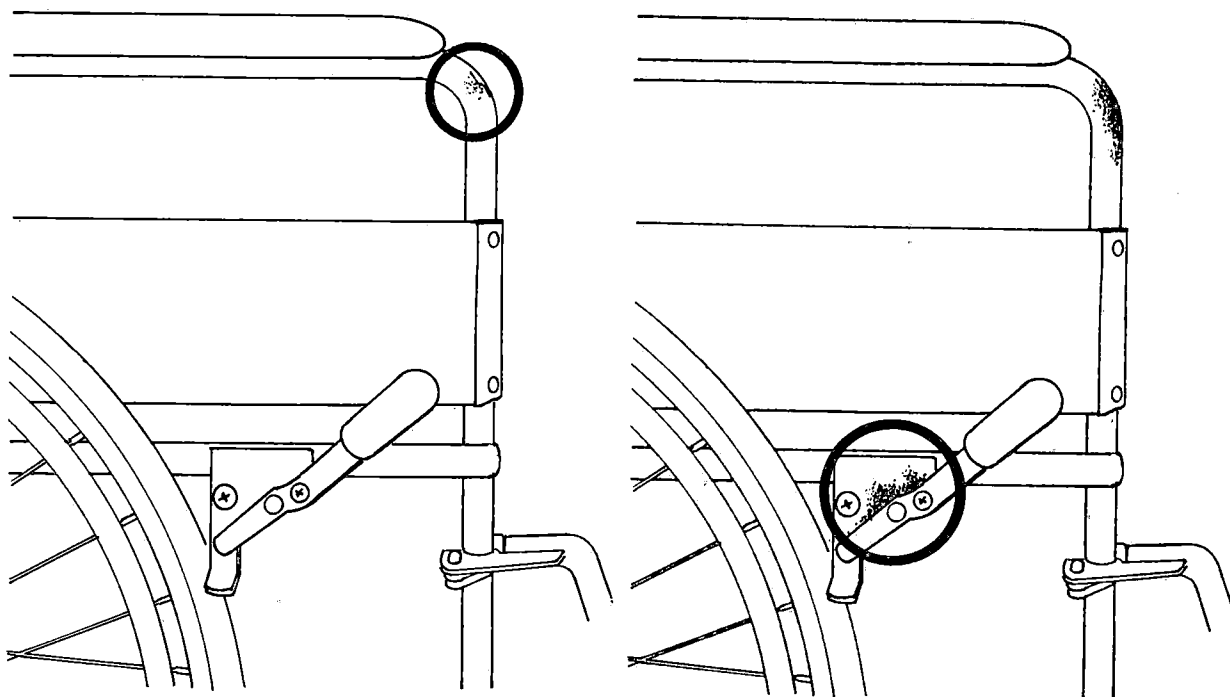


Figure 1. Rust spreads

things. First, it will continue to weaken the metal until it is removed. Second, it will spread to other metal parts. Once affected, these parts will also weaken. If the rust works its way below the metal's surface, it will require professional service for removal. You could lose the use of your wheelchair for days or even weeks. So the best defense against rust is to remove it as soon as you find any.

In summary, a few quick rubs with steel wool and chrome polish or rust remover will remove most small rust spots in a matter of minutes. Care must be taken to remove the rust flakes from the wheelchair. If the dust is allowed to touch the other metal parts, they will also rust. If a rust spot is too large or tough to remove with steel wool, use a commercial solvent. Solvents are messy and can be dangerous. So use them only if the rust cannot be removed with dry steel wool.

This chapter will conclude by presenting the materials and steps needed to remove rust from the wheelchair.

Materials (See fig. 2):

1. Steel wool pads
2. Commercial solvent
3. Clean cloth
4. Newspapers or drop cloth

Tasks, Steps, and Key Points:

Task No. 1: Remove rust from metal parts.

Key Point: Unless a part is completely contaminated with rust, it does not need to be removed from the frame before cleaning. If any part is removed from the frame, see the appropriate chapter in this manual for removal instructions.

1. Prepare a work area. This area should be free of drafts which might scatter the rust flakes. Lay out a circle of newspapers or spread a drop cloth to catch any removed rust.
2. Check the label of the solvent (if you are using one) for safety precautions and first-aid instructions. If you get solvent in your eyes, it's painful and you will

be unable to see clearly. For these reasons, it is better to have first-aid materials on hand. Most solvents can be removed from the eyes by flushing with water. You should have a source of running water nearby or a pan of water in the work area. It's best to use rubber gloves and safety goggles. Other safety precautions that are typical of solvent use include having plenty of ventilation, avoiding breathing the material, and keeping sources of fire away from the job. Read the label carefully to determine exactly what a particular solvent requires to be safe.

3. Position the chair over the newspapers. Make sure the chair is placed so that all removed rust from the chair will fall onto the newspapers.
4. Work from the top to the bottom. Rust flakes will fall to lower parts of the chair. Working top to bottom will help keep parts free of rust once they are cleaned.
5. Remove the rust spots with a steel wool pad. When steel wool ages, it blackens and begins to get brittle. It's a good idea to wear gloves when using steel wool to avoid getting a metal splinter.
6. Buff the metal until the surface feels smooth all over. The surface of rust is rough. As you rub the steel wool over rust, you will feel it "catch" on the rough spots. Keep rubbing until the surface feels even and smooth. Then the rust has been removed.
7. If you are unable to remove the rust with the steel wool, use a commercial solvent. But do this only as a last resort. Solvents can be messy, and there is a potential for danger. The solvent could get in your eyes. And it is also flammable.
8. After the solvent dries, buff the area with steel wool until the surface feels smooth and even.
9. Remove all rust flakes from the wheelchair. This is a very important step. If all the rust flakes are not removed from the wheelchair, new rust spots can form

wherever the rust touches metal.

10. Clean the work area. Deposit all the rust flakes into a bag and dispose of them.

Check Your Knowledge

1. Rust can form on _____.
2. _____ is the process used to apply rustproof coatings to metals.
3. The wheelchair should be completely rust stripped _____.
 - a. once a year
 - b. twice a year
 - c. four times a year
 - d. three times a year
4. Electroplating causes tiny pieces of coating material to bond to the _____.
5. _____ chemicals cause rust in snowy areas.
6. Cracks or breaks in the rustproof coating should be cleaned _____ weekly.
 - a. once
 - b. twice
 - c. three times
7. Before you use any commercial solvent, read the _____ carefully.
8. A light rinse with _____ and careful drying will retard the growth of rust.
9. Some people use _____ to seal surface cracks.
10. Salt in the air _____ the rust development.
 - a. speeds up
 - b. slows down
 - c. has no effect
11. Name two things unremoved rust will do.
 - 1.
 - 2.
12. What is the best defense against rust?
 - a. let it develop
 - b. remove it as soon as you find any on the wheelchair
 - c. wash it often

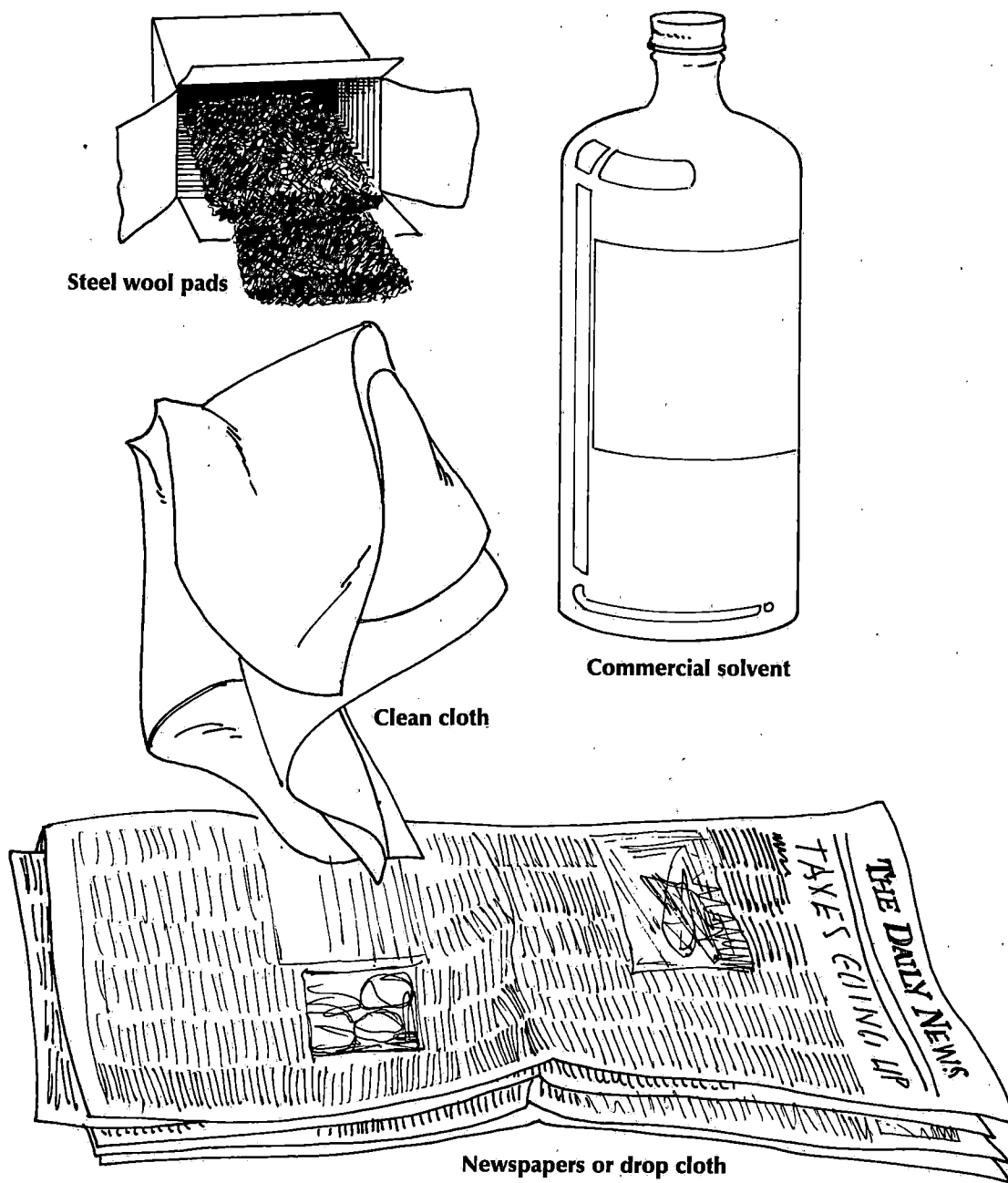


Figure 2. Materials for Removing Rust

WHEELCHAIR SAFETY

Objectives: After completing this chapter, you should be able to—

1. state the main rule for safe wheelchair operation;
2. name the factors you must consider when setting your own speed limit;
3. explain the steps for determining your own braking distance;
4. tell why you need an aide to determine reaction time accurately;
5. define reaction time;
6. explain why gloves should be used when operating the wheelchair outdoors;
7. tell why leather gloves are better than cloth gloves for wheelchair braking and control;
8. describe the safety steps for reaching out of the wheelchair;
9. tell how reaching over the side of the wheelchair could cause a flat tire; and
10. give the safety procedures for protecting yourself if you should be thrown out of the wheelchair.

Losing control of a wheelchair is dangerous. The wheelchair user could be thrown and injured. The chair could also strike and injure other persons. And a fallen wheelchair can become a hazardous obstacle. This chapter provides some broad advice for safe wheelchair operation.

The main rule of safe wheelchair operation is to keep control of the chair at all times. There are no set rules about how fast you can travel. And there are no set limits on how high a grade you can climb. You must find your own limits. Your only limiting factor is your ability to control the wheelchair.

You guide the wheelchair with both hands. Your hand turns the moving wheelchair by pressing down on one wheel or the other. And you slow or brake by pressing both wheels. The downward pressure creates friction or *drag* on the wheel, slowing it down. The other wheel is still spinning at its original rate. The chair will turn in the direction of the wheel that is pressured (see fig. 1).

The same friction that slows the chair wheel also produces heat. Wear-

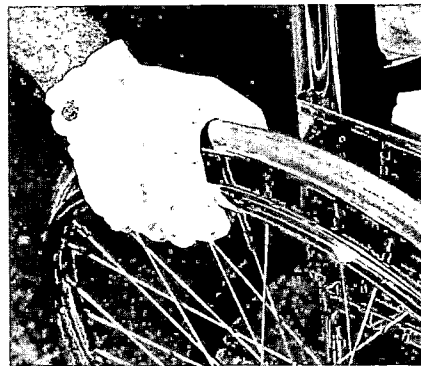


Figure 1. The wheelchair turns in the direction of the wheel that is pressured.

ing gloves allows the wheelchair user to resist the heat of friction. The gloves also prevent skin punctures by any sharp objects caught on the tires. Coming to a sudden or emergency stop without wearing gloves can cause severe friction burns on the hands. Also wearing gloves increases the speed at which you can travel safely.

Gloves are recommended for all outdoor wheelchair activities. They are also suggested for climbing steep ramps. Most medical supply houses sell gloves designed for wheelchair

use. A less expensive option is to use a pair of handball gloves with a padded palm. Using gloves also helps to get rid of callouses (see fig. 2).

Leather gloves are better than cloth gloves for wheelchair use. The leather is a more efficient insulator than cloth. It also resists abrasions. Wearing leather gloves, a person can withstand more friction than one wearing cloth gloves. Cloth gloves are more likely to snag sharp objects imbedded in the wheel. They also tend to pick up burs and thorns. Leather gloves will outlast several pairs of cloth gloves.

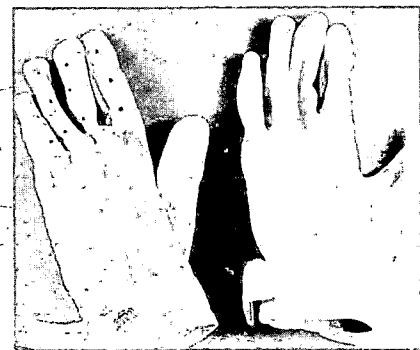


Figure 2

You should test yourself to find your own speed limit. An empty parking lot is a good test surface. You may test for level-ground safety range alone. An aide is needed to test for downhill-braking ability.

Testing for level ground speed limit is very simple. Select a clear mark on the pavement with plenty of open, flat ground around it. Take as much room as you need to work up to full speed before reaching the mark. When you cross the mark, apply full braking pressure to both wheels. When you have completely stopped, turn around and look back to the mark. The distance between where you are now and the mark is your minimum braking distance. Whenever you are operating the wheelchair, use this distance for comparison. Any time you are at top speed in the wheelchair on level ground, you need *at least* this much room to stop safely (see figure 3). Finding out how sharply you can turn at various speeds is another important consideration.

Unless you have access to a very steep ramp that opens into a large and level open area, you will need an aide for the second measurement. Wheelchairs are difficult to stop when they are heading downhill. The steeper the hill, the harder they are to stop. This measurement is important to use when deciding how fast to let yourself roll downgrade. Using the same marking on the pavement, have the aide push you to full speed. Again, apply full braking pressure as you cross the mark. The braking distance will be greater than the level-ground measurement. This extra force of the aide's push is similar to the speed gained on a typical grade.

Both of these measurements are approximations. In both of these tests, you knew in advance that you would be applying maximum braking power. In the real world, you will also have to compensate for your *reaction time*. *Reaction time* is the amount of time between stimulus and response. That moment of hesitation between seeing the danger and applying the brakes is the reaction time. Figure 4 shows how reaction time affects braking ranges.

The illustration shows a person

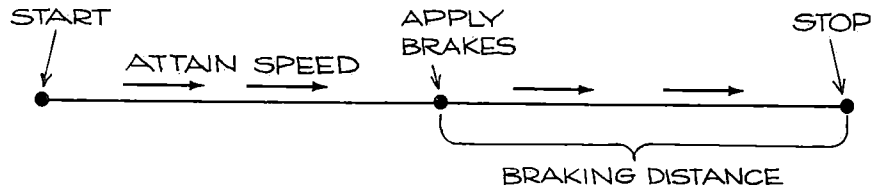


Figure 3. Finding your Braking Distance

moving at 10 mph. If the person has a reaction time of one second, 15 feet will pass before the brakes are applied.

It is very difficult to measure precisely a person's reaction time. If someone knows he or she is being measured, the "unexpected" cannot come as a surprise. An aide can assist by selecting a reference mark and ordering you to brake without warning. This will be a better test of your braking ability.

Be aware of your personal reaction speed. Add 5-10 feet to your braking safety range if your reflexes are average. Add 10-15 feet if they are slower than average, or if you have difficulty suddenly placing your arms for braking.

Reaching over the side of the wheelchair is also dangerous. Overreaching is the most frequent cause of wheelchair spills. Side-reaching can also place excessive strain on one wheel. The rim can become bent, or spokes can be forced through the tube (see following page, figs. 5A and 5B).

Care should be taken any time you stretch or reach out of the chair. The main rule here is to remember to turn your chair to face the object you want to reach. Back up a few inches and realign your chair so that the caster wheels are forward. Then, make sure the wheels are firmly locked into place before you extend your reach (see fig. 6).

Reaching over the side puts enormous pressure on one wheel. The wheel can be damaged by the pressure. The rim is intended to deform slightly as a shock absorber. Too much pressure can bend the rim further than intended. Bent rims are very difficult to repair. And they are expensive to replace.

If you lean too far out of the chair, it can tip over. Both you and the chair can be damaged in the spill. If you find yourself falling out of the wheelchair, protect yourself immediately. Tuck your chin onto your chest. Cover your face and head with your arms. As you fall out of the chair, try to tuck your upper body into a curled, fetal position. You should try to rotate your body so that you absorb the shock of impact on your side and shoulders (see figs. 7A and 7B).

Even if side-reaching does not cause a spill, it can damage the main wheels. The extra stress can force the main wheel to tilt (see fig. 8).

A bent main wheel will make the chair very difficult to operate. A chair with a bent wheel will not roll in a straight line, and extra effort is required to maneuver it. The damaged wheel will sway back and forth when in motion. This extra motion can cause discomfort to the occupant. And that discomfort and irritation could cause pressure sores to form.

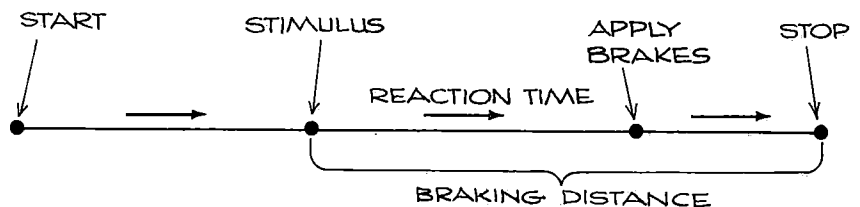


Figure 4. Reaction Time + Time to Apply Brakes = Braking Time



Figure 5A. Reaching the wrong way



Figure 5B. Reaching the right way



Figure 6. Align caster wheels and lock the main wheel before extending your reach.

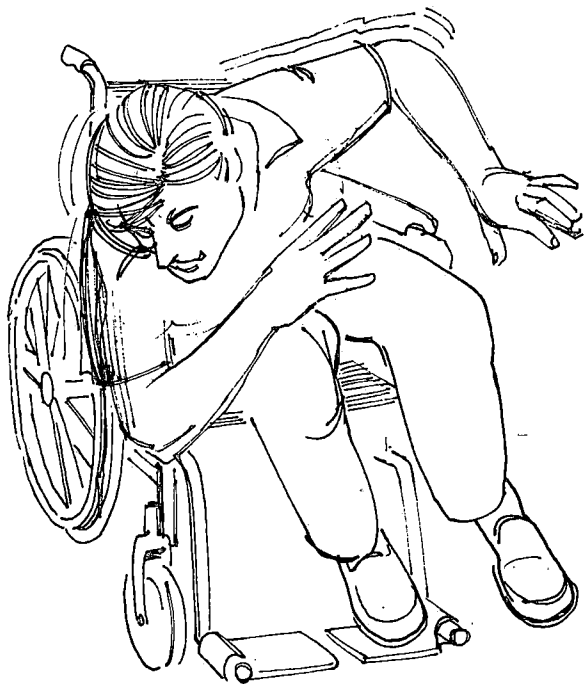


Figure 7A. If you should fall from wheelchair . . .



7B. Tuck the chin into the chest; land on the chest and shoulders.

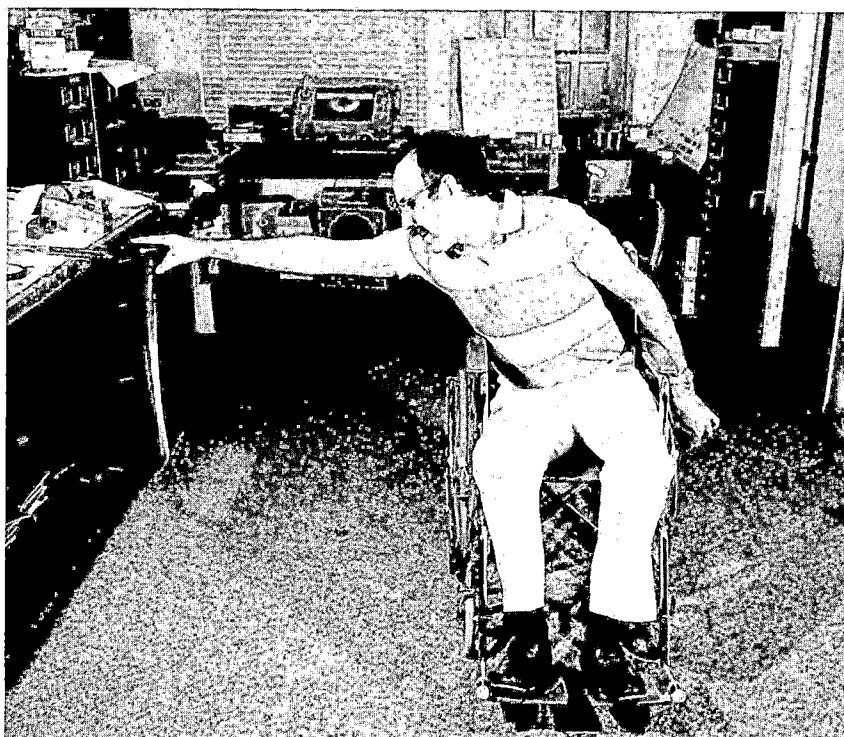


Figure 8

Check Your Knowledge

1. Gloves for outdoor wheelchair use should be made of _____.
 - a. vinyl
 - b. cotton
 - c. leather
2. Burrs and other sharp objects can catch in _____ gloves.
 - a. vinyl
 - b. leather
 - c. cotton
3. Leather gloves assist in braking the wheelchair because they _____ heat.
 - a. transmit
 - b. insulate against
 - c. reflect
4. The best gloves for outdoor wheelchair use have _____ palms.
5. You should always straighten the _____ before reaching out of the chair.
 - a. armrests
 - b. caster wheels
 - c. main wheels
6. Reaching over the side of the chair can damage the _____.
7. Always lock the _____ before reaching out of the chair.
8. You should test yourself to determine your own safe _____.
_____.
9. A self-test for braking distance cannot accurately measure _____.
 - a. stimulus response
 - b. reference marks
 - c. reaction time
10. The reaction time is the gap between _____ and _____.
_____.
11. If you do fall out of the chair, you should attempt to absorb the impact on your _____ and _____.

Objectives: *After completing this chapter, you will be able to—*

1. *tell who must guard against the formation of pressure sores;*
2. *describe the conditions that favor the growth of pressure sores;*
3. *tell if pressure sores are a reaction or a disease;*
4. *locate on a chart the areas of the human body where pressure sores are most likely to form;*
5. *cite the physical signs that show a pressure sore is developing;*
6. *explain how heat, moisture, and pressure interact to form pressure sores;*
7. *tell what information a person needs when making a telephone request to a physician for assistance in treating pressure sores;*
8. *give two reasons why the pressure must be removed from a decubitus ulcer;*
9. *tell why a pressure sore must be continually observed once it has been discovered; and*
10. *cite the dangers of a skin break over a pressure sore.*

All persons confined to a wheelchair must be on guard against the formation of mobility-robbing pressure sores. These sores, also called *decubitus* (de-kyú-ba-tus) *ulcers*, can form on anyone who spends long periods of time in one position.

The effect of weight pressing down against the wheelchair causes pressure. This pressure slows circulation and deprives the body of needed blood that both feeds and cleanses the tissues. Undernourished skin, without good circulation, is likely to get infected. Infections caused by the effects of pressure and friction on under-circulated skin are called *pressure sores*, *friction sores*, or *decubitus ulcers*.

Once these ulcers begin to develop, they are extremely painful. Without prompt treatment, they will grow and spread. In their later stages, the skin becomes extremely sensitive and irritated. Continuing to use the wheelchair after serious sores have formed is out of the question. Thus, a pressure sore can rob you of your mobility.

Pressure sores are a reaction to adverse circumstances; they are not the result of disease. There is no pill or injection that will immunize a person from developing these sores. By knowing the places on the body where pressure sores are most likely to form, you can develop a procedure for routine self-inspection. Early detection greatly reduces the amount of time and pain involved in curing the sores. By knowing the physical conditions that cause the formation of sores, you can take steps that will prevent irritation to the skin.

Lack of circulation coupled with pressure and friction is the primary cause of pressure sores. By keeping your chair in proper alignment, you reduce the amount of effort needed to propel and turn it. The farther out of alignment the chair is, the harder you must work. And the harder you work in your seat, the more heat, sweat, and friction you exert on the pressure points. Keeping your chair in proper alignment will remove at least half of the causes for the formation of sores.

The effect of your weight pressing down on the seat, arms, and back of the wheelchair exerts pressure on the skin. The body cleanses and feeds itself by circulating blood throughout the tissues. Pressure constantly applied to the one area deprives the skin of a chance to renew itself. And it is likely to become infected. When friction, heat, and sweat are added to a pressured area, sores are very likely to develop.

Pressure is most likely to damage those areas of the body where the skin thinly covers the underlying bones. Figure 1 illustrates those areas of the body most likely to develop pressure sores. In these areas, the thin skin is squeezed against the bone, and circulation is reduced.

The body is, to a large degree, a self-repairing mechanism. Using its natural defenses, it can cope with most minor infections. But without proper circulation of blood to an affected area, the body cannot restore the damage.

The problem with sitting in a wheelchair is that the same parts

of the body are constricted, unless the user consciously shifts or changes positions. And a chair that is out of alignment will put unusual pressures on the body as it rocks, rubs, or constricts flesh.

Two key points to remember about pressure sores formation are:

1. The body is capable of withstanding stress as long as the effects of stress are not applied to a small area of the flesh. The following example illustrates. Most of us have seen a carnival act where a fellow lies on a bed of sharp nails and suffers no ill effects. The secret of the "trick" is that he is lying on a lot of nails, not just one. The effect of using many nails is to spread the downward pressure or his body over many pressure points. If he sat on *one* nail, it would probably puncture the skin.

The same principal is true for the wheelchair owner. The full weight of the body is pressing downward on the chair. If the weight is distributed evenly, there will be no bad effects. If the pressure is applied locally on one or two points, the skin will suffer. With the effects of abusive pressure over time, a sore could form.

2. If the body is allowed a few seconds rest and reprieve from stress, it will recover its ability to resist that stress.

Understanding these two points is important for preventing decubitus ulcers. The pressure points on your body are a constant; they do not change to a large degree. The skin under those points will always be deprived of full blood circulation. So it is likely to become injured or infected. When you move about in the chair, these pressure points will become friction points.

If pressure is applied *constantly* to these points, pressure sores are likely to result. If, however, the pressure on these points is relaxed regularly, the risk of skin damage decreases greatly.

When constant pressure is combined with friction, the area becomes hot. And the body sends moisture to cool it off. Repeated failure of the moisture to evaporate leaves the skin tissue damp and hot. This combination of heat, moisture, and lack of

air is the perfect medium for the growth of destructive bacteria.

As part of daily self-examination, the wheelchair user should check all pressure points for the following physical signs of the development of a decubitus ulcer:

1. redness of the area;
2. heat radiating from the area (passing your hand lightly over all pressure points should reveal any hot spots);
3. blue spots show that the capillaries have been damaged and that circulation of blood has been impeded; and
4. cracks in the skin.

Treatment of Pressure Sores

If you have located the beginning of a pressure sore on your body, you

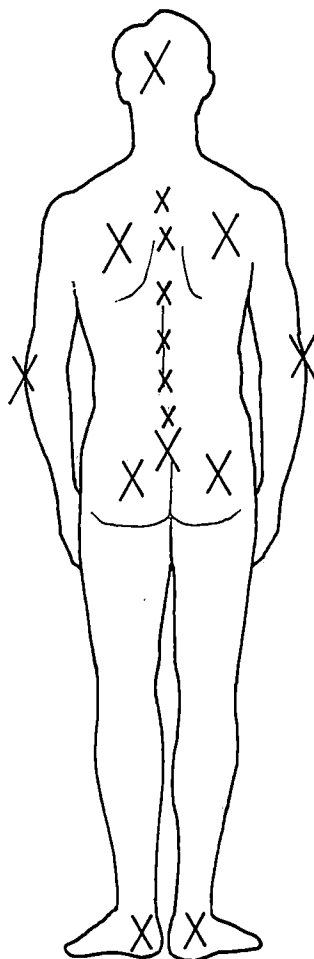


Figure 1. Body Pressure Points
Adapted from The Geriatric Aide, Jane Henry Stolten, R.N., Little, Brown and Co., Boston

should first alert your doctor. When you call, be prepared to provide a full description of the affected area. Your description should include:

1. the physical appearance of the sore including size and shape, location, and color;
2. the date when you first noticed it;
3. location of any breaks in the skin;
4. how the sore feels (i.e., is it throbbing, does it burn?); and
5. a brief summary of any treatments that you have already applied to the area.

The physician will probably either request that you come in for an examination or that you treat the problem at home first. The following suggestions for home treatment are not intended to replace the advice of a physician.

1. Observe

Once you have located a possible pressure sore, keep it under regular observation. Decubitus ulcers are not static; they either get better or they get worse. Your task as an observer is to determine which way your ulcer is progressing. You should note the size, location, color, and degree of inflammation of the ulcer. By monitoring changes in the sore's appearance, you can determine whether it is healing or spreading. These observations will be useful in any future contacts with the physician. Accurate monitoring can save you the time and expense of frequent doctor visits.

2. Remove the Pressure

Earlier, we saw that the decubitus ulcer forms as a result of the interaction of heat and moisture on skin with poor circulation. The first step in treatment is to remove the pressure from the skin, since this area is extra sensitive to touch. This allows the blood to circulate normally again. Often, the renewal of the cleaning and nutritional functions of the blood will stop the formation of an ulcer if it is detected at onset.

The best way to remove pressure is to give up the wheelchair for a few days of bed rest. This will give

the sore time to heal completely and will greatly lessen the chances of a recurrence. This also gives any moisture in the affected area a chance to dry.

If your sore is small and has not broken the skin, you can still use your wheelchair. But the time you spend in it should be broken into short segments. Rather than spending an entire day in the chair, break it into one- or two-hour segments. Take frequent "breaks" from the chair. Massage the affected area often to increase the flow of blood. When massaging, rub from the center of the area toward the edges.

Persons confined to wheelchairs often use rubber cushions or air rings (donuts) to relieve the pressure on a sore while remaining in the chair. However, these do more harm than good. They create a circle of pressure which constricts circulation. So, they may aggravate the problem.

A person in a wheelchair should never use a rubber pad without using an absorbent soft pad as a covering. The rubber causes the body to sweat, and allows no escape for the moisture. As we have seen, moisture and heat applied to skin with poor circulation is the main cause of decubitus ulcers in the first place. Avoid any "cure" or "remedy" which produces the same poor conditions that originally caused the infection.

3. Keep the Area Clean and Dry

Once a potential decubitus ulcer has been observed, it must be kept clean and dry. This retards the growth of destructive bacteria. Every three or four hours, the area should be

gently washed with soap and water. Then the area should be carefully dried and a layer of nonperfumed powder applied. In addition to this regular routine, you should massage the area to restore circulation.

4. If the Skin Breaks or Cracks

The risk of secondary infection is greatly increased if the skin cracks or breaks. The tissue under the skin has been weakened by lack of circulation. It is open to other forms of infection that might enter through the wound.

Any skin breakage should be reported to the physician at once. Meanwhile, you should protect the broken skin with sterile dressings. You should clean and dry the skin once every two hours.

If the skin breaks, you must remove all pressure from the area at once. Ways of dealing with a suspected ulcer, such as spending fewer hours in the chair and using rubber pads, should not be used with an open wound. The infection could be forced deep into the skin. And it could spread to other parts of the body.

Note: Persons who have suffered nerve damage or who are taking pain-killing medicines must be doubly careful to look for signs of ulcers. They may not be able to "feel" the telltale signs of a newly forming ulcer.

Check Your Knowledge

1. All persons in wheelchairs must guard against the formation of

mobility-robbing _____

2. Undernourished skin is likely to get _____
 - a. healthier
 - b. infected
 - c. energized
3. Once ulcers begin to develop, they are extremely _____
 - a. large
 - b. insensitive
 - c. painful
4. Pressure sores are a _____ to adverse circumstances.
5. Lack of circulation coupled with _____ and _____ is the primary cause of the formation of sores.
6. Pressure is most likely to damage those areas of the body where the _____ thinly covers the underlying bones.
7. By keeping the chair in proper _____, you reduce the amount of effort needed to propel and turn yourself.
 - a. alignment
 - b. positions
 - c. locations
8. You should conduct a daily _____ for pressure sores.
9. _____ indicate that capillaries have been damaged.
 - a. yellow spots
 - b. blue spots
 - c. large bumps
10. The best way to remove pressure is to give up the wheelchair for a few days of _____.
 - a. motor activity
 - b. vacation time
 - c. bed rest

APPENDIX

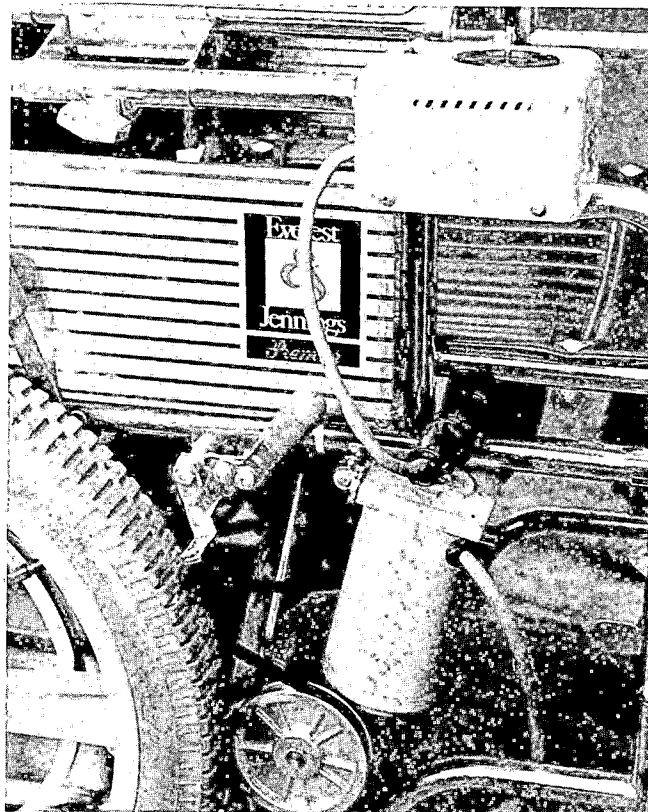
MOTORIZED WHEELCHAIR INSPECTION AND MAINTENANCE

Motorized Wheelchairs— *The Script*

This appendix provides the entire script for one of six audiovisual units for *A Stitch in Time—Wheelchair Inspection and Maintenance*.

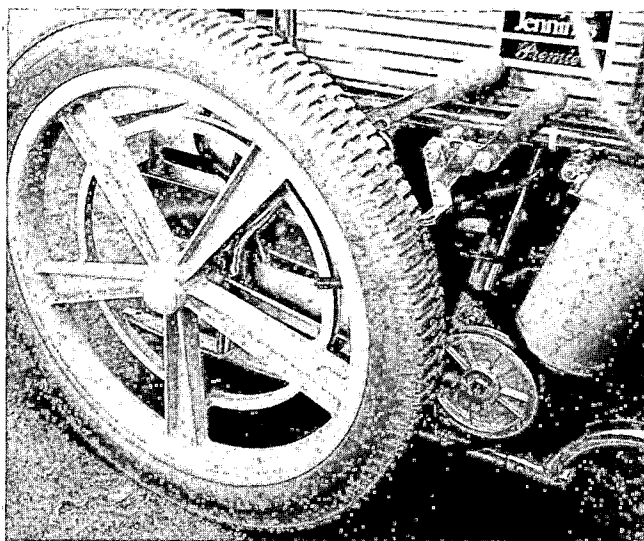
Slide Number

- 1 (Focusing slide. No voice. Show before starting tape)
- 2 *Wheelchair Maintenance—A Stitch in Time.*
- 3 "A/V Unit 6, Motorized Wheelchairs."
This unit covers inspection and basic maintenance of motorized wheelchairs.
- 4 Most motorized wheelchairs are like manually propelled wheelchairs, except that they have electric motors, batteries, and control boxes added on.
- 5 Most of the inspection and maintenance information that applies to manually propelled wheelchairs also applies to motorized wheelchairs. This unit covers the differences in maintenance and the additional basic maintenance that motorized chairs require.
- 6 Because of a number of different makes and models of motorized wheelchairs, this unit covers general procedures for representative commonly used chairs. For answers to very specific maintenance and repair questions, consult the owner's manual that came with your chair, or talk to your wheelchair dealer.
- 7 Motorized wheelchairs closely resemble manually propelled chairs in most respects. Some components, like the main wheels, may be bigger and stronger to absorb the stresses and carry the extra weight of the motorized chair.
- 8 A motorized wheelchair is propelled by electric motors which are usually located in front of the main wheels. Usually the motors drive the main wheels by means of pulleys and reinforced rubber belts that resemble the fan belts in a car engine.



Slide Number

- 9 There is a clutch lever on each side of the chair behind the wheel lock that engages or disengages the motor drive to the main wheels by tightening or loosening the drive belt tension. Moving the clutch levers toward the rear of the chair engages the drive,
- 10 while swinging them forward disengages the drive so that the chair may be manually propelled or pushed by an attendant. You will need to check the drive belt tension once a month.

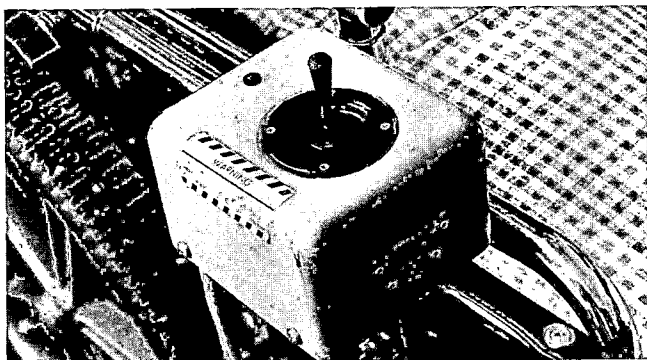


- 11 Energy to run the electric motors comes from one or two lead acid storage batteries that usually rest in a box mounted low down at the rear of the chair between the main wheels. You need to charge the battery or batteries daily, check their water level once a week, and clean them every three months.

- 12 The wheelchair user generally controls the motorized chair by means of the control box, which is usually mounted in front of one of the arm rests. The control box has a control stick to control direction, speed, and braking.

- 13 Also mounted on the control box is a power switch that can have either "off" and "on" settings, or "high," "off," and "low" settings for those chairs that have two different speed ranges. The power switch is turned "on" or to one of the speed ranges when the chair is to be operated, and is turned "off" when the chair is at rest or not being used.

- 14 A battery voltage indicator light is also mounted on the control box. If it begins flashing while the chair is in use on a hard, smooth, level surface, that means the battery voltage is low and the battery should be charged as soon as possible.



- 15 Movements of the control stick carry information to the electronic circuitry module. This is a box that mounts either behind the seat back or on top of or in front of the battery box. The electronic circuitry module tells the electric motors what to do to follow the movements of the control stick. Normally you should let your wheelchair dealer do all the inspection and repair work on the circuitry module.

- 16 All the electrical components connect to each other with plugs and electrical cables. You must check to see if the electric plugs are securely attached and the electrical insulation on cables and plugs is not cracked or worn off.

- 17 To prevent dangerous overloads, one or more electrical fuses are installed in the wiring. The fuse is usually installed in a housing in the battery cable and should be checked periodically for signs of corrosion or poor contact with the battery cables.



- 18 While not part of the motorized chair itself, the battery charger is a very important item. It recharges the wheelchair's batteries that discharge quickly through use and even discharge slowly when the wheelchair is not being used.

- 19 You need to make sure the battery charger's electrical cables and connectors are in good condition, that the charger does not get damp or wet, and that the louvers or ventholes in the case are unobstructed so that air can circulate.

- 20 The inspection and maintenance of motorized wheelchairs can be divided into two parts: mechanical inspection and maintenance, and electrical inspection and maintenance. Mechanical inspection and maintenance of a motorized chair is almost exactly the same as for a manually propelled chair, but there are some differences.

- 21 Every month, check and adjust the tire pressure on chairs with pneumatic tires. There are several different sizes of tires fitted to the main wheels of motorized chairs, so to find out the recommended tire pressure, either consult your owner's manual, talk to your dealer, or look for a number molded into the tire's sidewall. If your wheelchair has pneumatic caster wheel tires, check and adjust their pressure also.

- 22 Once a month, check the adjustment of the wheel locks and check the main wheel spokes for proper tightness. Use the same procedures as you would with a manually propelled chair.

- 23 Check drive belt tension once a month. Turn the control box power switch "off." With the clutch levers in the rearward engaged position, press down firmly on the middle of each drive

belt with one finger. The belt should not move more than one-half inch from its normal position. If it deflects more than one-half inch it is too loose and should be adjusted.

- 24 To adjust drive belt tension, make sure the power switch on the control box is in the "off" position. Then disengage the drive motors by swinging both clutch levers forward.

- 25 Next, look at each clutch lever. A metal adjustment rod extends downward from the clutch lever. It is attached to the clutch lever by a retainer clip that looks like a big hair pin. Pull the retainer clip off the adjustment rod. Using pliers or a screwdriver makes the job easier.



- 26 Slide the top of the adjustment rod out of the hole in the clutch lever.
- 27 Rotate the adjustment rod clockwise several times,
- 28 then slide the top of the rod back into the hole in the clutch lever and push the retainer clip back on. Slide the clutch lever back to the engaged rearward position.
- 29 Recheck the drive belt tension by pressing down on it with your finger. If the belt still moves more than one-half inch, repeat the adjustment process, turning the adjustment rod clockwise several more times. But do not over-tighten the drive belts. A drive belt that is too tight causes friction which will drain the battery and wear the motor out faster.
- 30 Every six months, inspect the condition of the drive belts and the pulleys that the belts go around. Look closely at each drive belt. If it is worn, frayed, or cracked, have it replaced.
- 31 Check the tightness of the nuts, bolts, or screws holding the large pulleys onto the main wheels. Do the same thing for the small pulleys that attach to the electric motors.

- 32 All other *mechanical* inspection and maintenance tasks for motorized chairs are just about the same as for manually propelled chairs. Consult the other units in this series, the manual entitled *Wheelchair Maintenance and Repair: A Stitch in Time*, or your wheelchair owner's manual for more information.

33 *Electrical maintenance*

- Daily: Recharge the battery.* You should normally recharge the battery or batteries in a motorized wheelchair every day, even if it is only used for short periods. Keeping a battery fully charged can increase the life of the battery. This will save you money and inconvenience. Also, a fully charged battery is less likely to lose its strength or to freeze under cold weather conditions.

- 34 When being recharged, batteries release gases that can explode if allowed to concentrate and be ignited by a spark or flame. Make sure you recharge the wheelchair batteries in a well ventilated room without open flames, pilot lights, smokers, or electric sparks.

- 35 Try to choose a room with a floor that would not be damaged by a possible battery fluid spill. It is a good idea to lay down a protective plastic dropcloth under the wheelchair to prevent possible damage to the floor.

- 36 Recharge batteries in an area that is not hotter than a comfortable room temperature. Batteries heat up during recharging and can be damaged if temperatures go much over 100 degrees Fahrenheit.

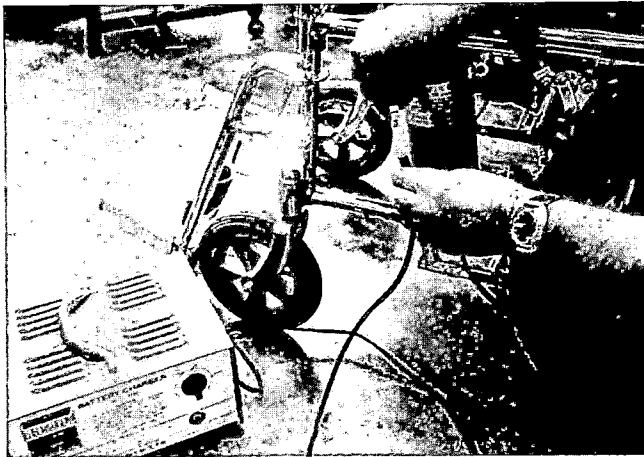
- 37 To recharge the wheelchair batteries, move the chair so that it is near a regular 115-volt grounded electrical wall outlet. Grounded outlets are the ones with a third round hole in addition to the two normal thin rectangular openings.

- 38 If you can't get close enough to the wall outlet for the charger cord to reach, use a heavy duty *grounded* extension cord. Do not use a regular household extension cord.

- 39 Make sure the battery charger is the correct one for the make and model of the chair you use. Do not plug the charger in yet.

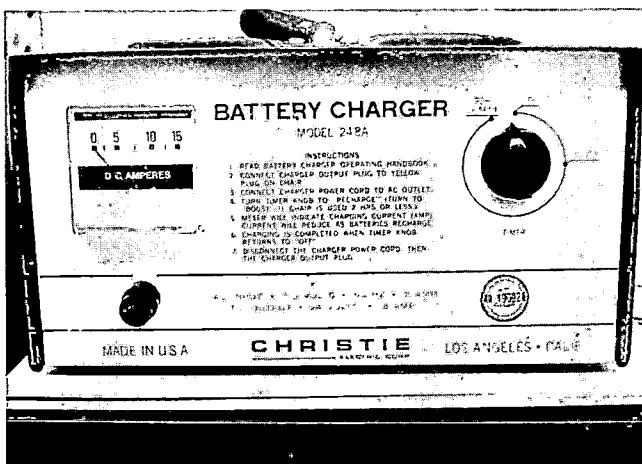
- 40 Move the power switch on the control box to the "off" position and lock the wheel locks. Find the charger extension cable on the wheelchair and connect it to the matching cable of

the battery charger. Read both the instructions that come with the battery charger and the instructions that are printed on the charger itself. Observe any caution warnings.



- 41 Now plug the battery charger power cord into the wall outlet. Set the timer on the charger to the proper setting for the amount of recharging needed.

- 42 Set it to "Boost" if the chair has been used for two hours or less. Set it to "Recharge" if it has been used for more than two hours. The charger will then turn itself off at the proper time.



- 43 If your battery charger does not have a timer, you must pay attention to the clock yourself. Give the battery charger enough time to charge the battery fully. The more the wheelchair has been used before recharging, the more time the recharging will take.

- 44 The battery should be fully recharged when the charger gauge needle either sits still or wiggles slightly at the low range of the meter.

- 45 Once the timer has shut off, or the gauge needle indicates the charging is complete, remove the charger power cord from the wall outlet. Then disconnect the charger cable from the charger extension cable on the wheelchair. Do not overcharge the battery. Unplug the charger as soon as convenient after the charging is complete.

- 46 *Weekly: Test and Fill the Battery.*

Once a week you should check the battery charge, check the fluid levels in the battery cells, and add distilled water as necessary. Testing the battery charge tells you how healthy the battery is, and can warn you if the battery is about to fail.

- 47 Test the battery or batteries about one hour or more after daily recharging has been completed. This lets the battery settle down to give you a more accurate reading of its charge. Do not add any water to the battery until after you have checked the charge.

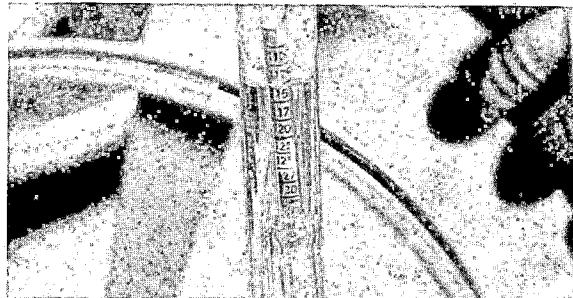
- 48 Wear protective goggles or glasses and rubber gloves any time you are working around the battery. The fluid inside the battery contains sulfuric acid which can blind you, burn your skin, and damage clothing, furniture, and floors. So be careful.

- 49 Unbuckle or undo any straps or catches holding the cover onto the rest of the battery case. On some chairs, you may have to move the electronic circuitry module up out of the way first. Remove the battery case cover, and read the cautionary information printed on top of the battery. Follow these directions.

- 50 To measure battery charge strength, you use a hydrometer. There are two types of hydrometers. The professional type has a float in it with markings and color coding that indicate how well charged each battery cell is. The other kind of hydrometer is smaller, cheaper, and less accurate, but it gives good enough results for our purposes. This type has some small colored balls in it. You can tell the battery charge condition by how many of the balls float.

- 51 Remove the vent caps that cover the battery cells. Insert the flexible tube on the end of the hydrometer deep enough into each battery cell to go below the level of the battery fluid. Squeeze the rubber bulb on the end of the hydrometer slowly and release. This draws battery fluid up into the hydrometer.

- 52 If you are using a professional type hydrometer, look at the float and see what marking or color coded area is right at the surface of the battery fluid. Compare this reading to either the information that comes with the hydrometer or to the information in your owner's manual under the section called "Battery Testing."



- 53 Generally, readings between 1.230 and 1.295 at room temperature indicate the battery cell is in good condition.
- 54 On a floating ball type hydrometer, all or most of the balls must be floating to indicate that the cell is well charged.
- 55 Now that you have taken the reading of the first cell, slowly squeeze the hydrometer bulb again to return the battery fluid into the cell. Repeat the procedure to test the other cells in the battery.
- 56 If one or two of the battery cells show much less charge than the others, then the battery will likely need replacement soon. If the battery tests poorly, have your wheelchair dealer or other competent repairperson double-check the condition of the battery.
- 57 After testing all the battery cells, wipe up any battery fluid that has dripped out of the hydrometer onto the top of the battery. Rinse the hydrometer in water and dry it with a paper towel. Dispose of any paper towels or rags that have battery fluid on them.
- 58 When you have completed your once-a-week testing of the battery cells, look down the vent tube holes to check the fluid levels of the cells. If you need more light to see down the holes, use a flashlight or other electric light.
- 59 NEVER use a lighter, match, candle, or any other open flame near a battery. It could cause an explosion. Avoid electric sparks for the same reason.
- 60 If the battery fluid level is below the split rings near the bottom of the vent tubes, you must raise

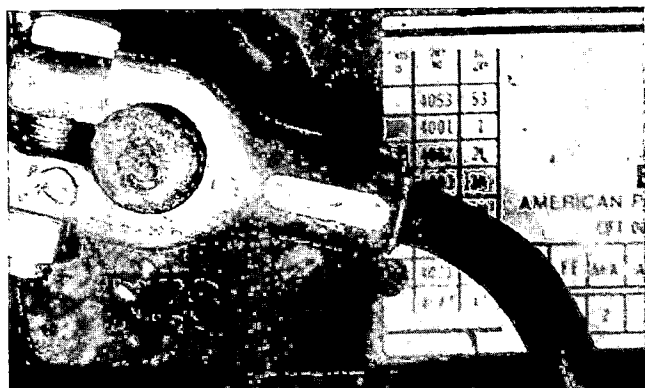
- the fluid level to the bottom of the split rings. Carefully add distilled water only. Distilled water is sold at many supermarkets. You can use a glass or cup and a small funnel.
- 61 You can use a bulb type battery filler or use a professional type hydrometer to transfer distilled water into the battery. Be careful not to over-fill the battery cells. Auto parts stores often carry battery filler bottles that automatically shut off when each cell is full.
- 62 After filling the battery cells, replace the battery vent caps. Wipe up any spilled water. There may be acid battery fluid on the tip of the funnel or battery filler. Rinse and dry it carefully. Replace the battery case cover and latch or strap it down securely.
- 63 Once a week you should also inspect all plug connectors to be sure they are securely attached. Check the connections between the batteries and the charge cable, between the battery and the electronic circuitry module, between the circuitry module and the electric motors, and between the control box and the circuitry module. Make sure the connections look alright, and are plugged in firmly.
- 64 *Three Months: Clean Battery, Inspect Wires*
Batteries get dirty over a period of time. This dirt and corrosion can cause the battery to discharge even when not in use. Dirty or corroded battery cable connectors make it harder for electricity to flow to the electric motors, and make it harder to recharge the battery fully.
- 65 When cleaning batteries, wear the same protective eyewear and gloves you use when testing and refilling the battery. First, turn the power switch off.
- 66 Then, once you have removed the battery case cover and unclipped any plastic caps covering the battery posts, begin disconnecting the battery cables.
- 67 The battery posts are usually labelled with either a plus (+) sign or the word POS for positive, and a minus (—) sign or the word NEG for negative. Observe which color cable connects to which battery post.
- 68 It is a good idea to tag one battery cable and one post with pieces of tape to make sure that you later reconnect the cables to the correct posts. Mixing up the battery cables and reconnecting them wrong can severely damage the motors and the electronic circuitry module.

69 If the cables are connected to your battery by wing nuts, you can disconnect them without tools. Just unscrew the wingnuts with your fingers.

70 Some cables connect with the same kind of clamps used on many car batteries. In this case, use an adjustable wrench or a proper size box wrench to loosen the nut that clamps the end of the cable onto the battery post.

71 You may need to insert the tip of a blade screwdriver at the base of the battery post under the clamp to pry it up off the post. Do this carefully, working around the base of the clamp. Do not force it.

72  Disconnect the negative, or minus sign, cable first. Then disconnect the positive, or plus sign, cable.



73 If your wheelchair has two batteries, disconnect the short jumper cable that runs from the negative post of one battery to the positive post of the other. Swing all of the battery cables out of the way.

74 The best way to clean the batteries is to remove them from the battery case first. Remember that batteries are quite heavy and they can break or spill acid if tipped over or dropped.

75 Some batteries come with a rope carrying handle that makes them easier to lift. Some do not.

76 If there's room enough around this kind of battery, you may be able to lift it out with your hands.

77 If there is not enough clearance, you should use a battery lift strap, which you can buy at an auto parts store. The ends of the strap grip the battery posts so that you can lift the battery up by the strap.

78 Put the battery on a surface that will not be affected by the cleaning process. A plastic drop-

cloth is good protection. If necessary, you can also clean the battery while it is still in place on the wheelchair.

79 Stuff rags or paper towels around the battery to catch any drips. Make sure to dispose of them later.

80 Wipe off the battery top and posts with paper towels, then mix together some baking soda and water into a thin paste and scrub the posts, top, and as much of the rest of the battery as you can.

81  An old toothbrush is a good scrubber, especially around the battery posts. Make sure the vent caps are on tight. Do not let any of the baking soda paste get into the battery. It will shorten battery life. Also use the baking soda paste and toothbrush to clean the clamps on the ends of the battery cables.



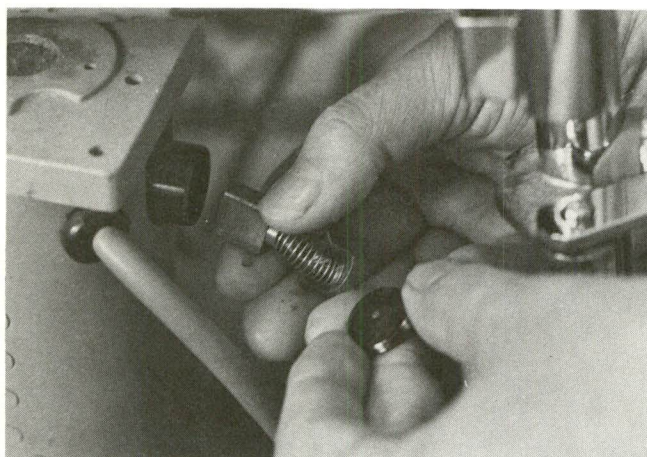
82 Rinse the battery and the battery cable clamps with plain water and let dry. Auto parts stores carry battery cleaning liquids and sprays that you can use instead of baking soda.

83 You can also buy several types of tools that help clean battery posts and clamps. Using these tools improves the flow of electricity from the battery posts to the cables.

84 If the battery was removed for cleaning, put it back in the battery case. Make sure it is in the same position it was before. Don't accidentally turn it around. Reconnect the battery cables in reverse order of the way you disconnected them.

85 Attach the positive, or plus sign (+) cable first, and then the negative, or minus sign (—) cable. If your chair has twin batteries, be sure to reconnect the short jumper cable from the positive post of one battery to the negative post of the other.

- 86 Either hand-tighten the wingnuts as tight as you can, or push the cable clamps down firmly on the posts and tighten the clamp nuts securely.
- 87 To help prevent corrosion, coat the battery posts and cable clamps with petroleum jelly. Reclip any plastic caps over the battery posts and clamps. Replace the battery case cover and latch or strap it down tightly.
- 88 *Three Months: Clean Battery, Inspect Wires*
Every three months you should inspect the condition of all the electric wires and cables on the wheelchair.
- 89 Turn the power switch off. Look carefully at all the electric wires, searching for worn or cracked insulation.
- 90 If you find any, you can usually make a temporary repair by wrapping plastic electrical tape around the worn or cracked insulation. But try to get the wire or cable replaced soon, and make sure that the new or repaired wire is securely safely away from whatever damaged the insulation in the first place.
- 91 *Six months: Inspect Motor Brushes*
Every six months you must check the condition of the carbon brushes in the electric motors.
- 92 There are two brushes in each motor. The brushes are located in the small cylinders that stick out of the sides of the motor near the top.
- 93  Remove the cap that holds each brush assembly in place. Then pull out the spring and the brush behind it.



- 94 The face of the carbon brush is the curved side opposite the spring. Inspect the face of the brush. It should be clean and shiny. If the face of the carbon brush is deeply scratched, or is rough and burned looking, then the motor needs service by the dealer or by a professional electric motor repairer.
- 95 Even with its face in good condition, the carbon brush may be worn down too thin. Check with your dealer to find out how thin the brushes can wear before requiring replacement. If the carbon brush is in good condition, replace it and the spring in the same position they were when you removed them. Then replace the brush cap.
- 96 *Yearly inspection and maintenance.*
Four electric relays in the electronic circuitry module must be inspected and cleaned or replaced once a year. As this is complicated and delicate work, you should have your wheelchair dealer do it.
- 97 It is possible to do this maintenance yourself, but it is advisable only if you are skilled and experienced at electrical repair and cannot easily get to a dealer. Consult your owner's manual for information on servicing the relays.
- 98 This concludes the inspection and maintenance of motorized wheelchairs.
- 99 (OCD)

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