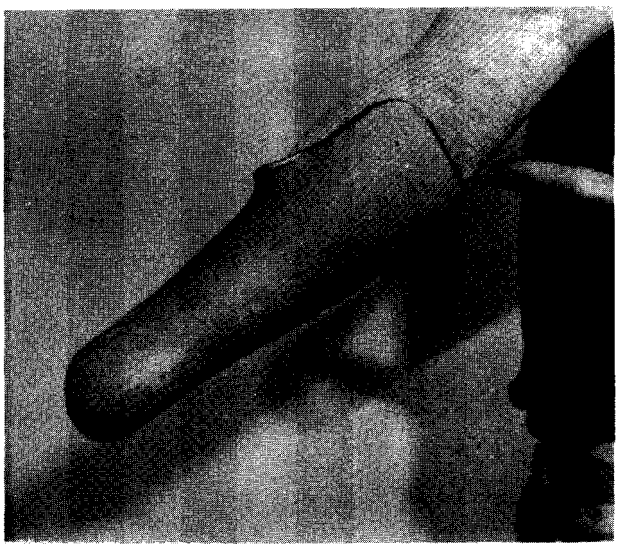
WAX CHECK SOCKET FIT FOR RIGID HINGE

When single pivot or polycentric rigid hinges are to be used, additional procedures must be performed, Procedures relating to trim for pronation and supination are excluded.

The proximal trim line is outlined as shown. Sufficient material must cover the medial and lateral humeral condyles where the joint spacer will be placed on the joint axis. The posterior trim should be one inch proximal to the olecranon.

When rigid hinges are used additional flare and trim at the cubital fold should sometimes be made to permit 135° of elbow flexion and to keep the tissues from forcing the socket off the stump.



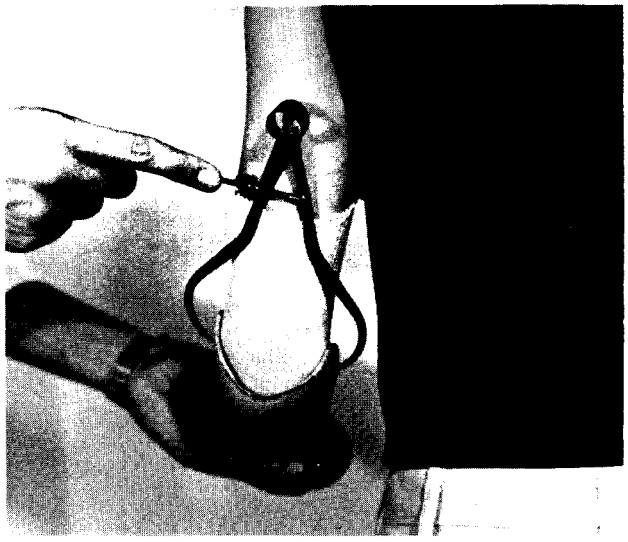
The posterior trim should be proximal to the olecranon.and without excessive pressure against the triceps tendon at 10° of elbow flexion. Ample socket material over the humeral on

Locate the axis of rotation for the rigid hinges joint center with a pair of pointed outside calipers. Select points over the medial and lateral epicondyles of the humerus. Put the points of the calipers into the outer surfaces of the check socket. This can be done with the socket off the amputee after the points have been selected. Be careful not to change the medial and lateral dimensions. This procedure should be carried out with care and precision to avoid motion between the mechanical joints and the stump in the finished prosthesis.

Begin the procedure as illustrated, with elbow flexed 90°, and the calipers nearly parallel to the humerus.

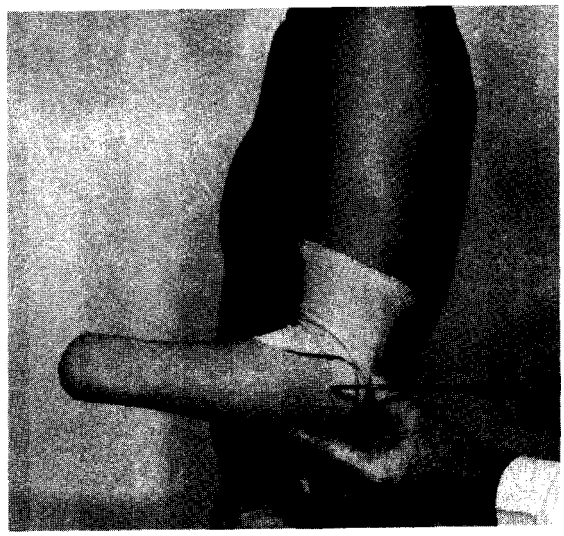
Lightly pull the socket upwards while the amputee slowly extends his arm to approximately 30° and returns it to 90°.

Observe the motion of the calipers at the point illustrated. If properly placed, no motion will be observed.



If no relative motion exists between the calipers and the arm, have the patient slowly flex his elbow to approximately 130°. Use a goniometer if necessary, maintaining the check socket on the stump with the opposite hand as shown.

Change the direction of the calipers until they are perpendicular to the humerus as illustrated. Repeat the procedure with the amputee flexing and extending his elbow within the parameters established in the previous step.

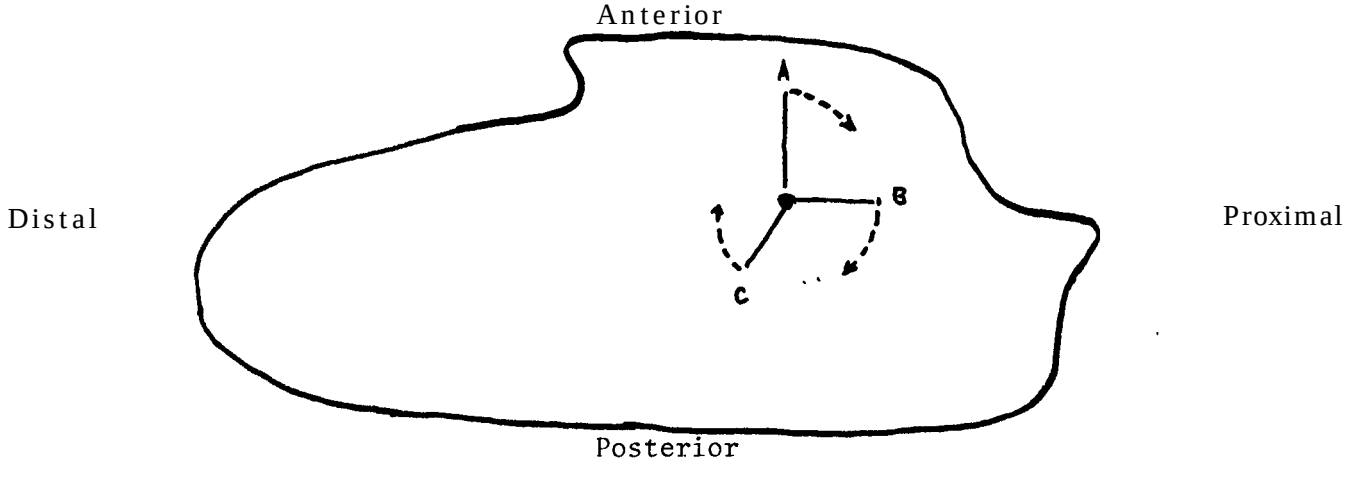


When the calipers do not exhibit medio-lateral wobble or the points do not move in a semicircle in both caliper positions, the rotation center has been located.

Hold the calipers as illustrated. If they move medially or laterally, the joint centers are too anterior or posterior.

Again hold the calipers perpendicular as illustrated. If they move medially or laterally, the joint centers are too distal or proximal.

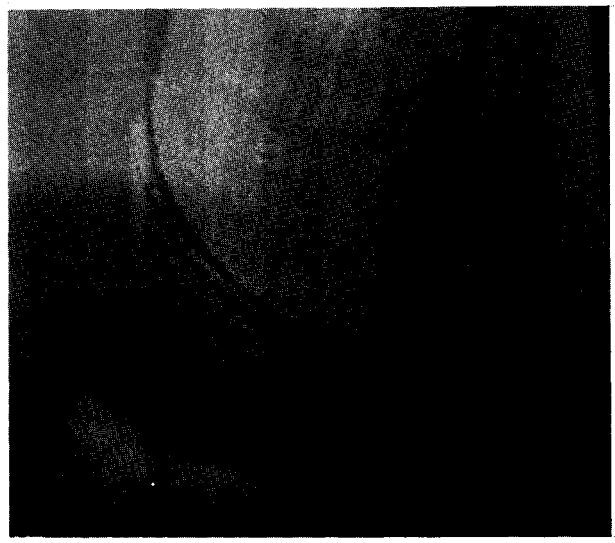
The elbow joint centers may or may not fall over the epicondyles. If in the above steps, the calipers move, the points of the calipers must be repositioned on the wax check socket. Observe both points of the calipers as follows.



If the point of the caliper moves in an arc as shown by (A) in the above diagram, then the point must be moved posterior on the socket toward the true center of rotation (0). If the point of the caliper moves in an arc, (B), then the point must be moved distally. If the point moves in an arc, (C), then the point must be moved anteriorly and proximally.

As described above, reposition the points of the calipers and observe their movement, as shown on steps (1) and (2) until the calipers no longer move with elbow motion. Now the elbow joint centers have been located. If the cam action of some elbow joints or excessive soft tissues prevent exact placement over the centers, a compromise must be made.

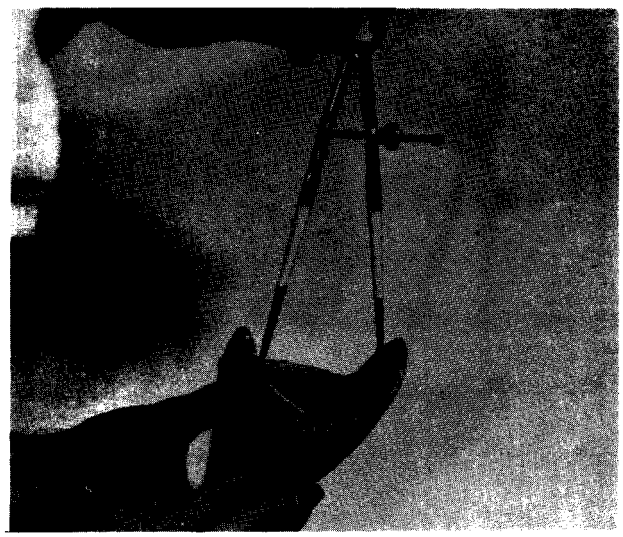
Provide clearance of 1/4-inch over the medial condyle of the humerus.



Repeat the above over the lateral epicondyle allowing clearance of 3/16-inch.

The fitted check socket is shown. Mark the correct joint axis center.

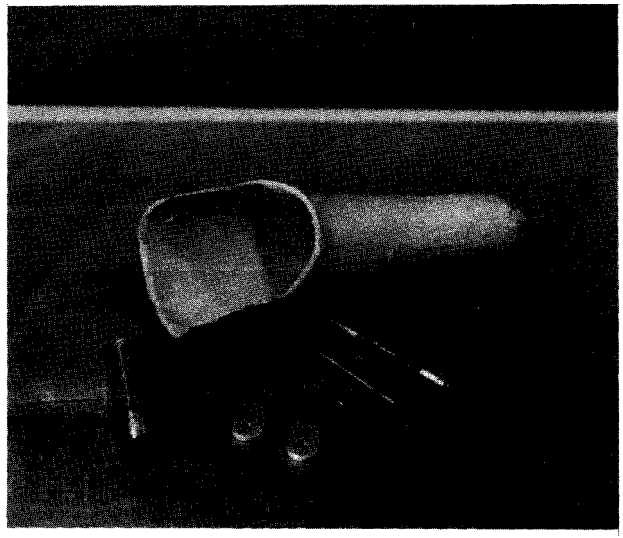
With a pair of inside calipers, measure the medial-lateral width at the joint centers and record it on the prosthetic information sheet. This will be needed when the joint spacers are installed.



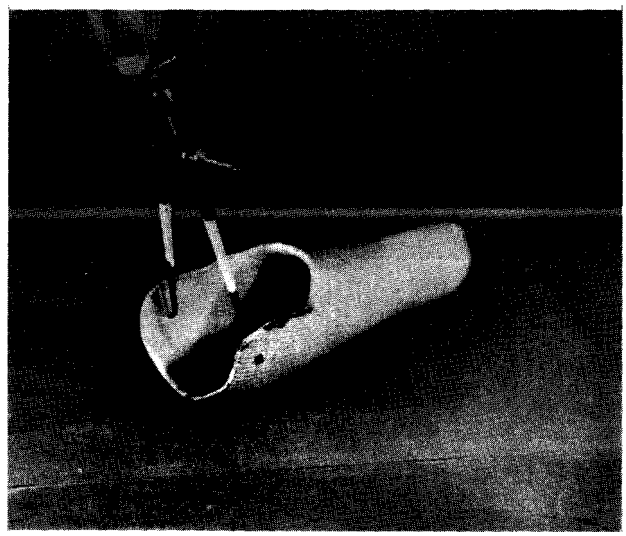
Single Joint Spacer

Joint spacers hold rigid hinges in alignment until lamination procedures are complete. Immediately after the fitting, the joint spacers are installed in the check socket. The joint spacers must be carefully installed so that the check socket is not distorted. (See Chapter IV, Materials, for details).

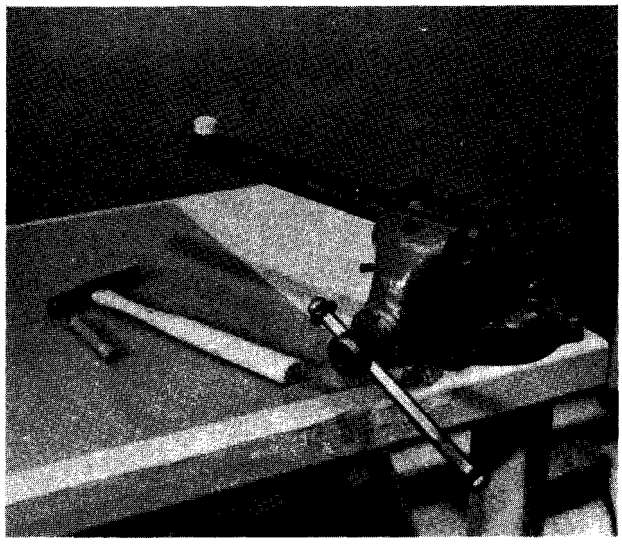
The complete spacer assembly is shown, with a cutting- tool for making the spacer holes in the check socket. (See Chapter IV, Materials on how to make a cutting tool.)



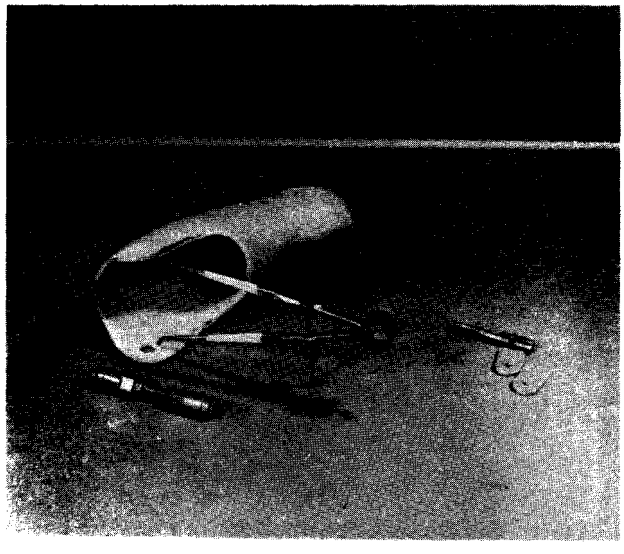
Set the inside calipers to the width of the medial-lateral distance of the socket.



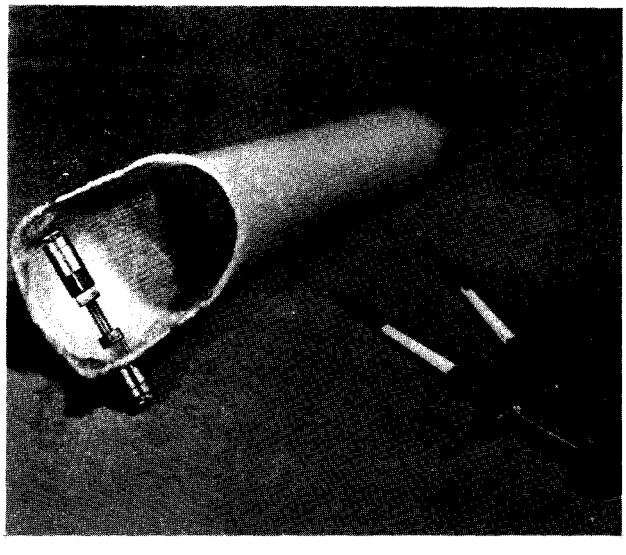
Punch the joint spacer holes. Recheck the medial-lateral distance with the calipers. If the distance changed when the spacer holes were being made, reset the distance.



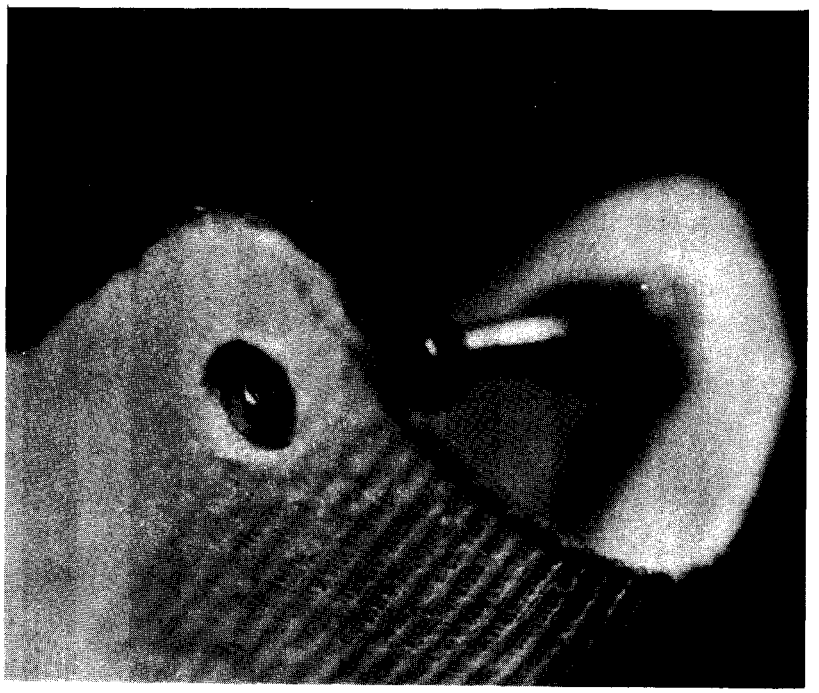
Set the joint spacer to the approximate medial-lateral width. Do not include the steel spacer washer in the setting because it is used to determine the lamination thickness.



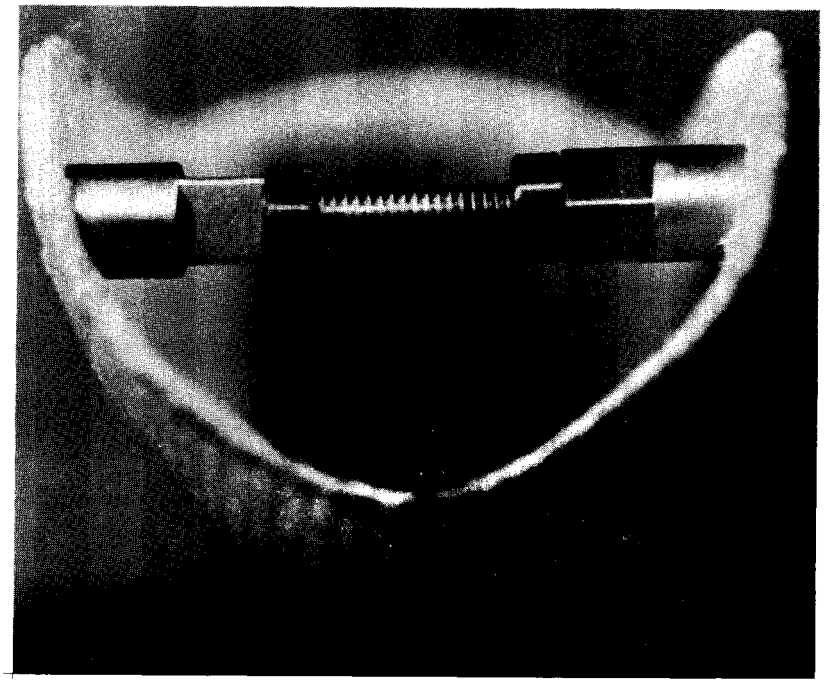
Slide the spacer through the holes.



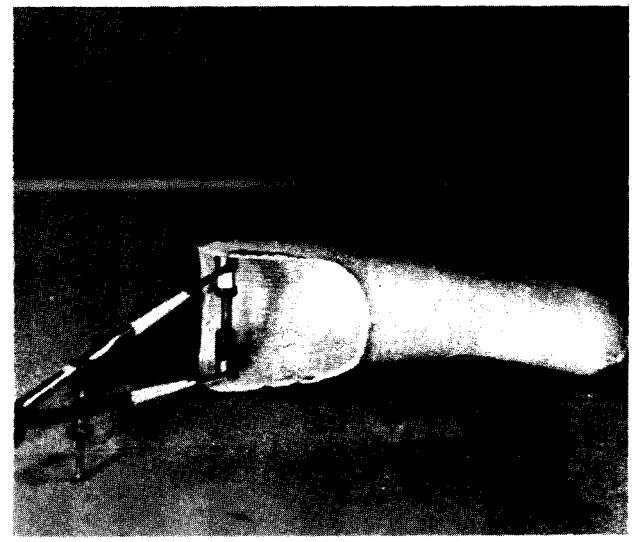
Align the face of the brass spacer. The steel spacers have been removed for illustrative purposes only. The wall of the check socket is usually on an angle to the face of the spacer. Place the face end of the spacer just inside the deepest point of the angle. When the lamination model is made the brass spacer will project out of the model approximately 1/32-inch at its lowest point.



Loosen the lock nuts and adjust the length until the above procedure is repeated on the opposite wall.



Recheck the medial-lateral width. Tighten the lock nuts on the spacer bolt. The spacer should now be held in true alignment by the threads. If the spacer heads wobble, replace the threaded bolt with a longer one. Put a parting agent on the spacer.



Breakout Mold

Materials:

plaster

mandrel

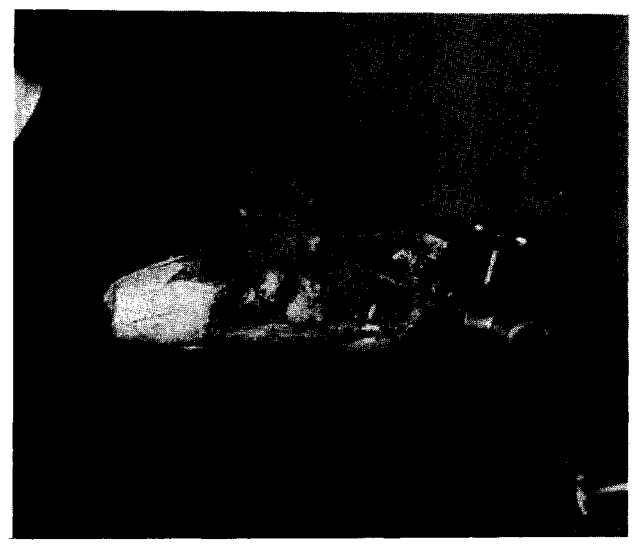
knife

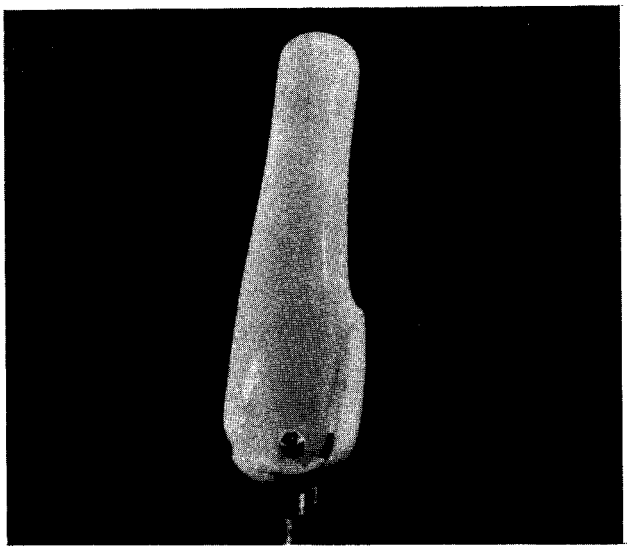
sandpaper or screen

parting agent for the mold

Seal the holes in the check socket and make a breakout mold as described in Chapter IV, Materials. Insert a mandrel in the plaster for holding the mold.

When the plaster has set, carefully remove the wax check socket by cutting, heating and peeling it off the mold.





Smooth the mold, especially the trim lines; they should be round enough to form a comfortable rolled edge on the plastic socket. Apply a parting agent to the mold for the plastic lamination.

Plastic Socket

Materials:

dacron felt

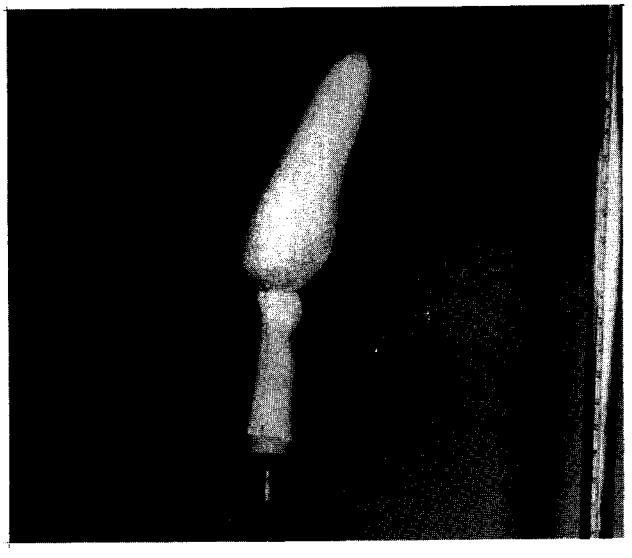
nylon stockinette (approximately 2 inches wide)

PVA and iron

polyester resin, catalyst, promoter and color pigment

masking tape

string



Flexible Hinge

Make a dacron bag and pull it over the mold. Sew across the end of the nylon stockinette and pull it over the mold. Make one layer of dacron and two layers of nylon stockinette. Now start the lamination.

Rigid Hinge

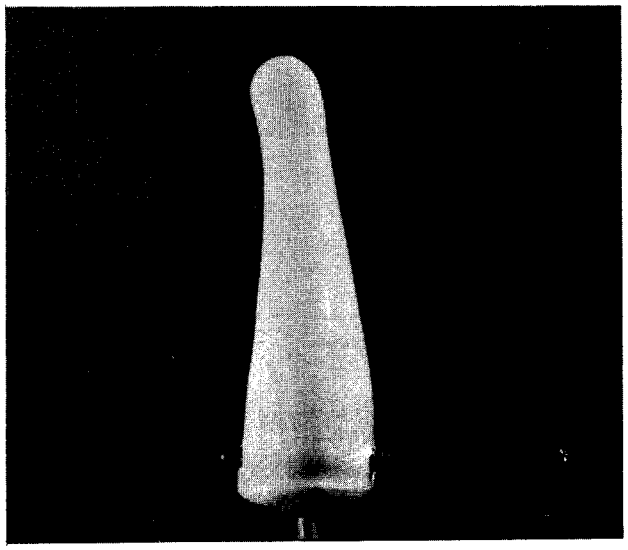
Materials in addition to above:

single pivot or polycentric hinge

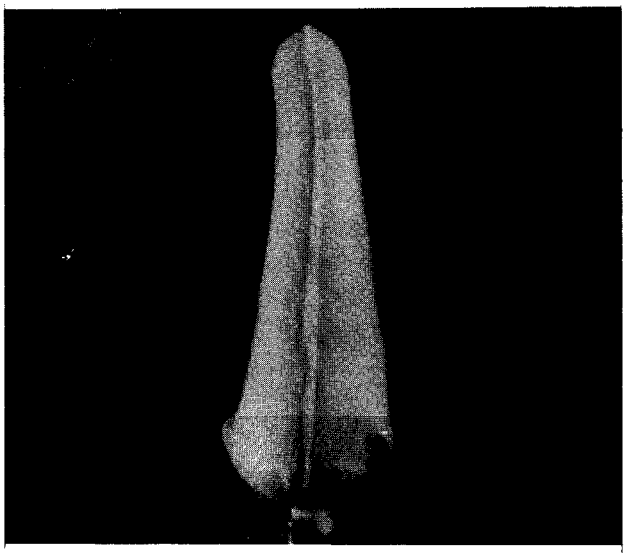
bending irons

lamination spacers

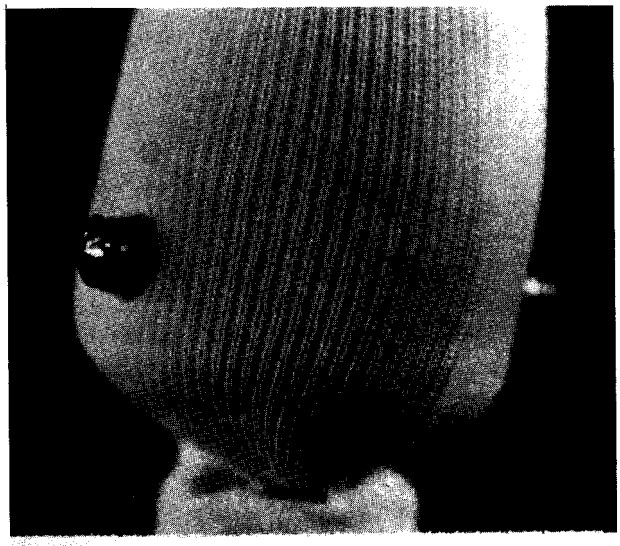
When the wax check socket is removed, the single steel spacer washers will project out of the model. This determines the thickness of the socket. If a heavy duty prosthesis is desired, add additional washers.



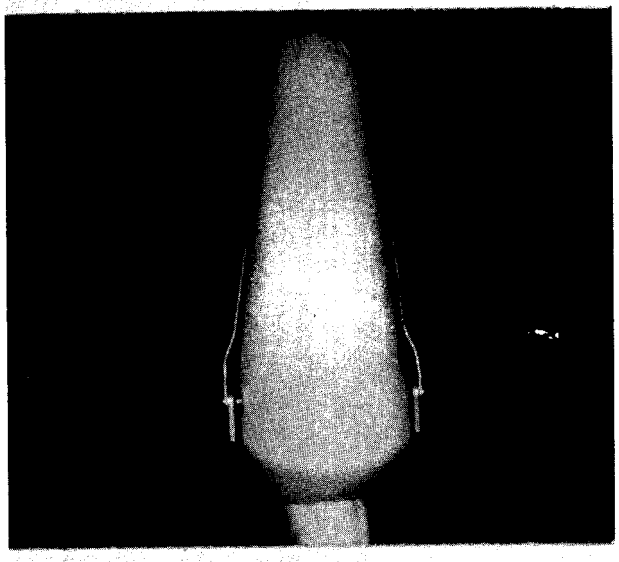
Apply one or two dacron layers and two layers of nylon stockinette on the lamination.



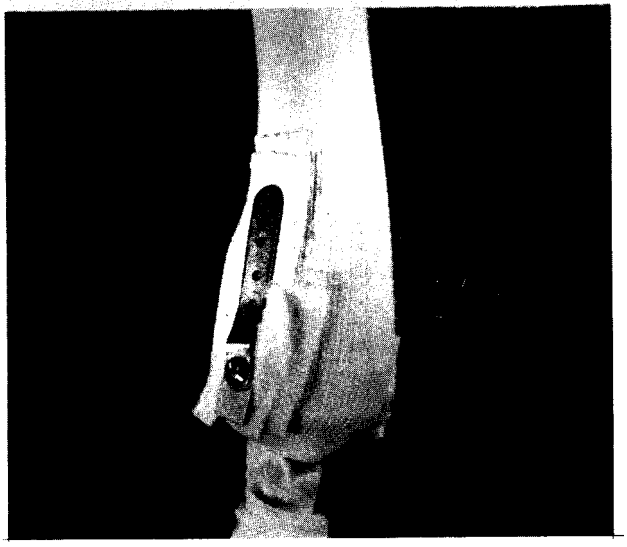
Cut small slits over each of the spacer heads as illustrated.



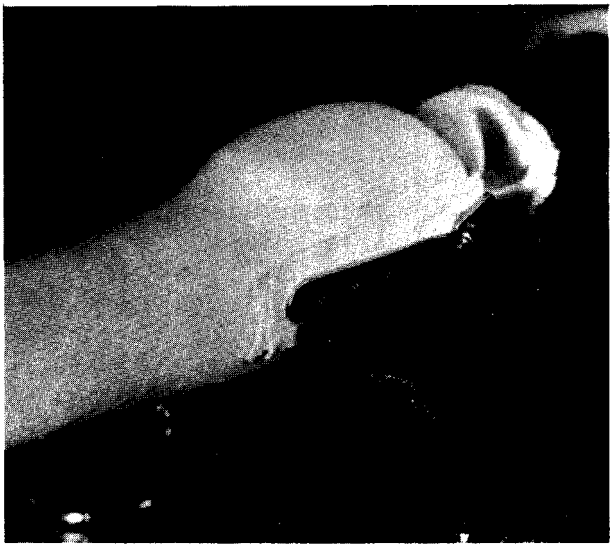
Assemble the joints to the model. First apply a lamination spacer (see manufacturers' instructions) over the steel spacer washer and then the lower joint straps. Bend the straps off the mold until they lie parallel to the axis of the stump with 1/8 to 3/16-inches of space under the straps. Do not tighten the straps against the model because the resin will not penetrate underneath.



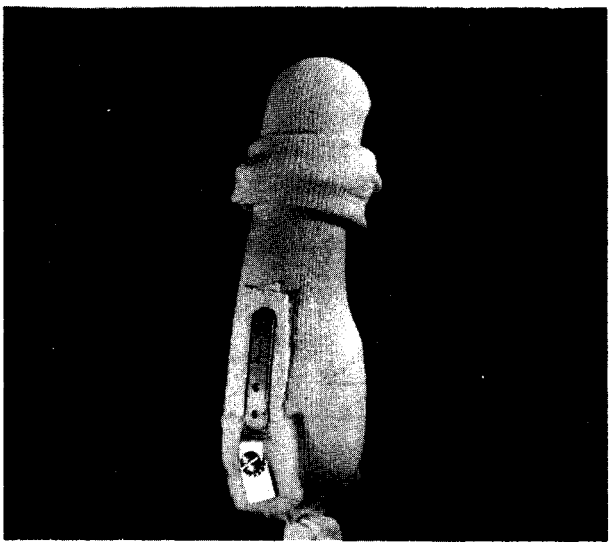
Fill the space between the stockinette and the straps with dacron felt.



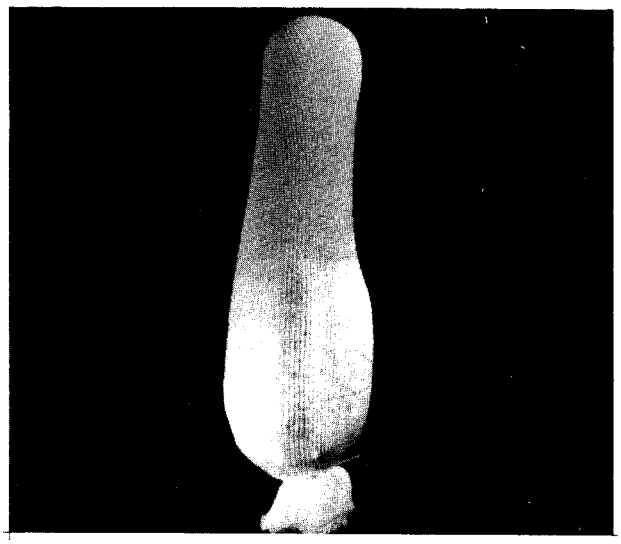
Align the straps parallel to the ulna or the posterior aspect of the model. This will preflex the joints 15°. If more flexion between the upper arm cuff and the socket is needed, move the end of the stump model upwards from the strap until the additional degrees are obtained. A simple way to check the alignment is illustrated: when both joints rest on the vice jaws the joints are parallel. Tighten the holding screws.

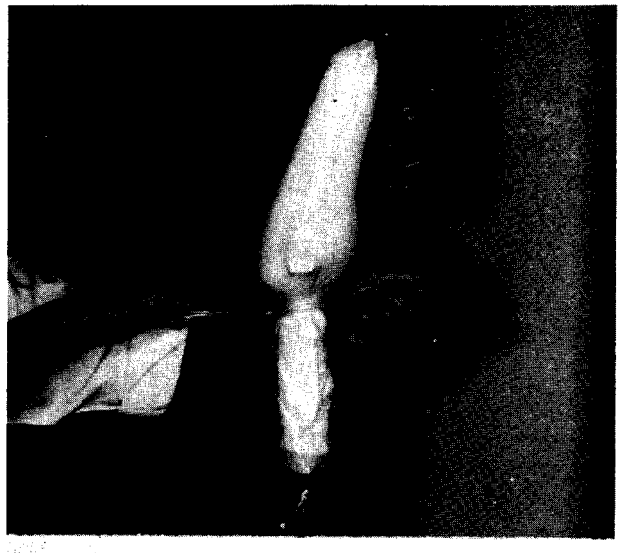


The lamination washers project proximally on a 15° angle to the lower strap. Put two layers of nylon stockinette over the straps so that they will be imbedded in the plastic socket.



Tie the stockinette at the bottom with string.





Make a PVA bag to fit over the mold (see Chapter IV, Materials). Dampen it and pull it down tightly until all wrinkles have disappeared. Tie the bag to the mandrel.

Mix polyester resin with its promoter, catalyst and color pigment (see page). Pour the resin into the top of the PVA bag and work it into the sotck-inette. Tie off the top of the bag to remove excess resin.

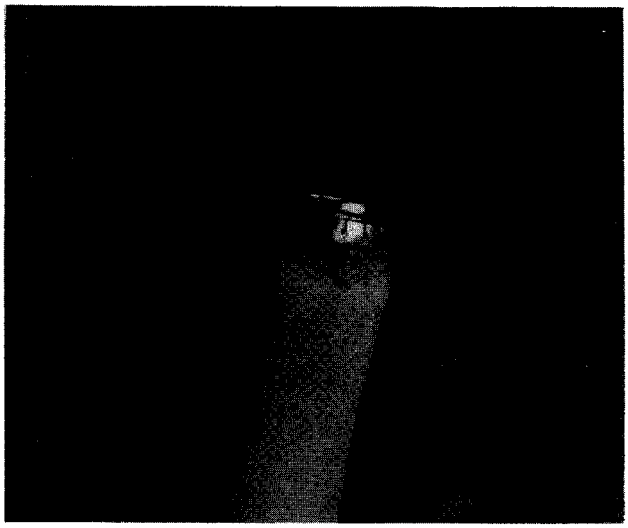
FOREARM EXTENSION

Flexible and Rigid Hinge Prostheses

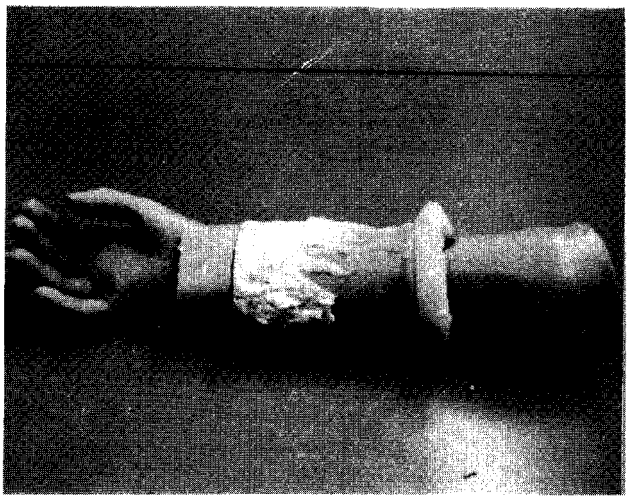
To establish the length of the below elbow prosthesis, a filler between the end of the stump and the wrist unit must be provided. This is the holding receptacle for the terminal device. If the amputation is unilateral, the overall length including the terminal device equals the length of the elbow to the thumb tip on the sound arm. This is standard procedure but variations do occur, such as congenital anomalies, or special occupational requirements. If the fitting is for a bilateral patient, consult the anthropometrical chart on page .

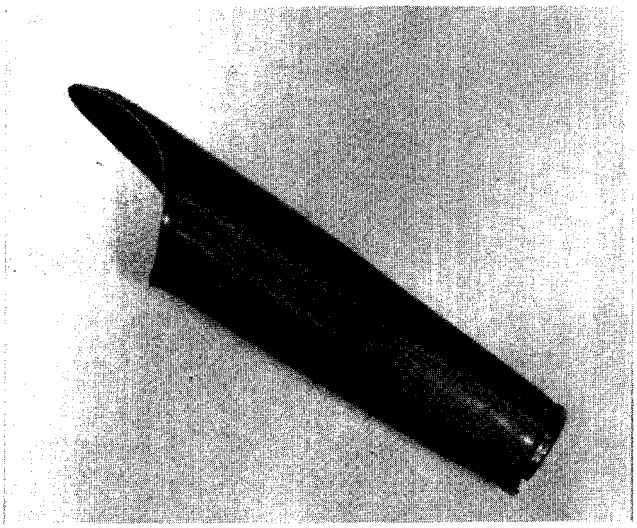
Materials used to form the extension vary according to stump length and the nature of the prosthesis, exoskeletal or endoskeletal,

Wrist Disarticulation: the extension is minimal and therefore exoskeletal.



Short Below Elbow: the extension can be either exoskeletal or endoskeletal as shown.





Alignment: Standard practice is to make the forearm straight, similar to the normal forearm. Certain advantages can be gained by preflexing the forearm and canting the wrist unit. Canting is described as an alternate method in the following steps. Preflexion is described in detail for the Muenster prosthesis in this chapter.

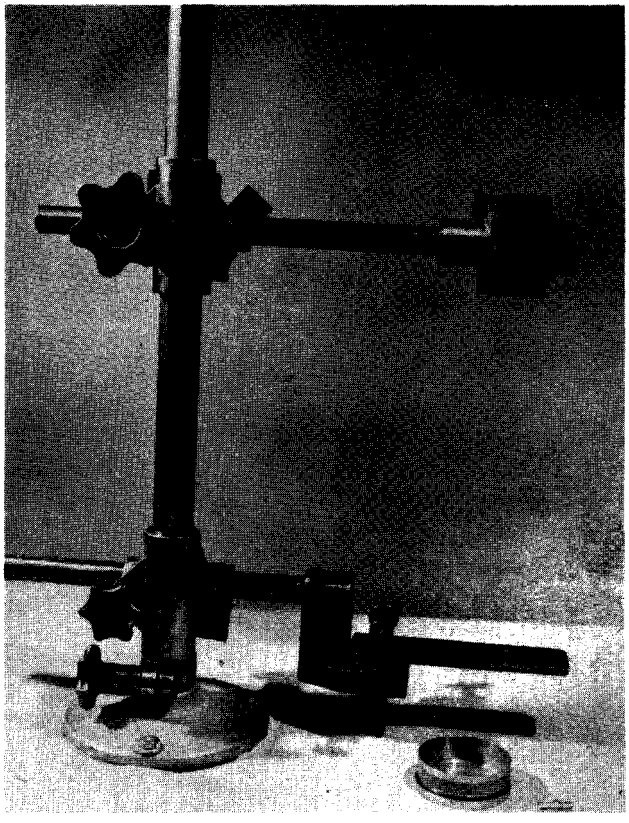
Forearm Extension Alignment

To determine the length of the forearm, take the lateral epicondyle to thumb tip measurement from the prosthetic information form. (The olecranon to thumb tip measurement may also be used.) From this measurement subtract the length of the terminal device to be used. (If the prescription calls for more than one terminal device, use the length of the longest device.) This remaining amount will be the length of the forearm.

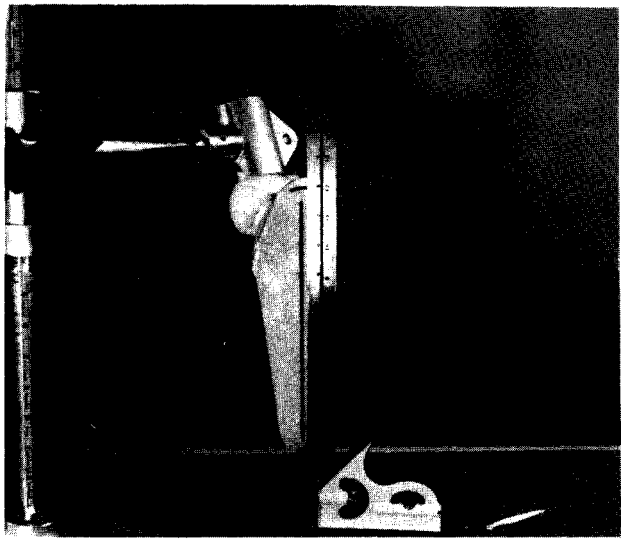
Draw a line on the posterior socket. For a flexible hinge prosthesis, make the line parallel to the long shaft of the ulna. For a rigid hinge prosthesis, draw the line perpendicular to the joint spacer.

Place the socket in a holding device. In the picture below, an alignment jig is used. Any suitable holding fixture may be used.

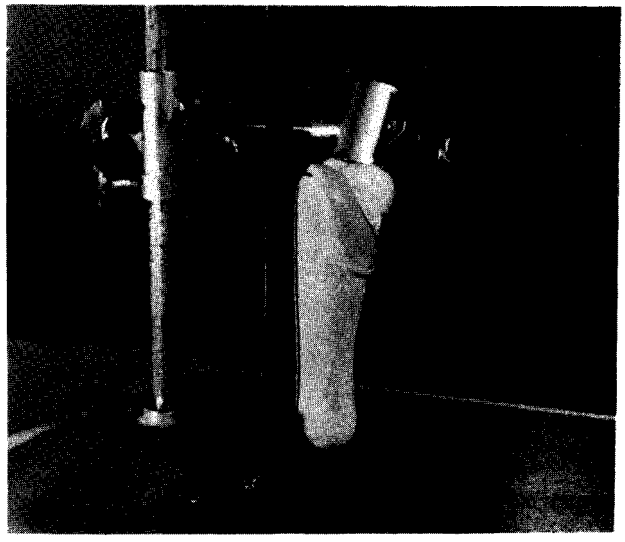
Adjust the holding device to the length of the forearm determined above. Measure from the flat level surface up to the mark (olecranon, epicondyle or the joint spacer, whichever method is being used).



No canting of the terminal device: Position the socket so that the long axis is perpendicular to a flat level surface. Use the reference line drawn on the socket.



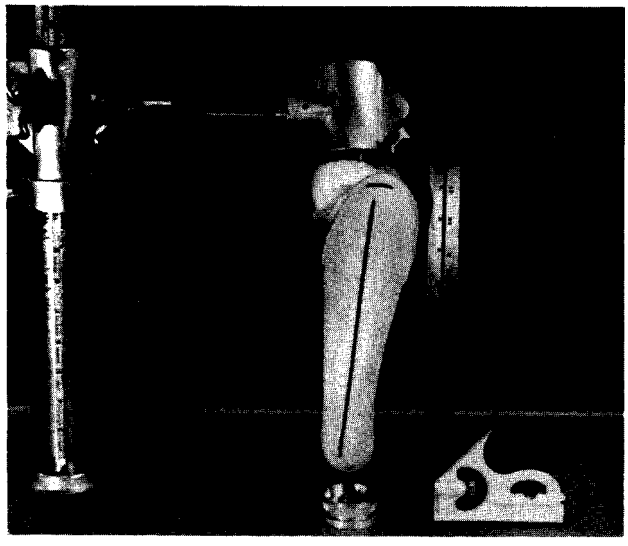
viewed from the posterior



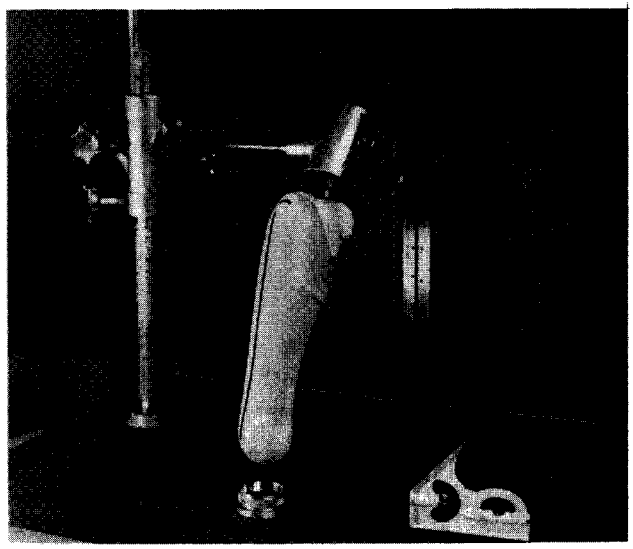
viewed from the side

Canting the wrist unit: From the prosthetic information form determine to what degree and direction the terminal device will be prepositioned from the long axis of the stump. Using the reference line as a guide, align the socket as follows:

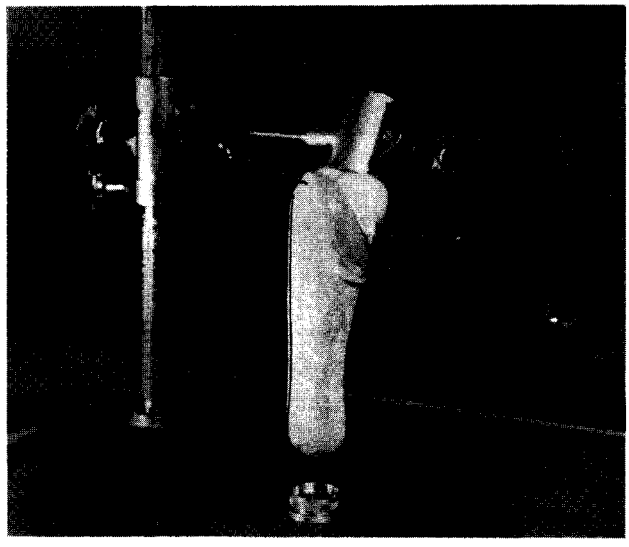
Viewed from the posterior position. To bring the terminal device inward toward the body (ulnar flexion), tilt the socket so that it leans toward the body at the proximal end. A left arm prosthesis is illustrated. The direction is opposite for a right arm prosthesis.



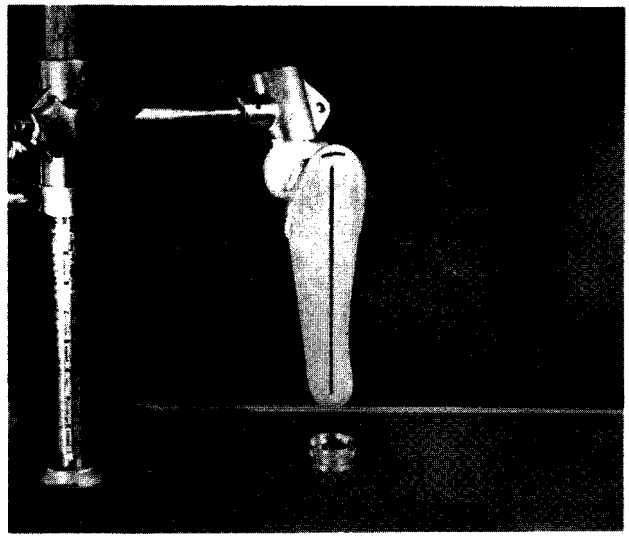
Viewed from the side (medial or lateral) . To bring the terminal device inward and upward, in addition to the step above, position the long axis so that it appears to lean toward the anterior at the proximal end of the socket. Recheck both angles with a protractor. It is important that they are correct; an error here could ruin the prosthesis. Secure the holding device so that it will not move.



Center the wrist unit under the long axis of the stump as illustrated and scribe the position.

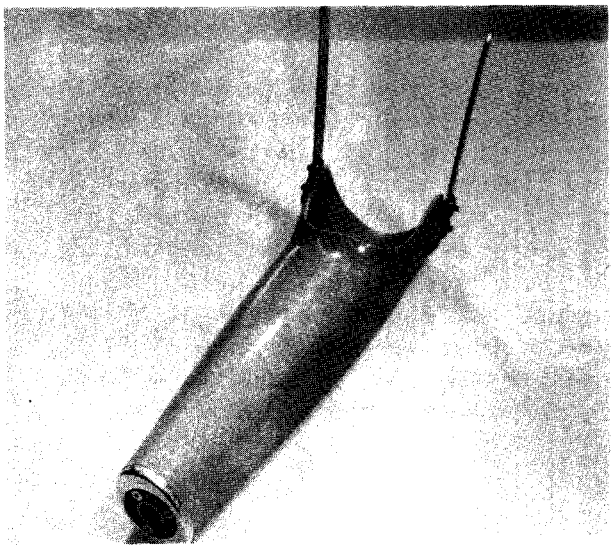


viewed from the side

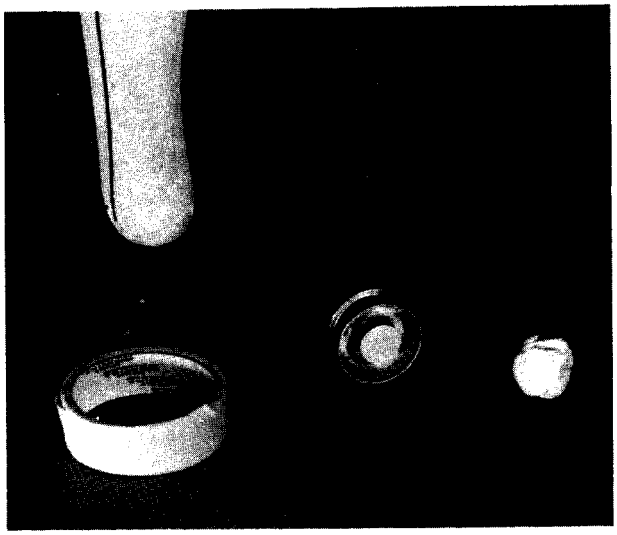


viewed from the posterior

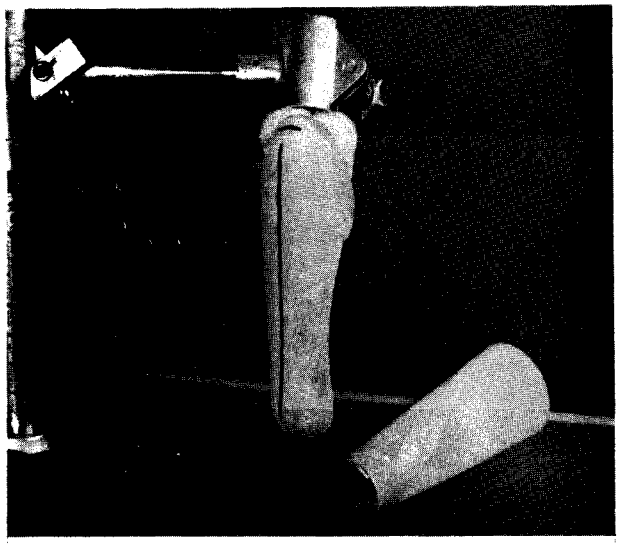
If an oval wrist unit is to be used, rotate it internally until it appears to hang at a natural angle (about 20°). A wrist unit at this angle also makes it easier for the amputee to work on a flat wurface with a terminal device.



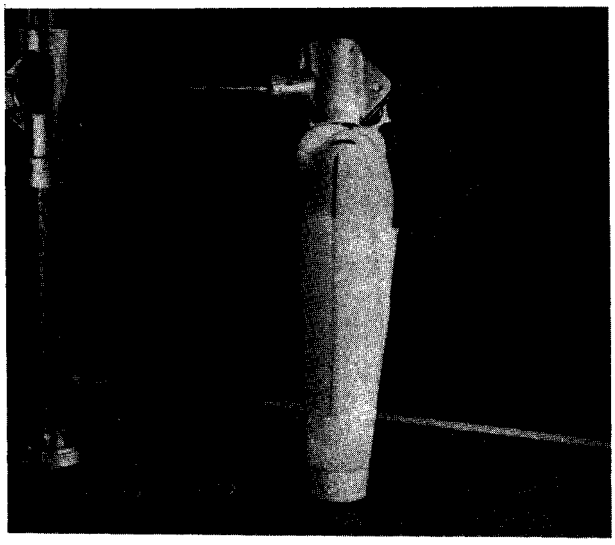
Mask the threaded hole and seal the vital parts with clay or playdough. Cover the knurled portion with masking tape to keep it clean for subsequent laminating.



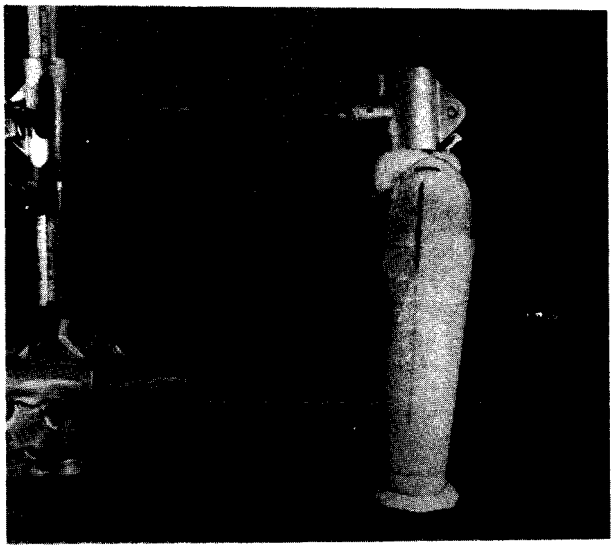
Make a cone for the forearm extension (see Chapter IV, Materials). Attach it securely to the wrist unit. In the illustration, polyurethane is used.



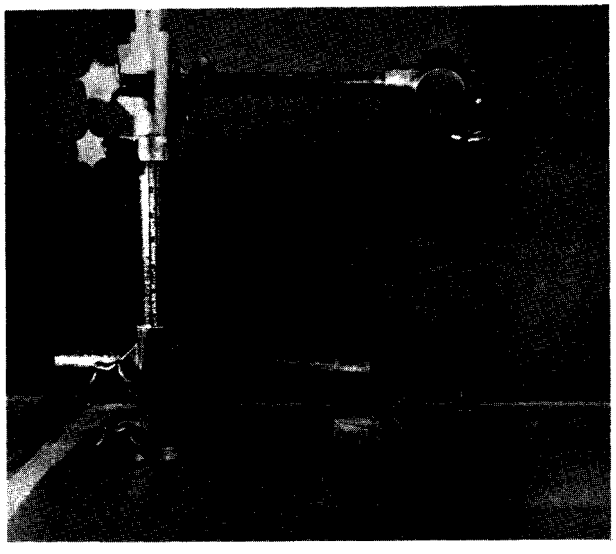
Temporarily replace the wrist unit and cone into the scribed position previously marked. Adjust it for size and length desired in the buildup.



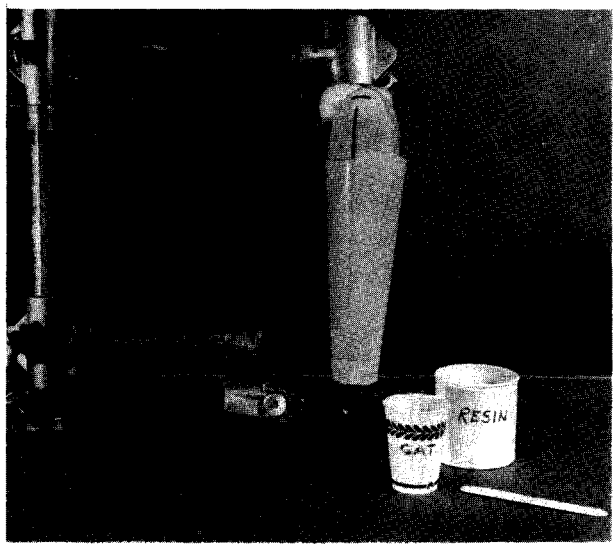
Fasten the wrist unit and cone so that it will not move. Clay is satisfactory if additional support is provided during the foaming action.



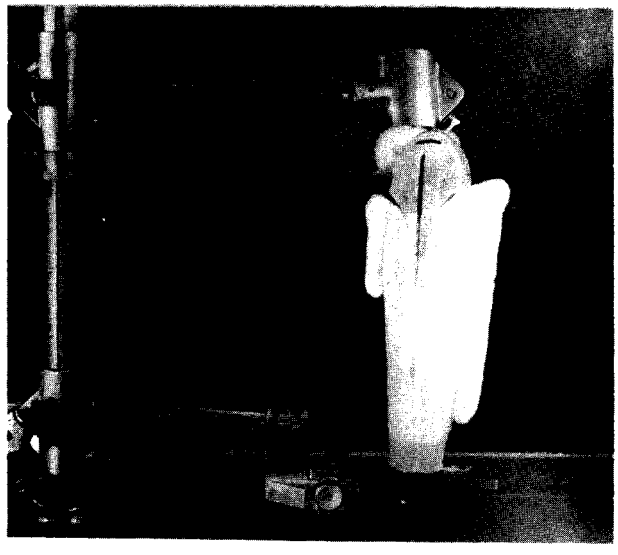
An elaborate holding device is illustrated.



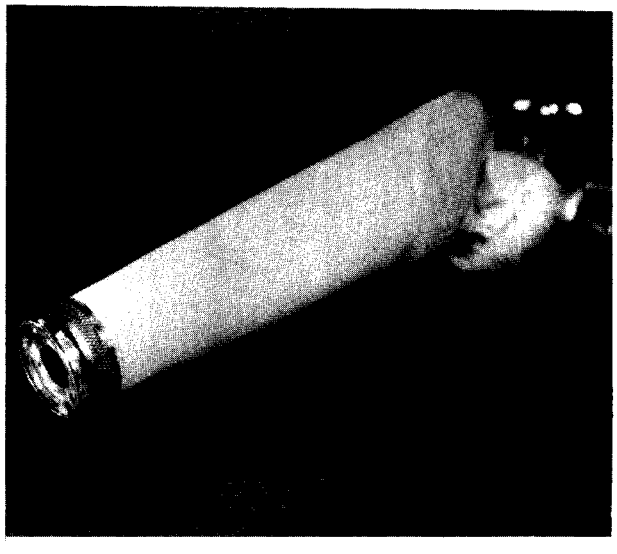
Prepare the foaming mixture (see Chapter IV, Materials) and pour it into the cone. Observe all safety precautions when working with polyurethane (see Chapter IV, Materials).



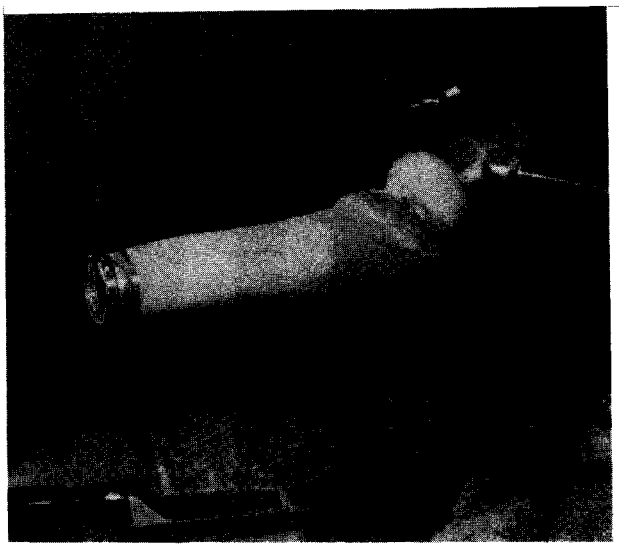
Use more material than necessary for the buildups. Ample material is needed for shaping.



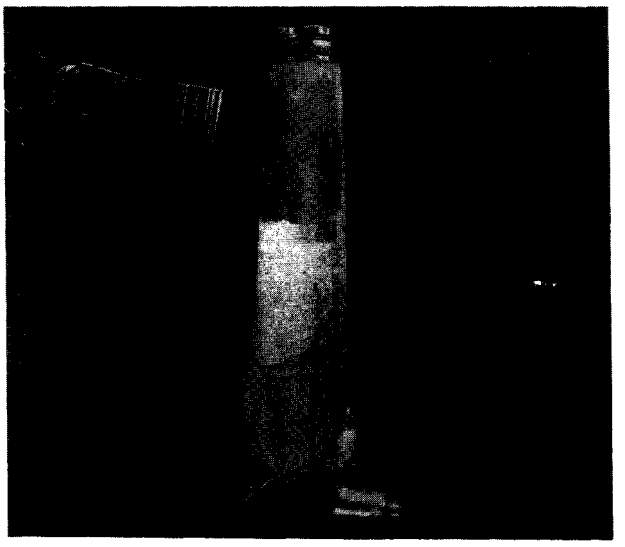
Remove the cone from the buildup. It should appear smooth and contain ample material for shaping.



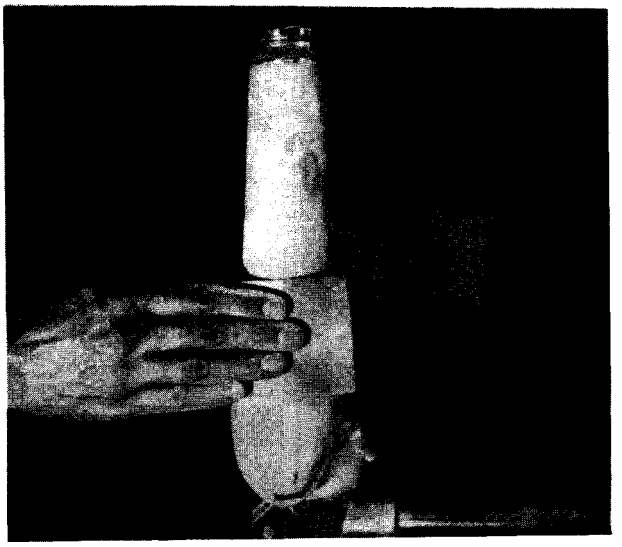
Shape and contour the foam to match the sound side as much as possible; the wrist unit will limit this somewhat. Be sure to remove all foam at the proximal trim line of the socket.



Paint all of the model except the wrist unit with mixed polyester resin. This will seal the foam and eliminate air bubbles during lamination.

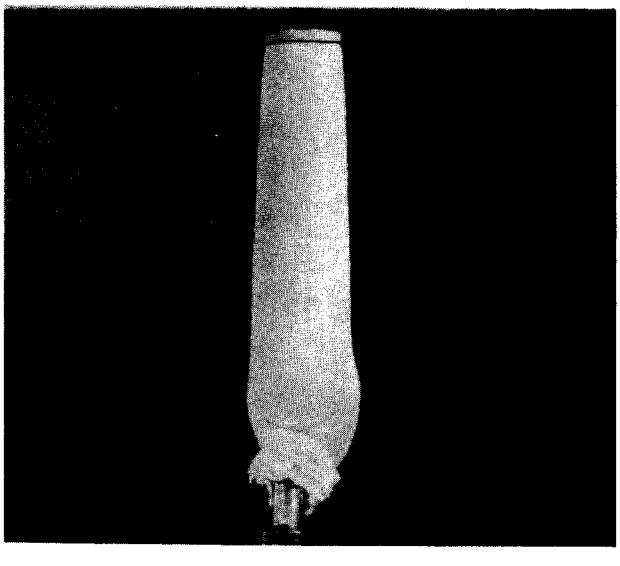


Sand the model until it is smooth; the final lamination will then bond.

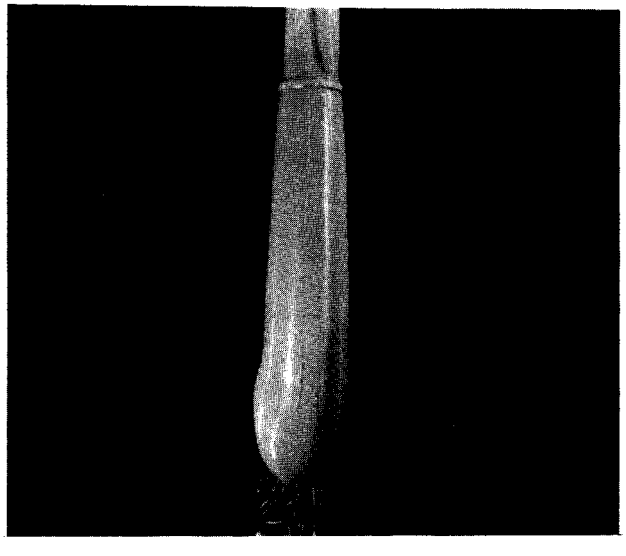


Mask off the end of the wrist unit.

Final Lamination: Make a layup of two layers of nylon stockinette. Double one piece of stockinette back over the model and tie it at the groove in the wrist unit. For a heavy duty prosthesis add more layers of stockinette.



Make a PVA bag, mix the resin, and laminate the model.



Fitting and Harnessing

Materials:

rubber mallet

sander

terminal device

pattern of triceps pad or arm cuff

polyethylene or flexible polyester plastic

flexible hinges

rigid hinges

cable and large cable housing and liner

diagonal shears

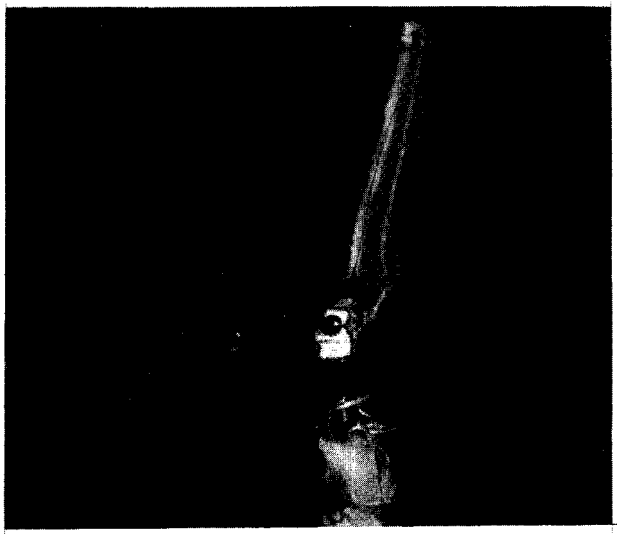
swivel terminal

retainer

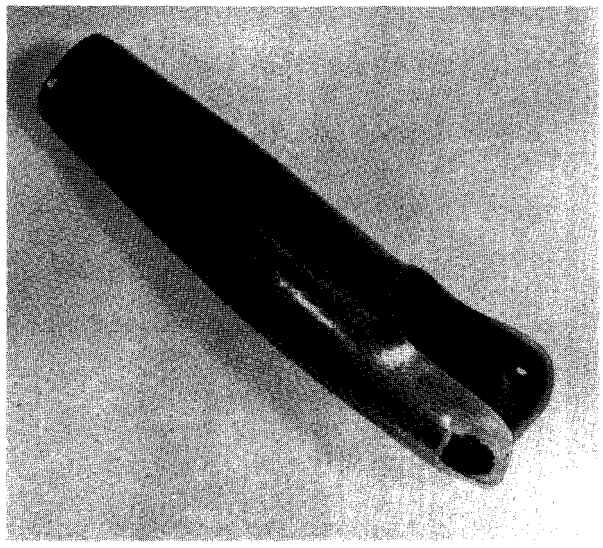
swaging tool or soldering kit

adjustable hanger and allen key

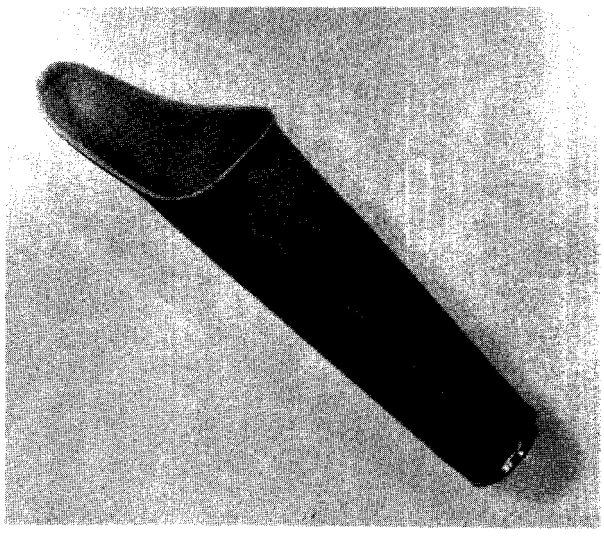
For rigid hinges only, uncover the joint portion of the lower strap and trim the plastic to remove the laminating spacer. Use a heat gun to soften the plastic.



After the final lamination has set and cured, break out the mold and trim the socket to the lines made from the wax check socket. The edges should be rounded, and the inside very smooth. For the rigid hinge prosthesis, remove the elbow joint spacer from the socket by loosening the joint spacer nuts and pulling out the spacer assembly.



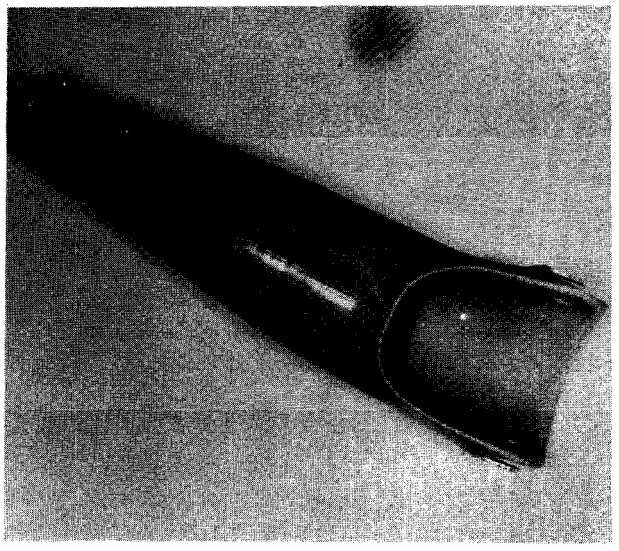
Typical trims for the rigid and flexible hinge prosthesis are illustrated. For more detail, see page .



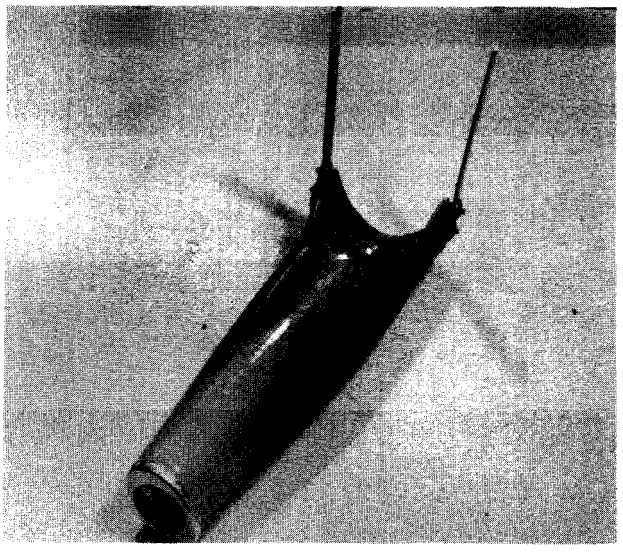
Prepare the flexible hinges (see page , Chapter IV, Materials). The patient with a flexible hinge prosthesis is now ready for fitting and harnessing. Turn to page

For a rigid hinge prosthesis, proceed to the next page.

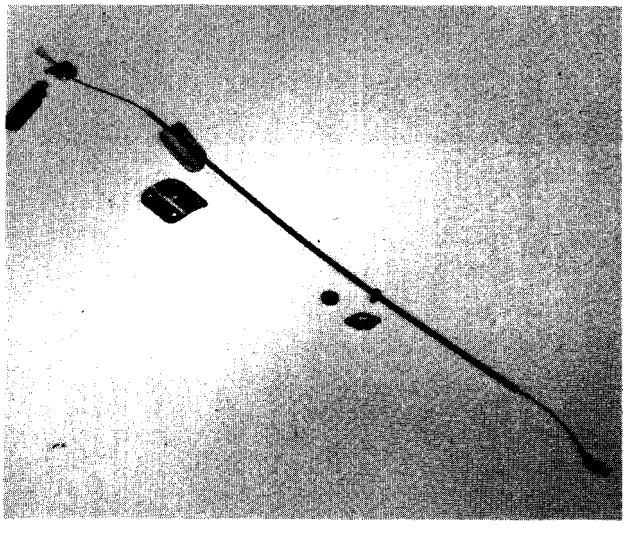
Remove al 1 excess resin that may have adhered to the joint surface. Sufficient clearance should exist between the joint head and the socket so that the upper joint strap will not bind. Clean and lubricate the wrist unit.



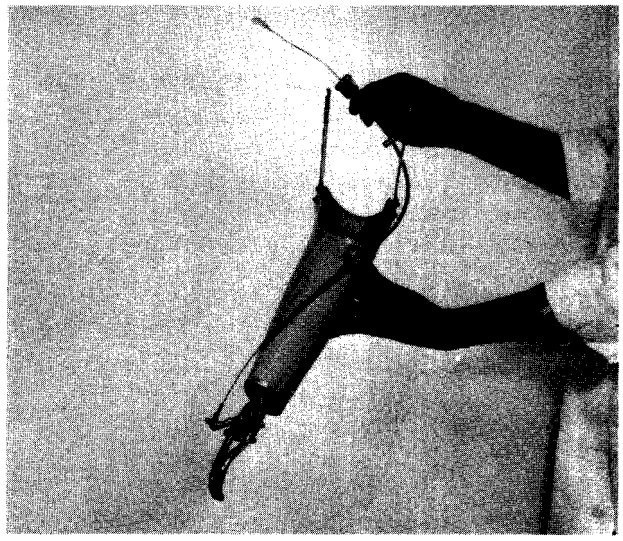
Assemble the joints and wrist unit. They should move freely without binding.



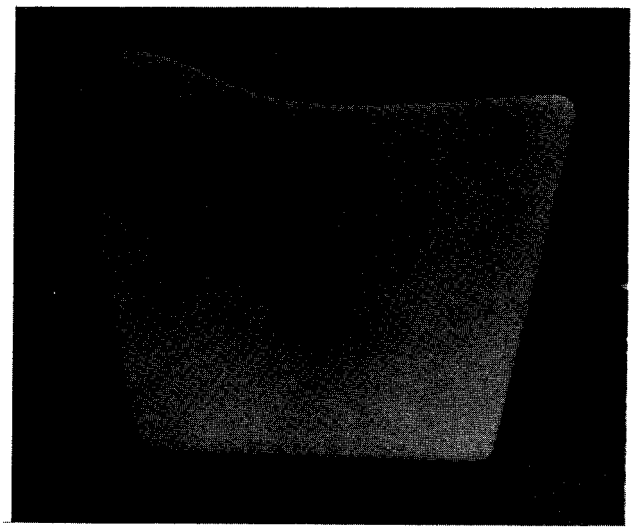
Prepare the control system assembly..

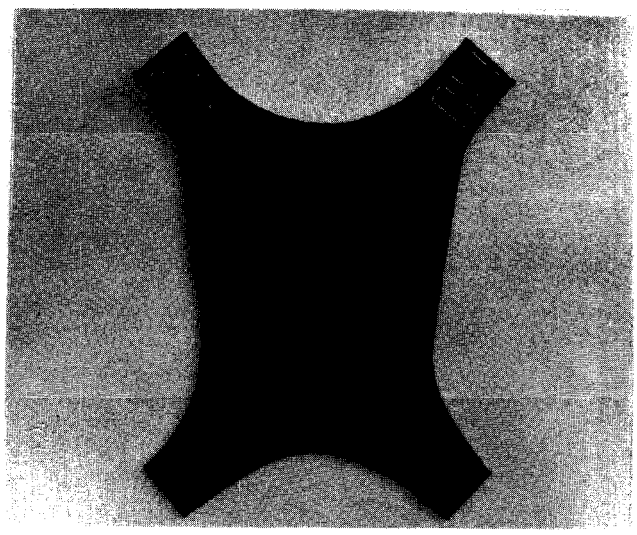


Attach the terminal device and the cable assembly forearm base plate. (An APRL hook requires an extra base plate on the posterior forearm.)

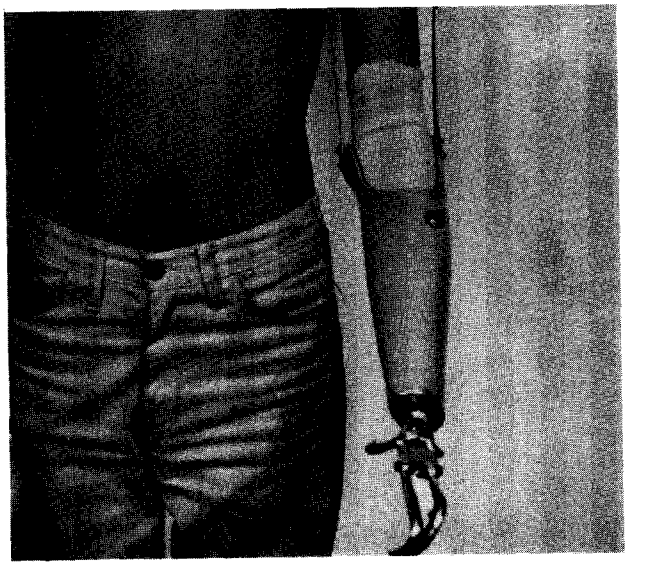


Make the upper arm cuff from the pattern that was drawn when the prosthetic information was obtained (see page , Chapter IV, Materials).

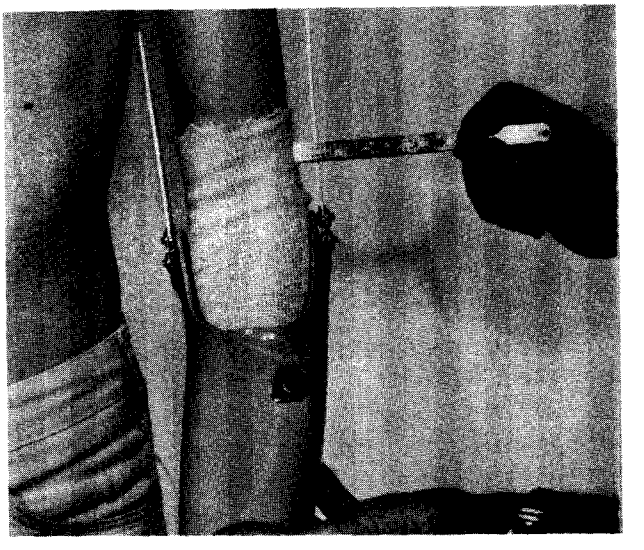




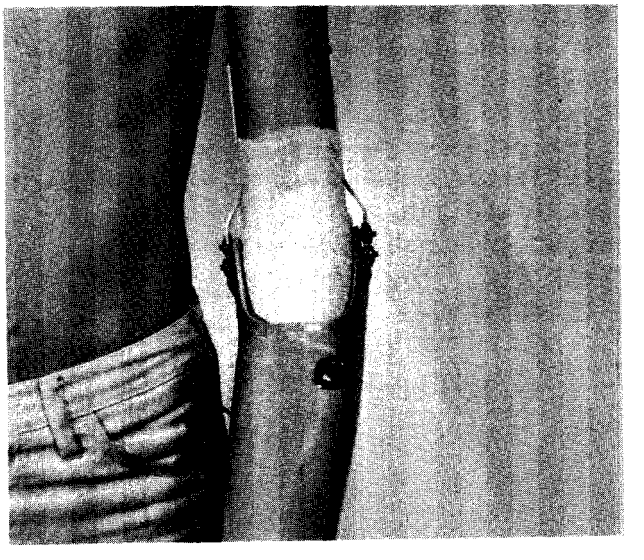
Apply the prosthesis using stump socks, if any. If the check or trial fitting socket technique is used, the prosthetic socket should be a perfect fit. There is no need to trim or carve the socket.



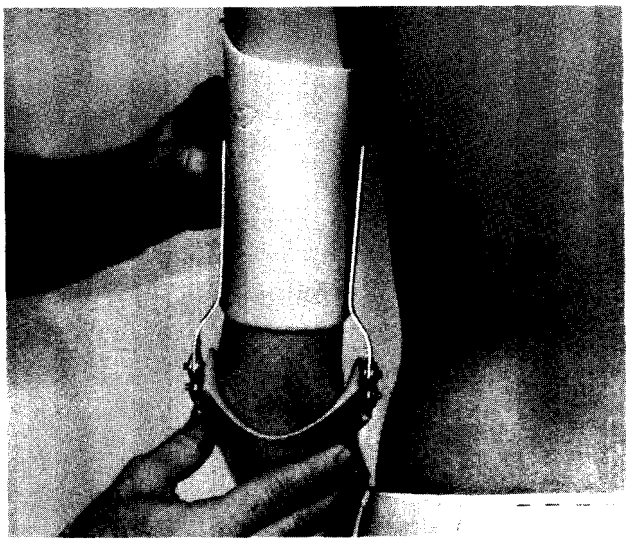
Observe the relation of the straps to the upper arm. They should lie evenly along the skin. In some cases no bending is necessary. If space does exist, measure the distance of the straps from the upper arm. Make sure the socket is properly oriented on the stump.



Bend the straps. If sharp bends or considerable offset are needed, remove the upper straps from the prosthesis while shaping the straps.



Locate the half cuff at the lowest possible point on the humerus. Leave enough room between the distal edge of the cuff and the posterior socket brim so that the tissues will not be pinched at full extension.



Adjust for even pressure against the posterior aspect of the arm. Fold the cuff and the top end of the upper bar, and ask the patient to flex and extend his elbow joint. Note the movement of the bar in relation to the lower edge of the cuff in the anterior-posterior plane. Adjustment can also be made by temporarily attaching the top of the bars to the cuff. If relatively little exists, scribe along the bars. If motion of the bars does not exceed 1/4-inch, mark the center of the two extremes of motion. Drill holes in the upper straps and rivet the cuff to the straps. If the motion exceeds 1/4-inch, investigate the socket fit. The probable cause is the anterior brim.