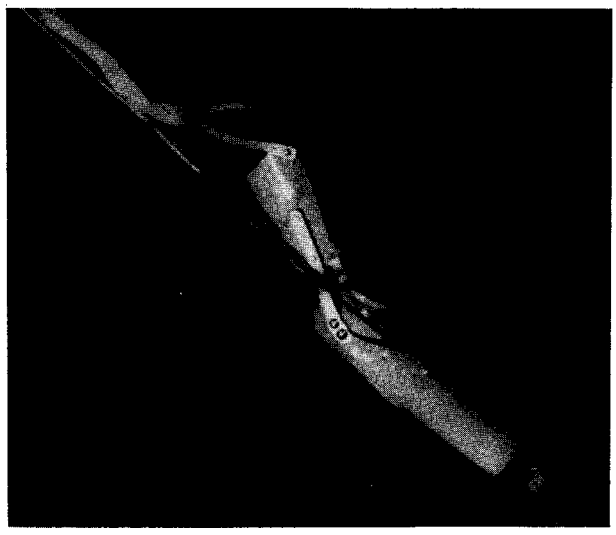
SHORT BELOW ELBOW PROSTHESIS

Two types of prostheses are used for fitting the short below elbow amputee, the step-up hinge and the Muenster. In the step-up hinge prosthesis, the socket and forearm are separated and multiple action hinges are used. In the Muenster prosthesis, the forearm and socket are integral and no elbow hinges are used. Instructions for the Muenster technique will be found on page

STEP-UP HINGE PROSTHESIS

The socket and forearm extension are separate as shown. The prosthesis generally weights about 1-3/4 pounds.



Wrap Cast

Materials:

cotton stockinette or tube guaze

casting sock

scissors

elastic webbing (approximately 1 inch wide)

Yates clamps

bucket of water

bucket of water

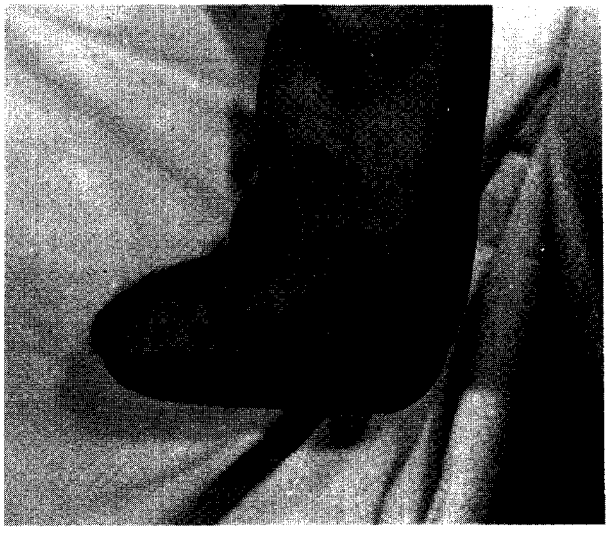
regular plaster bandage (2 to 3 inches wide)

inside calipers

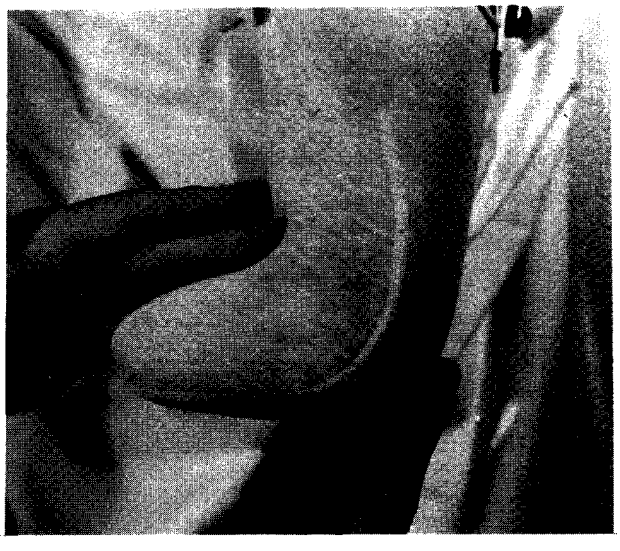
straight edge ruler

parting agent for cast

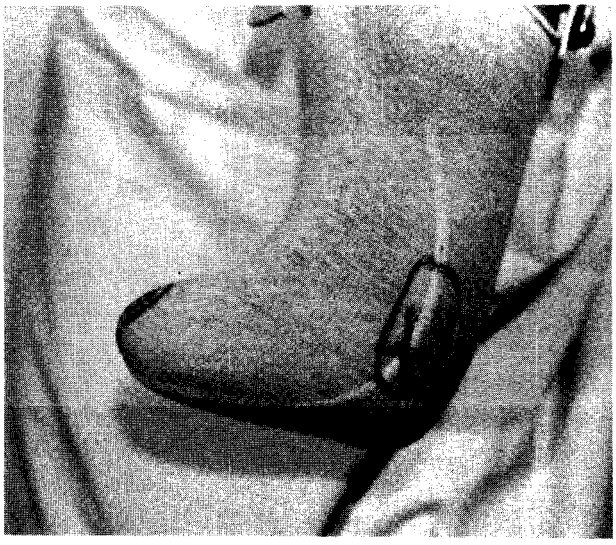
A short below elbow stump is illustrated. Note the pointed distal end and the excess tissue at the cubital fold. This patient? elbow is fully flexed at 90° because of a bony block in the joint . This is almost a classic example of a stump for step-up hinge prosthesis. The socket for the step-up hinge prosthesis cups over the olecranon and fits snugly into the cubital fold for purchase on the stump._, The socket covers the epicondyles in order that the rigid elbow hinges can be installed. The wrap cast should extend slightly past these expected trim lines.



To take the cast, sew across the end of the 2 inch wide cotton stockinette. Wet it and pull it over the stump past the elbow. Suspend it tightly with an elastic strap. A casting sock may also be used.



Mark for reliefs any bony prominences (e.g., olecranon, epicondyles and the end of the stump) and sensitive areas. lf the stump is thin, outline the humeral condyles.



Mark the proximal trim line, including the cubital fold anterior, all the humeral condyles, and approximately 1-1/2 - 2 inches over the posterior aspect of the arm.

Tell the patient about the casting and molding process and his part in it. Emphasize the importance of the molding process in the construction of a prosthesis for a short stump.

The elbow should be held at 90° flexion during the entire casting and molding procedure.

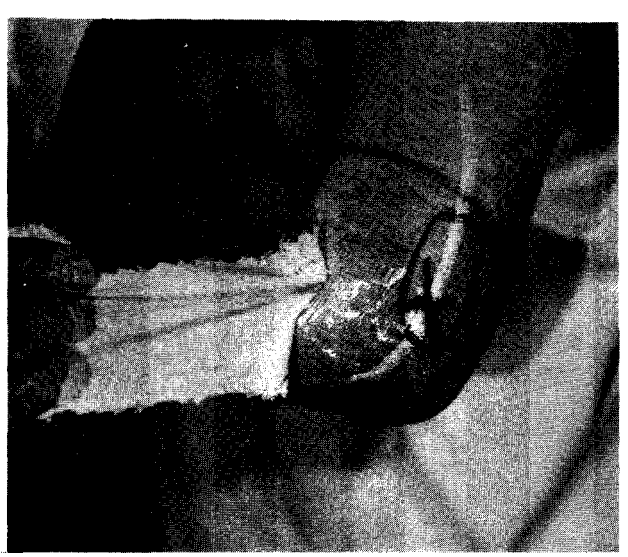
Demonstrate the molding procedure. If the amputation is on the left arm, position the stump in the palm of the right. hand. The fingers should be extended and the thumb curled gently around the proximal olecranon. Ask the amputee to press his stump lightly into the flat palm with the force coming from the shoulder, not by extension of the elbow.

Place three fingers of the left hand over the anterior proximal aspect of the stump and press lightly to flatten the model. The index finger should be in the cubital fold and against the biceps tendon. Keep the fingers extended as illustrated.

Avoid excessive tissue displacement. Practice this until the patient understands what is to be done.

If the amputation is on the right arm, reverse the hands.

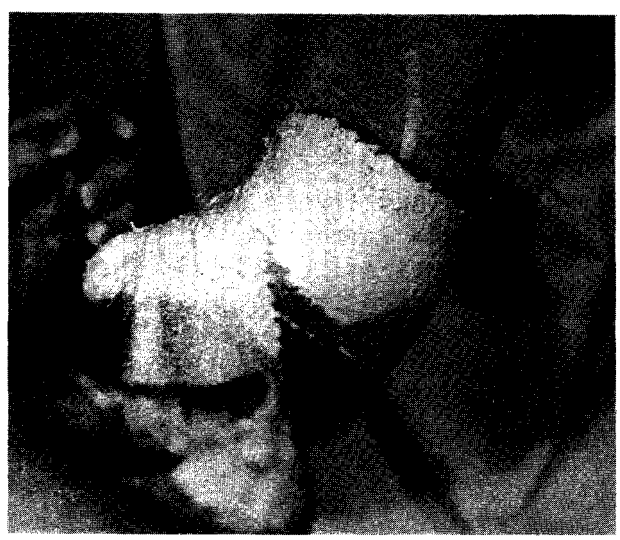
Wrap Cast: With 2 - 3 inch wide plaster of Paris bandage, double reverse the wrap from the medial to the lateral, covering the end of the stump,



Secure the reverses with a spiral wrap. Lay the plaster on. Do not pull it tightly.

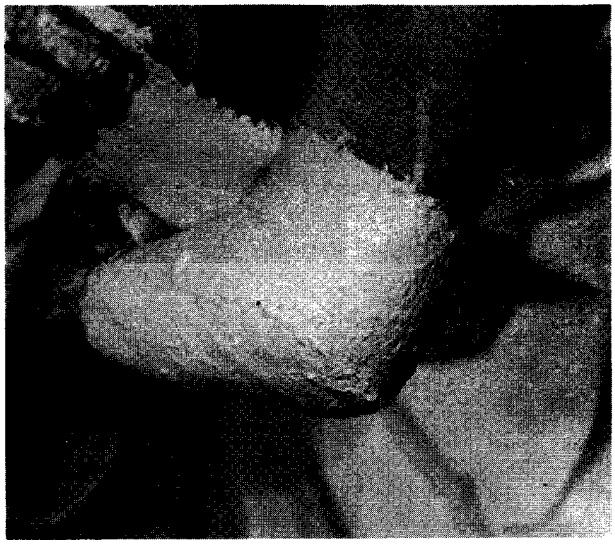
Continue to wrap proximally with spiral oblique wraps.

Wrap to the proximal trim line. Use figure of eights over the elbow area. Keep the plaster roll against the stump. The demonstration at right is for illustrative purposes only.



Spiral the wraps obliquely toward the distal end. On conical stumps use tucks in the wraps as illustrated. Fold and smooth the tucks against the wrap.

Wrap the bandage toward the proximal line again. Pull the wraps more tightly. Wrap the proximal edge with approximately four layers.

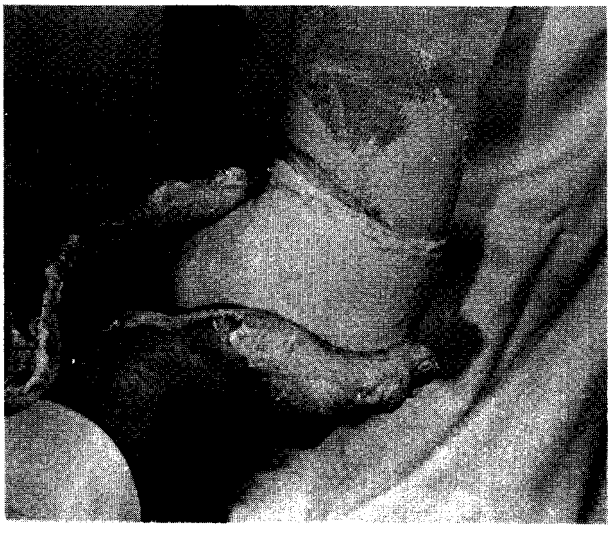


If the stump has distal complications or an accurate impression of the distal end is desired, finish the cast by wrapping the bandage around the end and the olecranon. Pull the plaster wrap firmly but do not distort the distal tissues.

Begin the molding process by massaging and working the cast from the distal to the proximal end. Do not rub the cast back and forth because ruffles will appear.

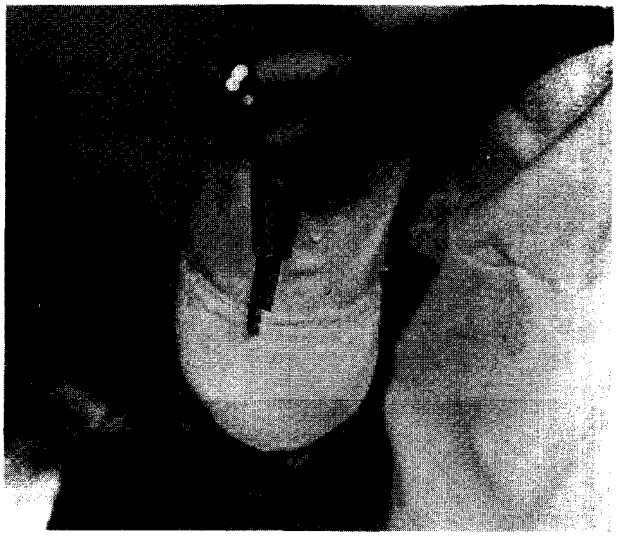
As the plaster firms, work the cast until it closely fits over the shaft of the ulna and the cubital fold against the biceps tendon. The biceps tendon should be relaxed.

Shape the cast until it closely fits over the proximal ulna and the olecranon.



Before the cast hardens and is still malleable, repeat the molding process demonstrated on the patient before the wrap was applied (described on page). Hold the position until the plaster sets.

After the wrap hardens, remove the cast by carefully pulling the skin away from the proximal brim of the cast to break the suction. Now gently pull the cast off the stump. If necessary, have the patient flex his elbow a little more. If the cast is difficult to remove,, cut the posterior as illustrated until it can come off.



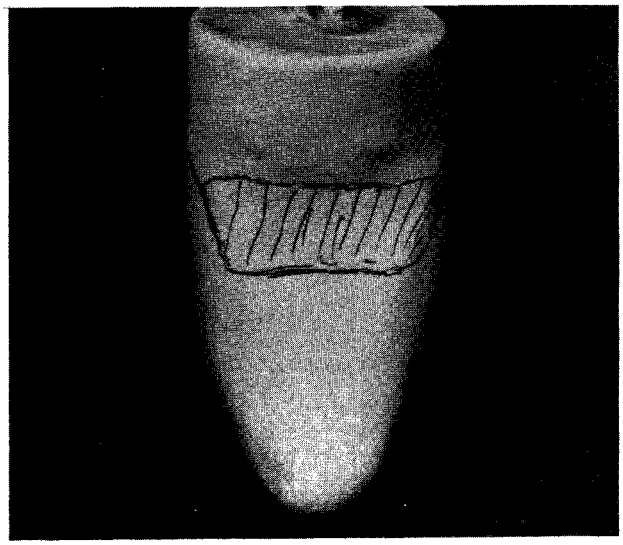
Inspect the isnide of the cast for wrinkles, bulges or indentations that would render it unsatisfactory.

If the cast appears to be satisfactory, apply a parting agent on the inside for making the model. If the amputee plans to wear a stump sock, remove the stockinette from the cast. Fill the wrap cast with plaster of Paris and insert a mandrel. After the plaster has hardened, peel the wrap off the model.

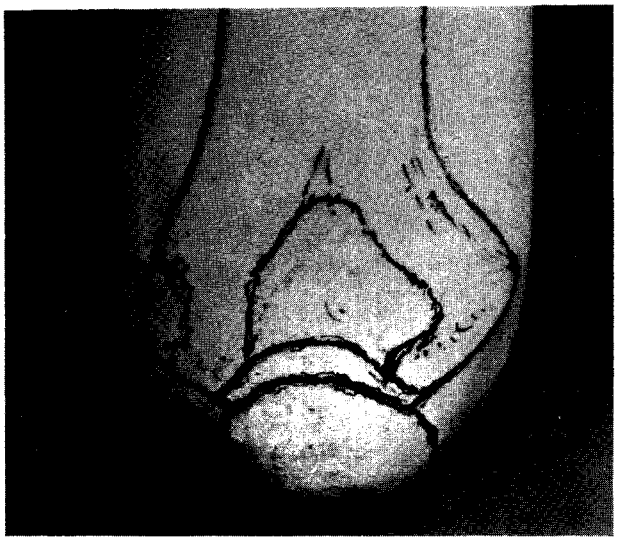
If a check socket of firm material is used (Warco 180) a series of buildups should be made on the model for relief.

The following steps are outlined for average or thin stumps. The steps are not necessary for obese stumps.

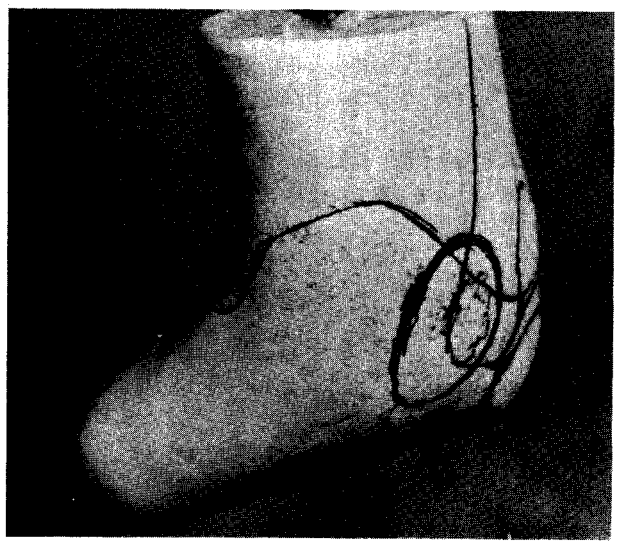
For illustrative purposes a plaster of Paris extensionhas been added to the model to represent a part of the upper arm. The skeletal anatomy has also been outlined.



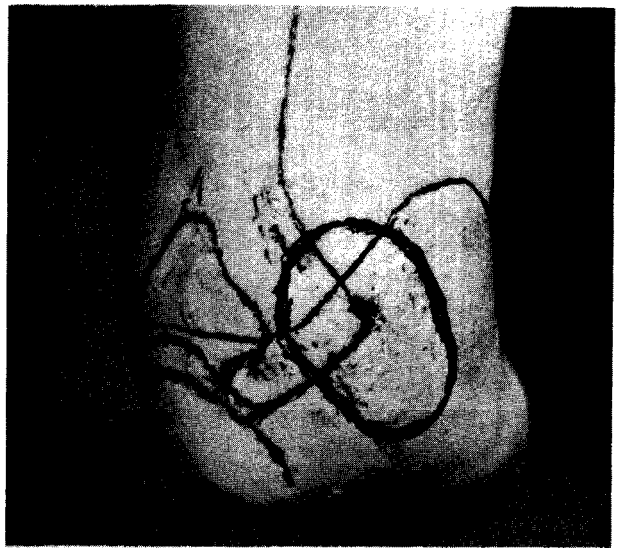
The bony anatomy sketched on the model shows the posterior humeral condyles and the olecranon. To establish the anterior brim line, consult the prosthetic information form for the measurement of the end of the stump to the cubital fold. As the casting technique tends to depress the cubital fold which increases the apparent length of the stump, outline the trim line at the correct distance.



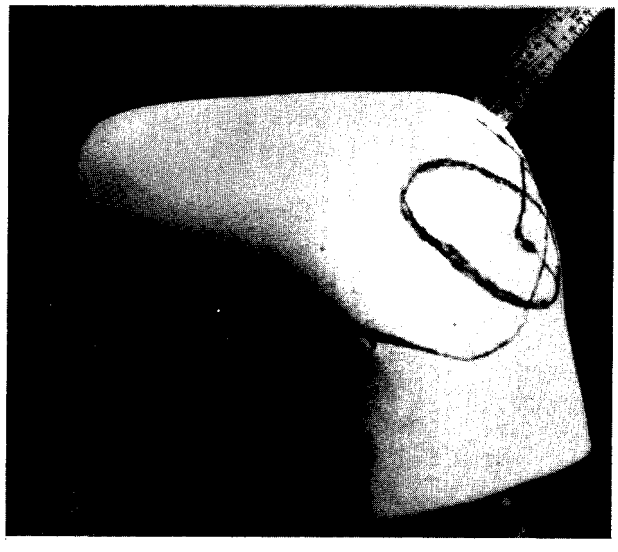
The lateral trim line can be easily established after the relief area is outlined. Note that the outline is oval. From the epicondyle mark toward the posterior and over the humeral condyle flare.



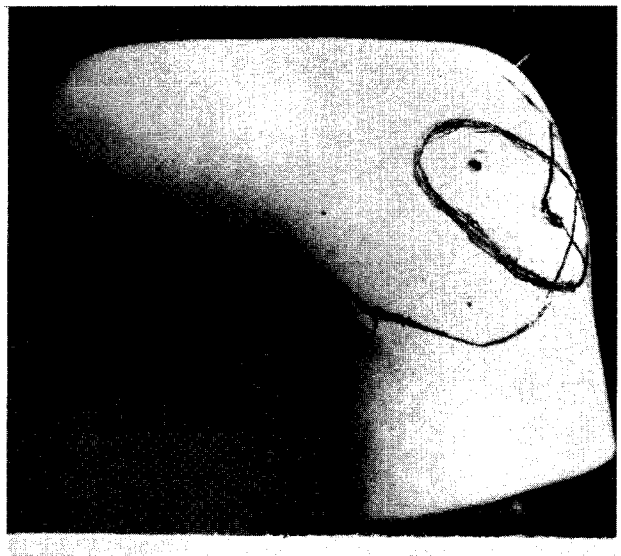
Repeat this procedure over the medial aspect of the model. The angle of the outline is oblique because when the elbow is extended, the flares of the humeral condyles move to this area.



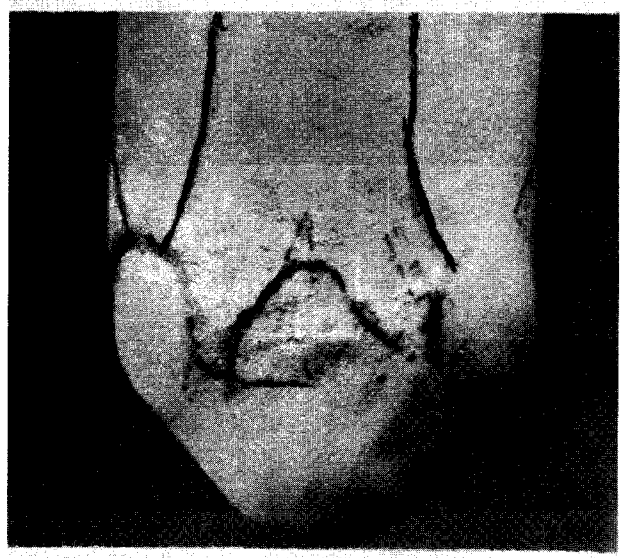
Drive a tack or nail into the model at the apex of the olecranon's proximal posterior radius at a 45° angle to the ulna shaft. Let the nail extend from the model 1/4-3/8-inch. The nail will serve as a point of reference for the buildup.



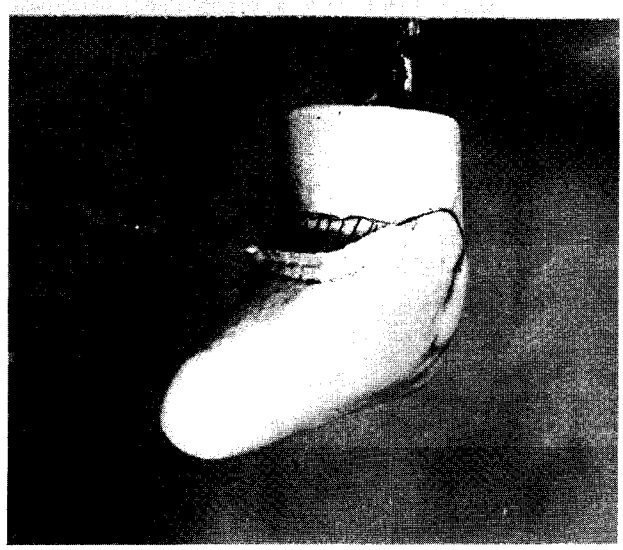
Drive a tack or nail into the model at the mark of the medial epicondyle. It should extend 1/4-inch. Repeat this over the lateral epicondyle with the nail projecting out l/S-inch.



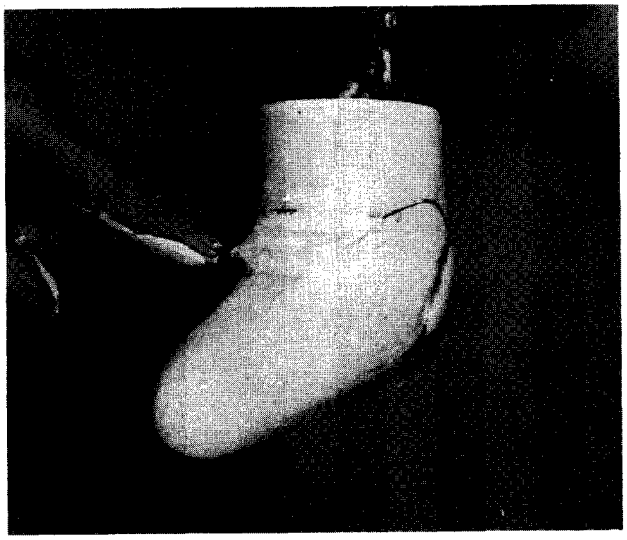
Make the buildups with plaster slurry. Taper the medial and lateral buildups where they cross the socket brim line. The contour of the model should be carefully preserved when plaster is put on the olecranon. Especially avoid bringing the buildup to a point.



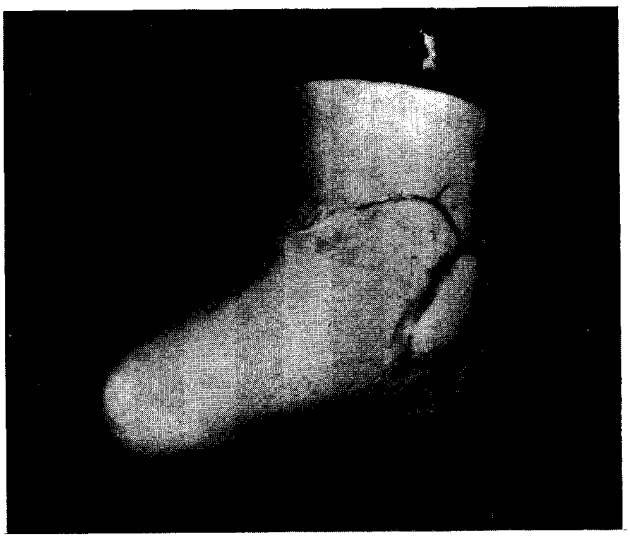
Make the anterior socket brim buildup previously outlined. Take a strip of plaster equal to the length of the line and fold it into three layers approximately 3/8-inch wide. Dampen it and form a dam on the model as illustrated.



Fill the area with plaster slurry.



The model is shown with the buildups completed. Smooth the model. Apply a parting agent for the wax check socket.



Wax Check Socket

Materials:

cotton stockinette

string

molten wax

knife

skin marking pencil

wood burning tool

powder

heat gun

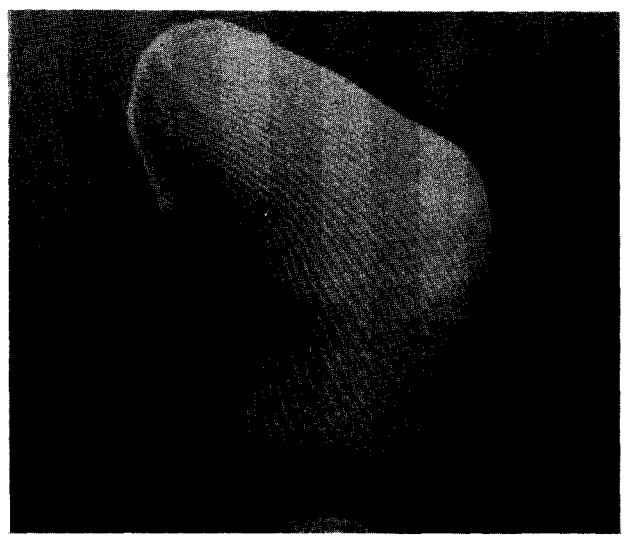
goniometer

outside calipers

1/2-inch bag punch

two elbow joint spacer assemblies

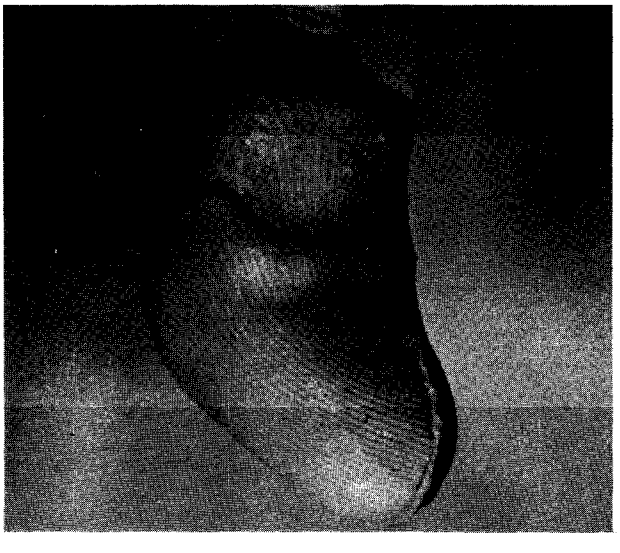
Put six layers of cotton stockinette over the model.



After tying the stockinette, impregnate it thoroughly with molten wax.

Immerse the model into cool water to harden the wax. When the wax is malleable, manually form it over the model to pick up all the contours. Observe the proper precautions when working with molten wax.

Cut the wax check socket to the approximate desired trim. Remove it from the model.



Wax Check Socket Fit

Step-up Hinge Prosthesis Socket and Forearm Separate

The advantage of a step-up hinge for a short below elbow stump is that a socket can be fabricated allowing the most usable range of motion: 10° flexion position to 90° (humerus to ulna) flexed position. Positions of flexion above 90° cause a short stump to almost disappear into the cubital fold.

For information on the mechanical data of the two available types of step-up hinges, see page , Chapter IV, Materials.

When fitting and testing the trial socket, use only those ranges of motion that the amputee will use when he operates his prosthesis (see page).

Round and smooth any sharp edges. Powder the inside of the socket.

Have the amputee put on any stump sock he will use in the finished socket. Apply the check socket. Use ample powder.

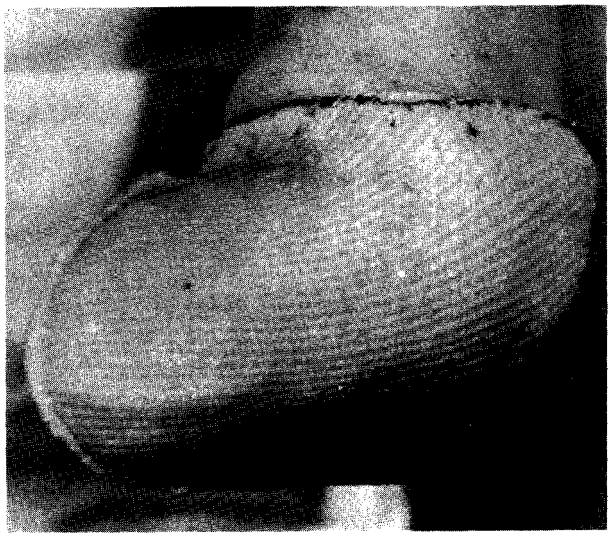
Observe the manner in which the stump goes into the socket. It should enter easily and fit snugly. If the amputee feels comfortable with it on proceed with the fitting.

If the socket goes on too freely, feels loose to the amputee, or if the amputee can wobble his stump around in the socket while he is supporting it with his stump, it is too large, Take new measurements of the amputee and begin again to remodify the model.

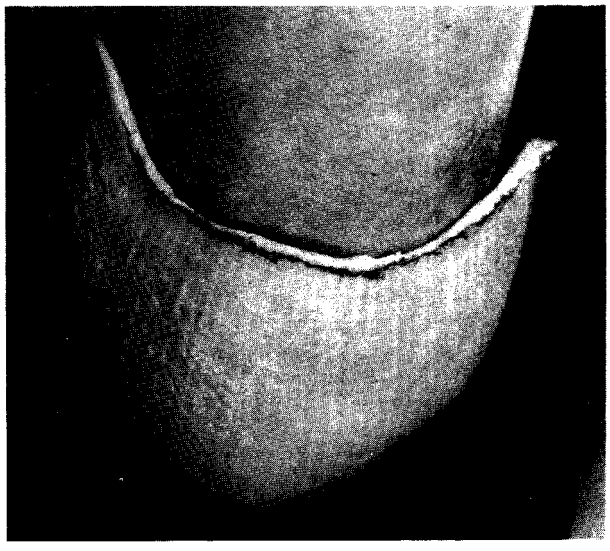
If the socket fits too tightly, edema may be present. Remeasure the stump and compare these measurements with the original ones. If edema did cause the disparity, wrap an elastic bandage snugly around the stump,

Put the check socket on the patient? stump and observe the anterior brim. It should permit a 90° flexion angle without excessive pressure on the biceps tendon or the tissues of the cubital fold.

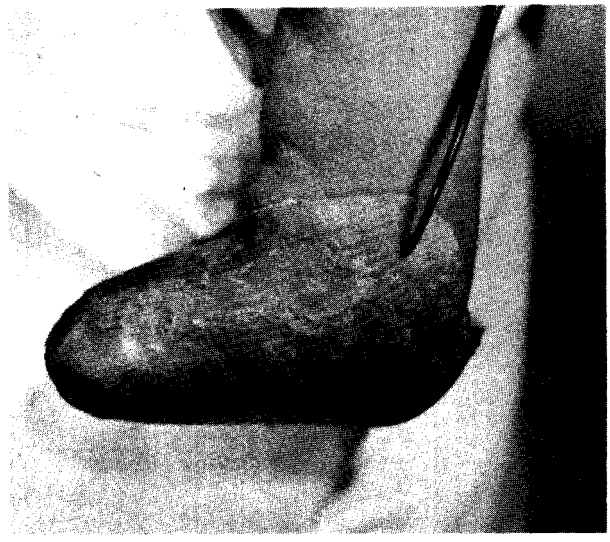
Flare and roll the anterior brim to receive all of the tissues in the cubital fold.



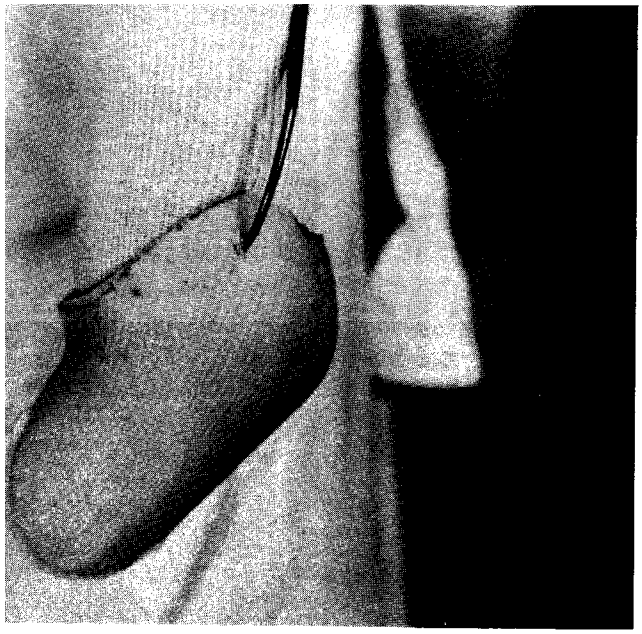
The posterior proximal trim: the amputee should be able to extend his stump to 165° without pressure from the socket on the flares of the humeral condyles or the triceps tendon. Do not allow the elbow to fully extend during this procedure. Again, the socket should completely encase the olecranon.



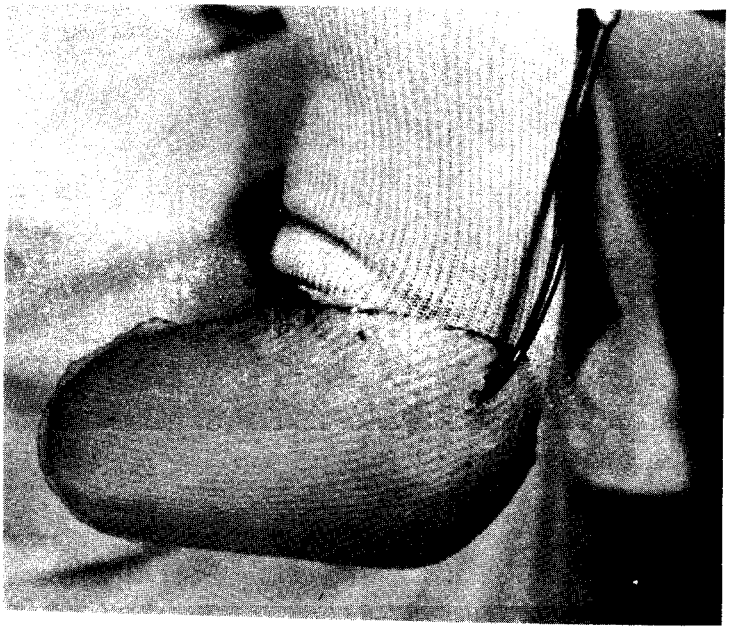
Locate the axis of rotation for the step-up hinges joint center placement on the socket with a pair of pointed outside calipers. Select a point over the medial and lateral epicondyles of the humerus. Put the points of the calipers into the outer surfaces of the check socket. After the points have been selected the socket can be removed from the stump. Do not change the medio-lateral dimension. Begin the procedure illustrated with the elbow flexed 90° and the calipers along the back of the humerus.



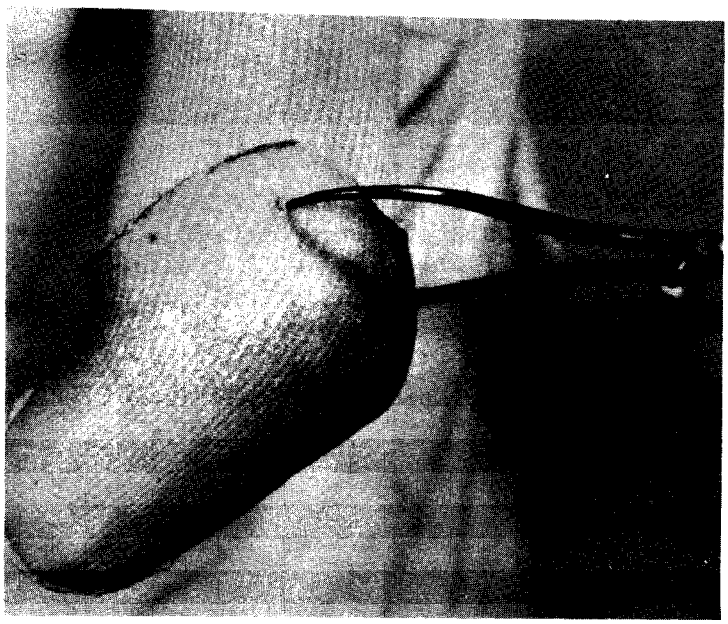
Lightly pull the stump upwards to retain the socket securely on the stump. Ask the amputee to slowly extend his stump downward to not more than 160°. The amputee should never fully extend his stump when this test is being made (a goniometer or protractor is helpful).



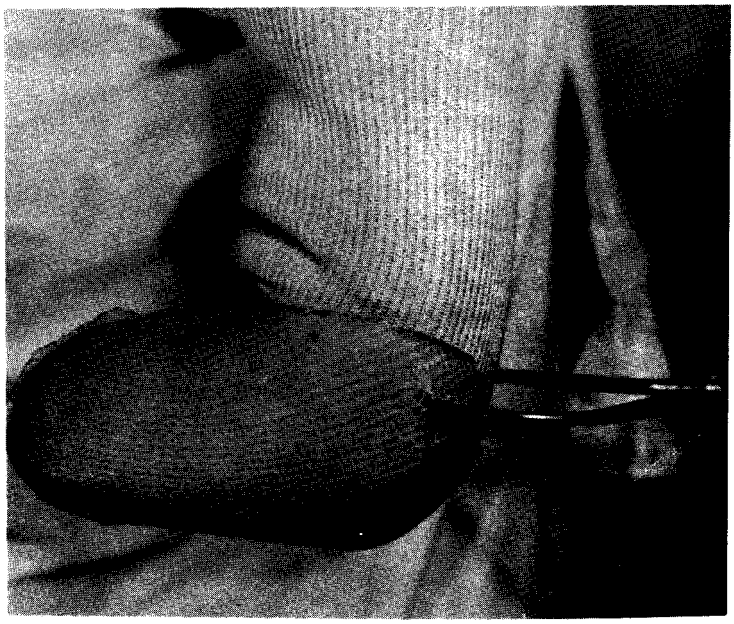
Observe the top of the calipers for any motion. If no relative motion exists between the calipers and the arm, ask the amputee to slowly flex his elbow back to the starting position of 90°.



Change the direction of the calipers so that they are perpendicular to the humerus. Ask the amputee to articulate his elbow within the parameters (established in step).

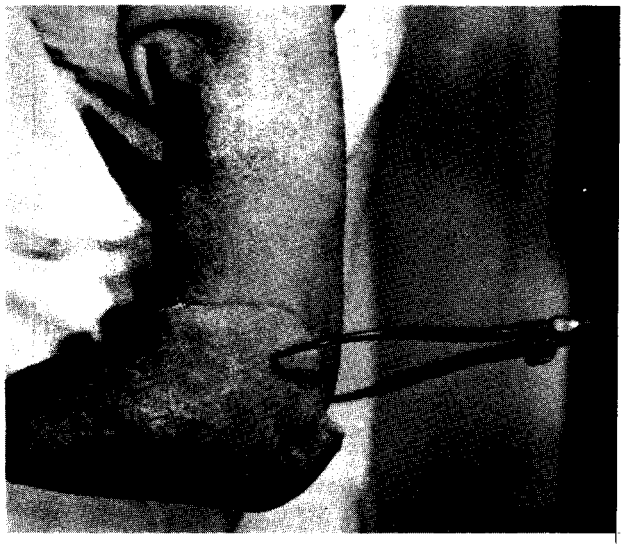


If the calipers do not wobble or the points do not move in a semi-circle, the rotation center has been located. Proceed to step and continue with the fitting. If the calipers move excessively, note the direction in which they move.

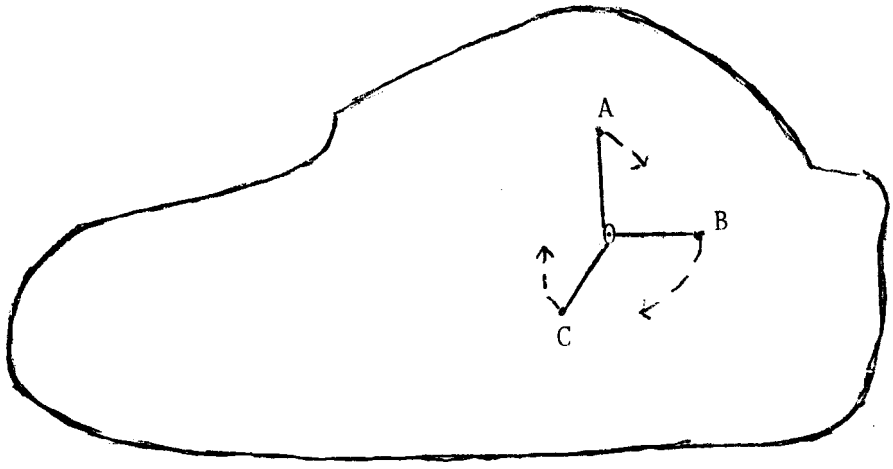


If the top of the calipers move medially or laterally, the position of the joint centers are too anterior or posterior.

Change the direction of the calipers so that they are perpendicular to the upper arm. If they move in a medio-lateral plane at this position, the joint centers are too distal or proximal.



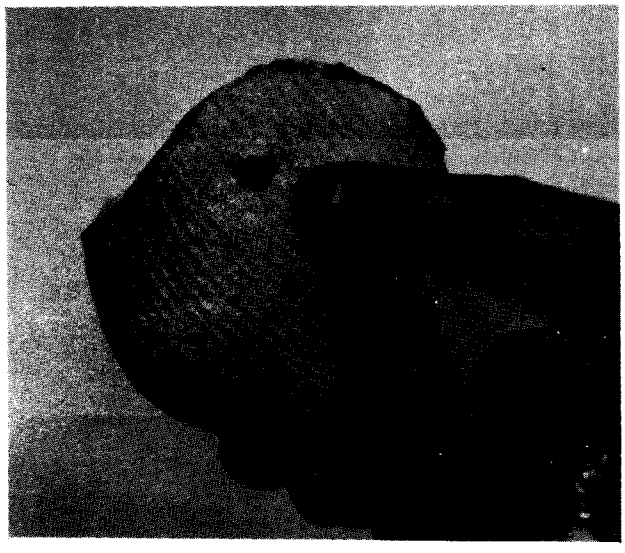
The elbow joint centers may or may not fall over the epicondyles. If movement of the calipers is observed in the above steps, the points of the calipers on the wax check socket must be repositioned. Observe both points of the calipers as follows:



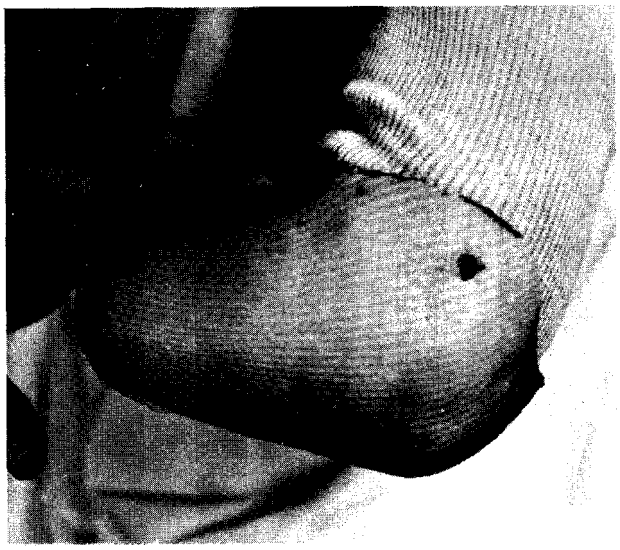
Refer to diagram number . If the point of the calipers moves in an arc as shown by (A), then the point must be moved posteriorly on the socket toward the true center of rotation (0). If the point of the calipers moves in an arc as shown by (B), then the point must be moved distally. Finally, if the point moves in an arc as shown by (C), then the point must be moved anteriorly and proximally.

The points of the calipers must be repositioned as described above and movement of the calipers observed as indicated in the first two steps above. This prevents any movement of the calipers with elbow motion. The elbow joint centers can then be located exactly. If the cam action of the elbow joint or soft tissues prevent exact placement over the center, determine the optimum location.

Mark the location of the correct joint centers.

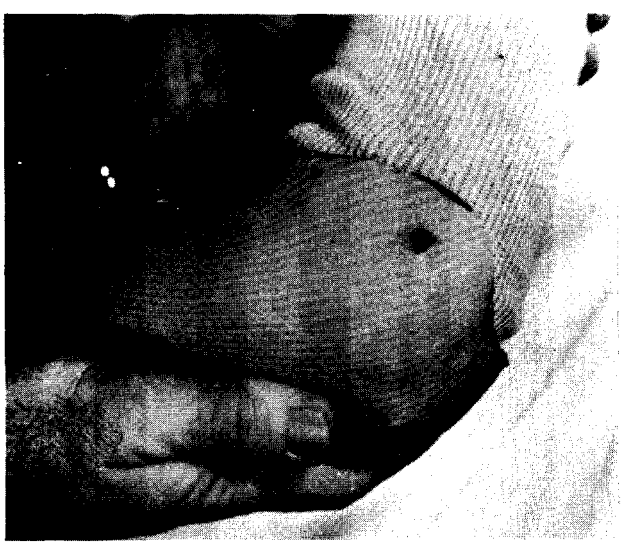


Dynamic Tests: Have the amputee actively flex his elbow, Apply resistance to this motion. The short below elbow stump acts like a cam in the socket. It is not unusual for the amputee to develop painful pressure at the distal radius or even the ulna. Test the socket for comfort against substantial loads. The elbow should not be flexed more than 90° when this test is being made. A socket that is too large distally will usually cause problems at this juncture.

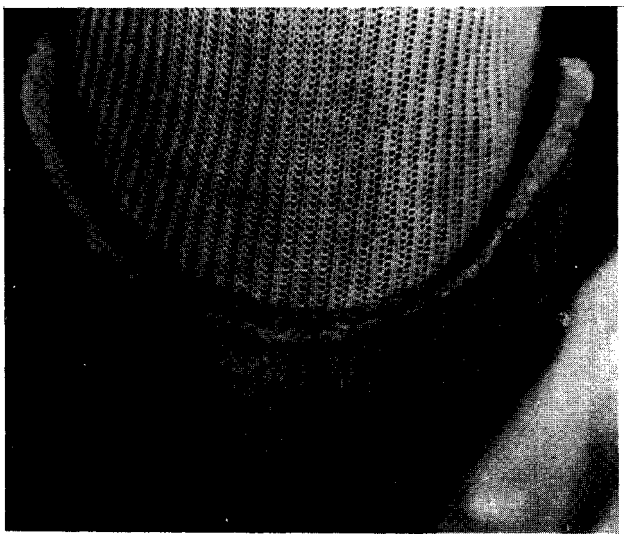


Ask the amputee to push the end of the socket against your hand to see if any discomfort exists. The elbow should be flexed 90°, and a major part of the force should be taken on the flare and roll of the anterior trim at the cubital fold. Try to distribute the forces between the anterior brim and the distal end of the stump.

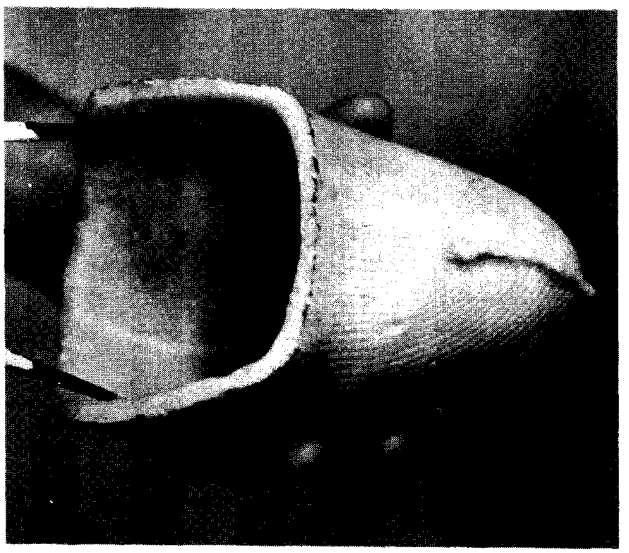
To test for a comfortable fit over the posterior shaft of the ulna and the olecranon, ask the amputee to extend his stump and force it downward against some resistance. To test the fit of the encasement of the olecranon, ask the amputee to push his stump backward into the area.



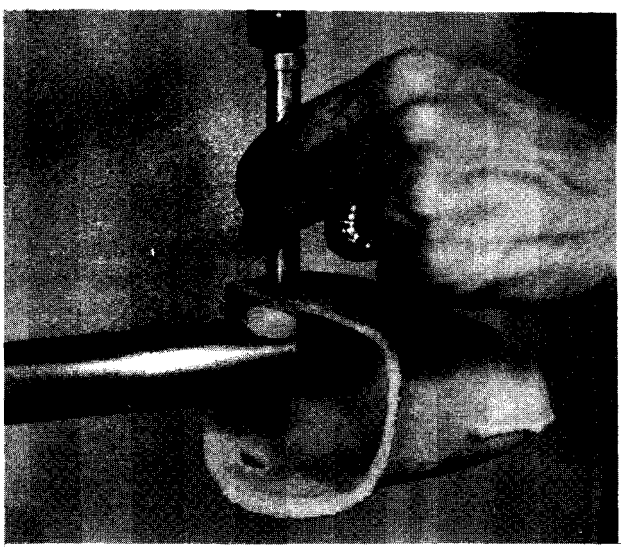
Check for clearance of a minimum of 1/4-inch over the medial epicondyle and 1/8-inch over the lateral epicondyle. In addition, the brim of the socket should not impinge on the flares of the humeral condyles when the amputee extends his elbow.



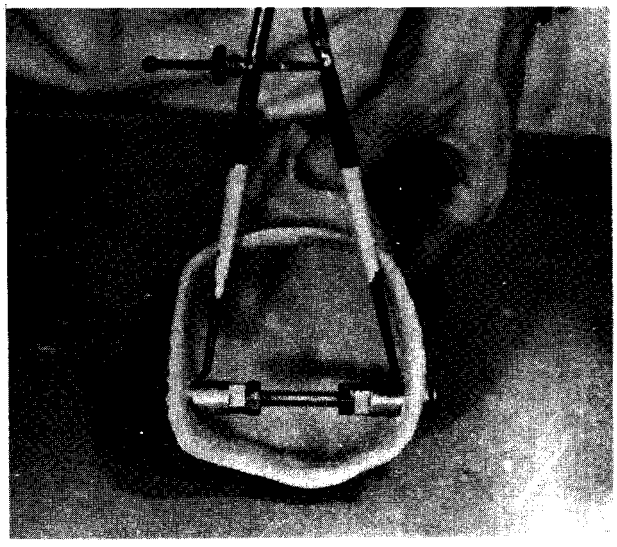
Measure the medio-lateral dimension of the socket-at the joint axis. It is important that this is done immediately after the removal of the socket from the amputee. Record this dimension.



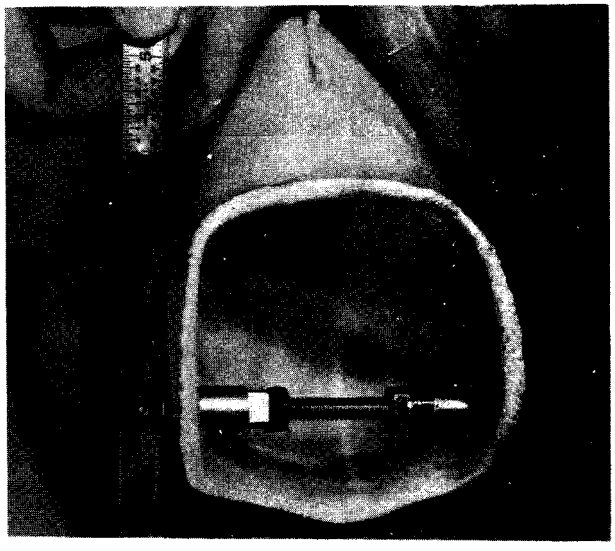
Joint Spacer Installation--Step-Up Hinges: Punch two 1/2-inch diameter holes over the joint axis marks [see page , Chapter IV, Materials for the type of punch). Do not distort the wax check socket.



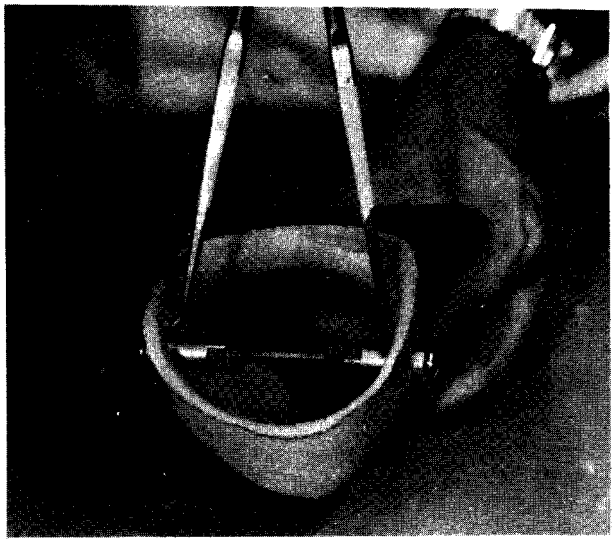
Insert the spacer assembly. Use the inside calipers set at the medio-lateral dimension to correct any distortions made while the holes were punched or the spacer was inserted.



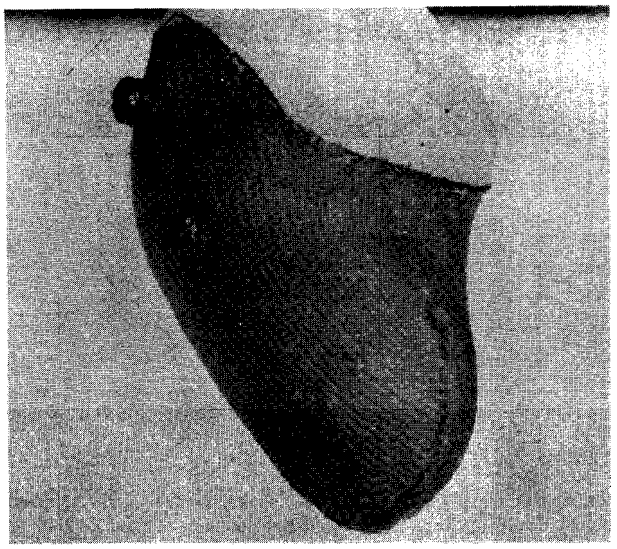
Extend the spacer from the inner wall of the wax check socket. Lay a straight edge flush to the spacer face and at right angles to the spacer axis. The ruler should have clearance and should be free from the model distal to the spacer at a minimum of 2 inches. Lengthen or shorten the spacer as required allowing for socket thickness.



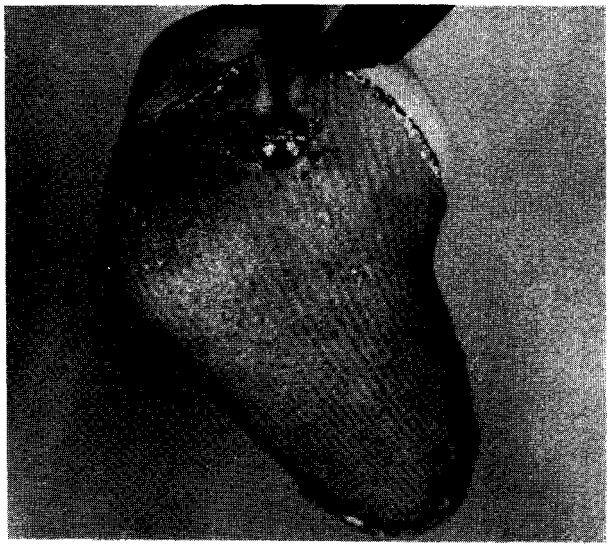
Repeat this on the opposite side. When the correct distances have been established recheck the medial-lateral width and tighten the spacer lock nuts.



Make the breakout mold. (See page Chapter IV, Materials).



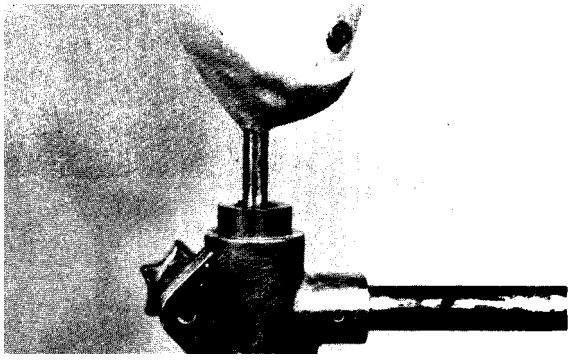
After the plaster has hardened remove the wax by cutting heating, and pulling it off the mold.



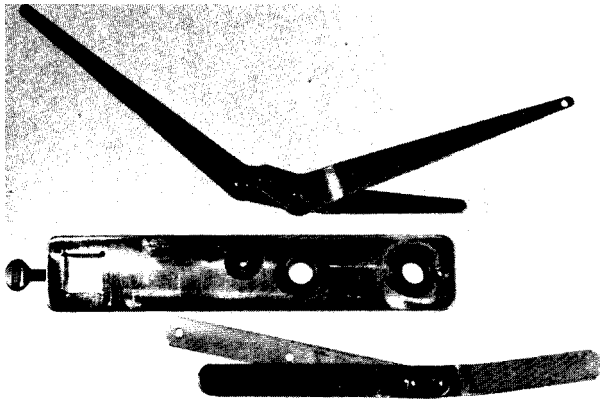
Smooth the mold. The trim lines especially should be smooth for they should form a comfortable rolled edge on the plastic socket. After smoothing the mold, apply a parting agent to it for the plastic lamination.

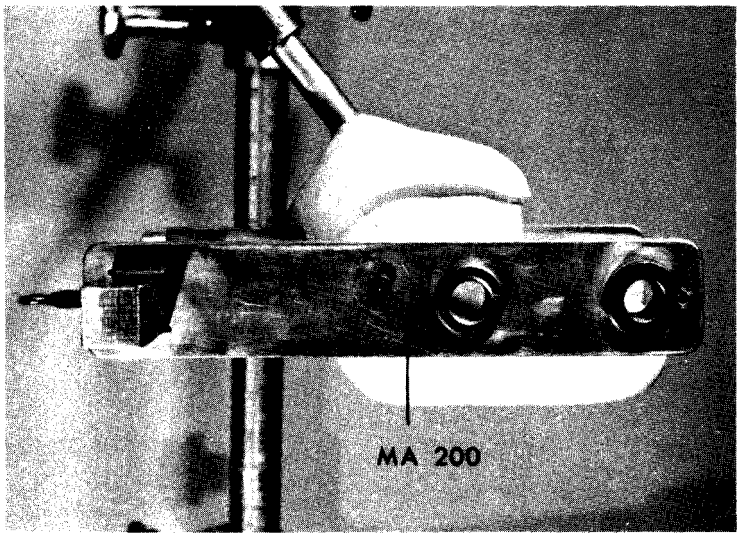
Alignment and Installation of the Multiple Action Joint Hinges

After the wax check socket has been removed from the model, smooth and clear any excess plaster from the base of the spacer heads.

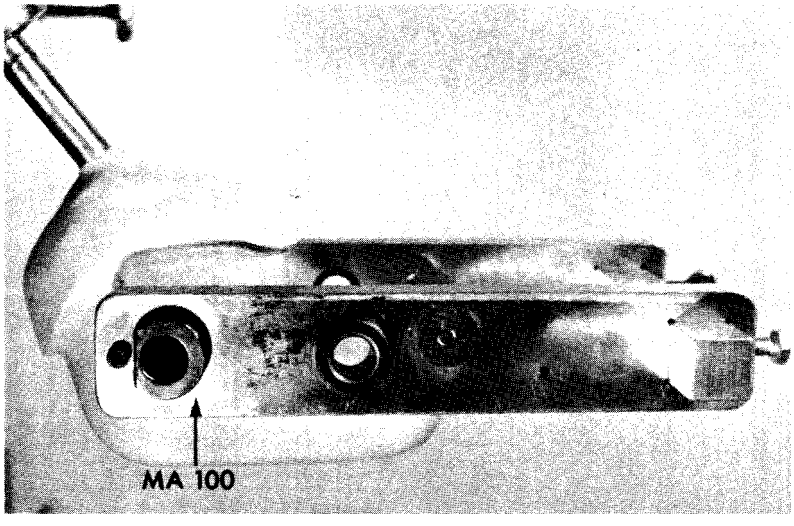


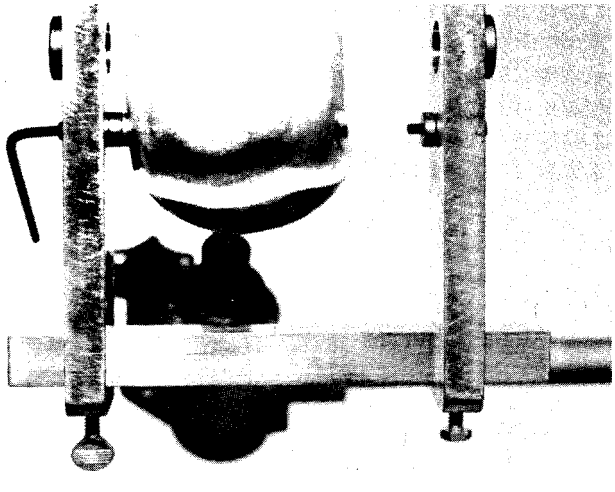
Step up hinges are designed to be used in the fabrication of the split socket prosthesis. Two types of hinges commercially available are shown (see page Chapter IV, Materials) along with the specially designed drilling jig used for installation and alignment of the second joint spacer.
(Blue prints of this jig may be obtained at the UCLA Prosthetics-Orthotics Program.)





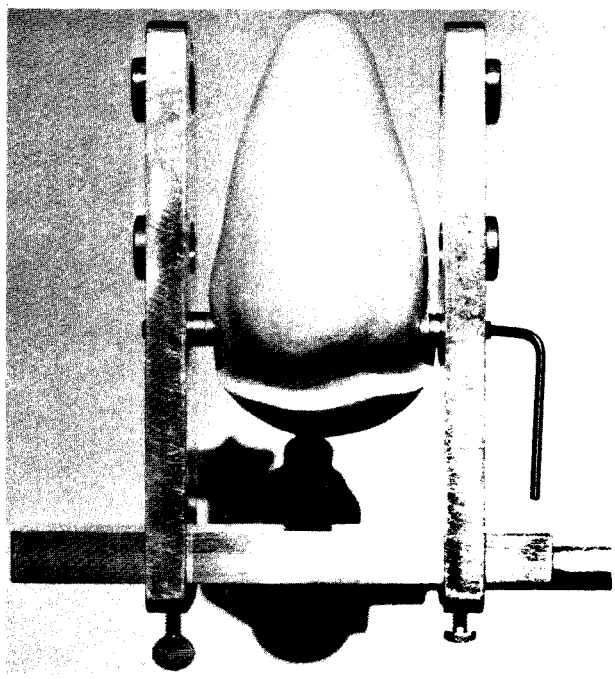
The drill jig mounting position for the multiple action hinges.



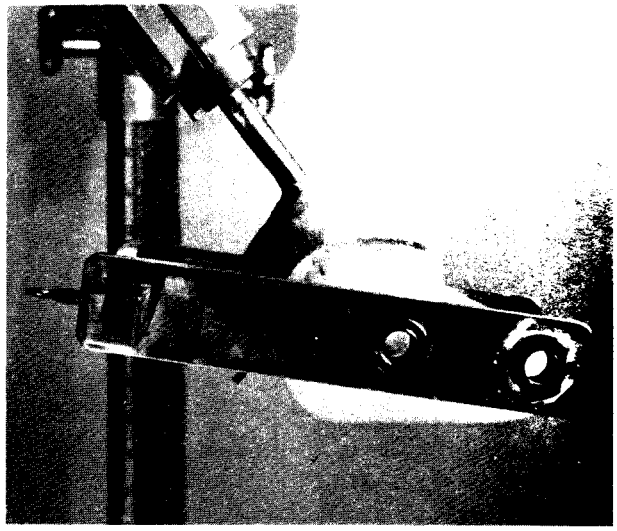


MA-200 multiple action sliding hinges are used in the following outline. Mount the drilling jig to one side of the model. If the drilling jig does not clear the model, add a spacer washer.

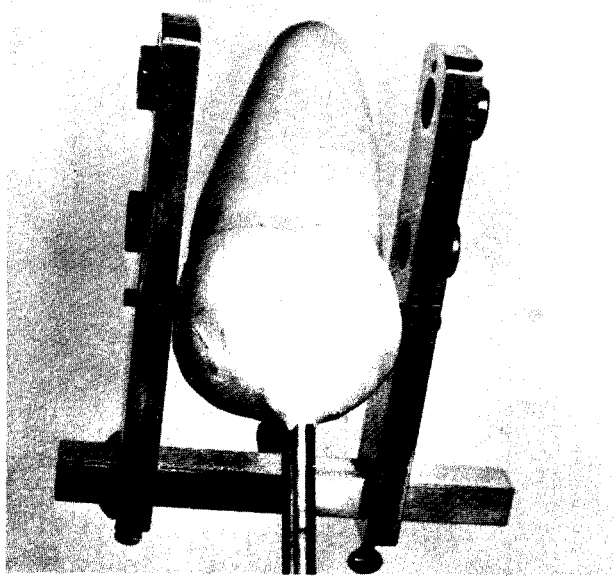
Repeat the process on the opposite side of the model. Tighten the holding screw on the horizontal bar.



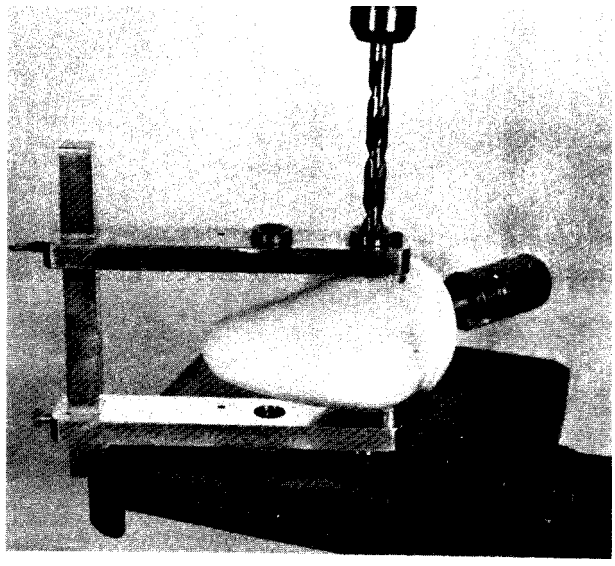
Align the model in the drilling jig for the desired initial socket flexion. Place the model so that the shaft of the ulna is on a 10° angle to the lower edge of the drilling jig as illustrated.



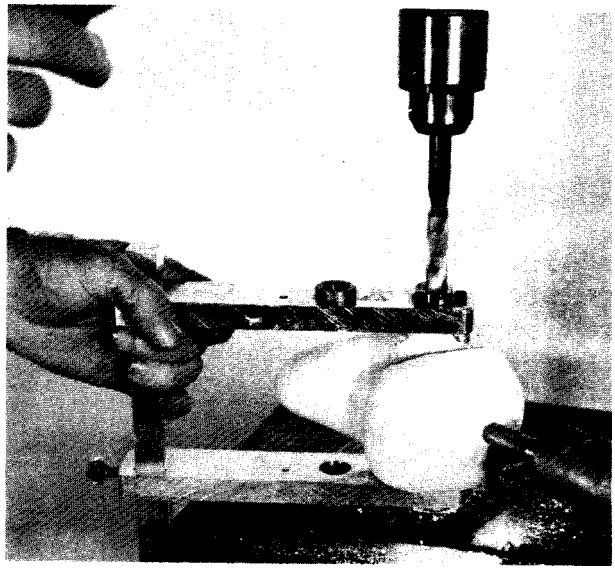
When the drilling jig is mounted on the joint spacer, there should be ample clearance for joint articulation, as illustrated. Tighten the joint spacer screws firmly.



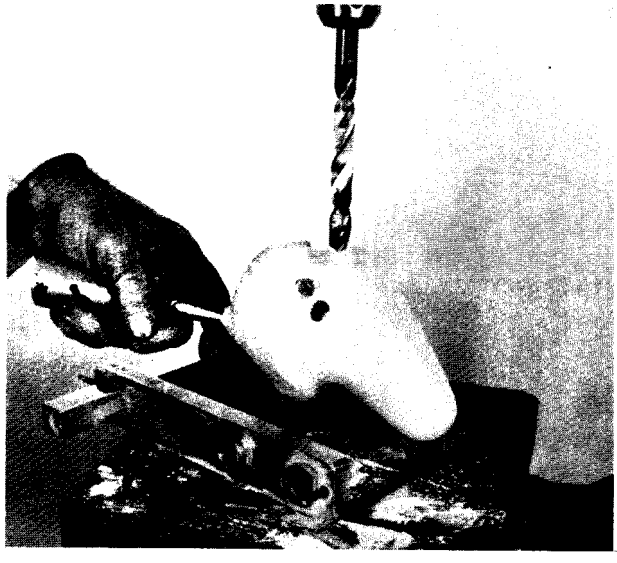
Align the drilling jig to a level drilling platform.



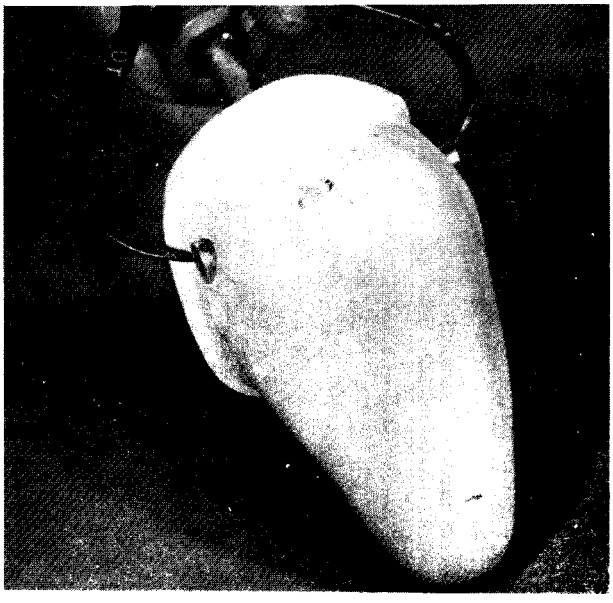
Hold the jig firmly, then drill through the master breakout model with a 1/2-inch drill. Do not allow the plaster model to rotate during drilling.



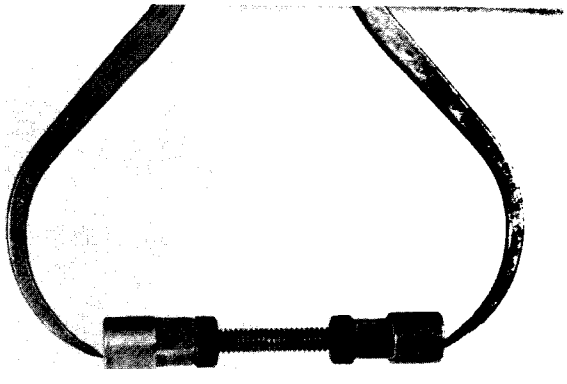
Remove the drilling jig from the model.



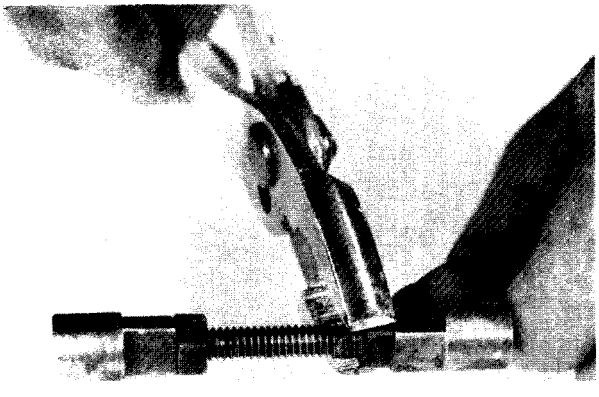
Measure the width of the first joint spacer with a pair of outside calipers.



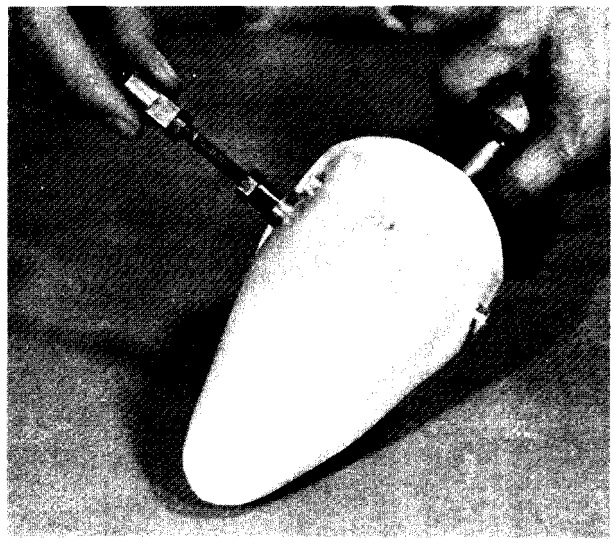
Duplicate this width on a second joint spacer. Note that the spacer washers have been removed.



Tighten the lock nuts and apply a lubricant to protect the spacer from the plaster.

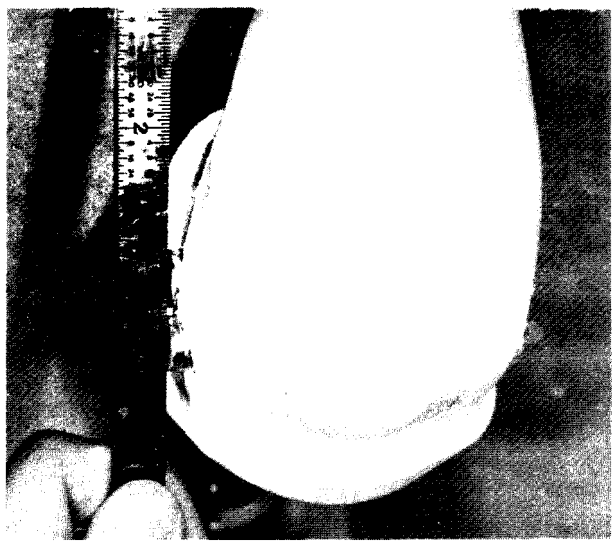


Slide the joint spacer through the previously drilled hole.

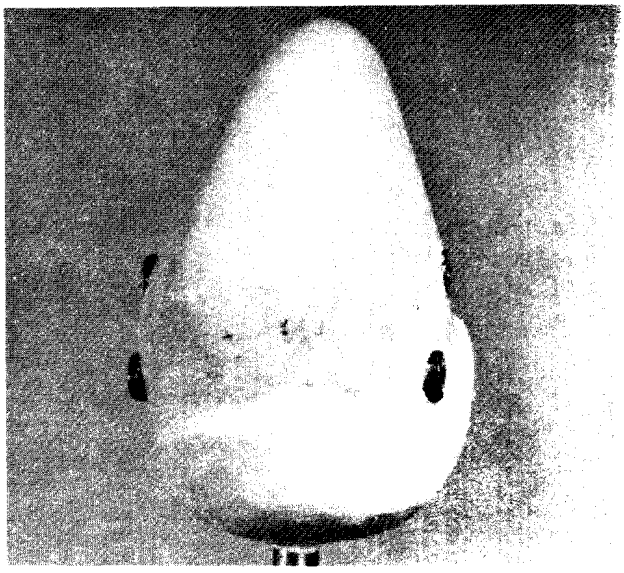


Secure the spacer with a thin mixture of plaster slurry.

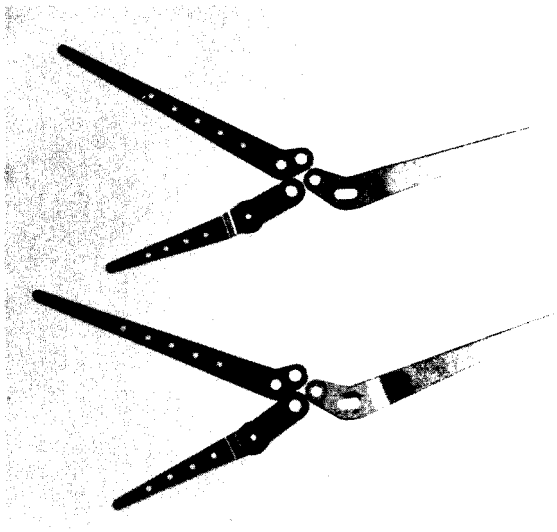
Before the plaster sets, align the faces of both joint spacers so that they are even and flat against a straight edge ruler.



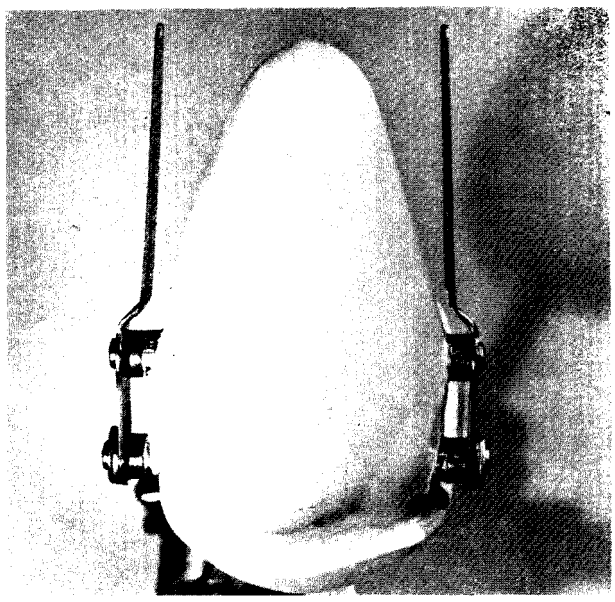
Apply a parting agent to the model and allow it to dry.

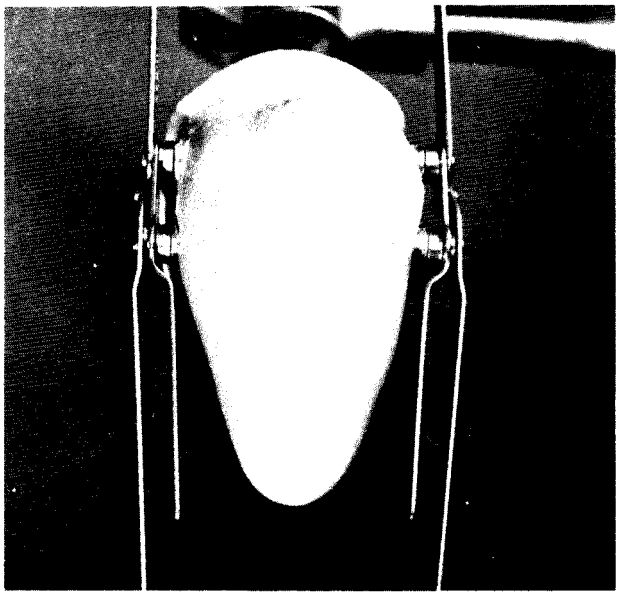


Disassemble the step-up joint hinges. The sliding type variable ratio are shown. The shortest piece at the double end will be placed on the model first.

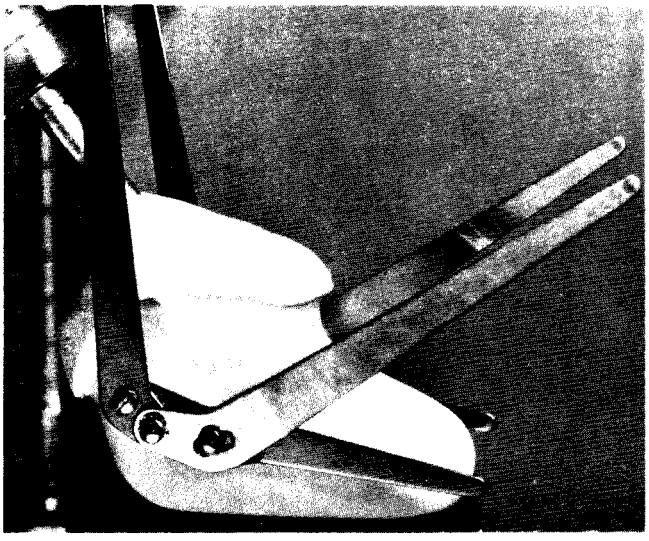


Select four washers of equal thickness and mount the straps to the model. The offset on the straps is toward the model.



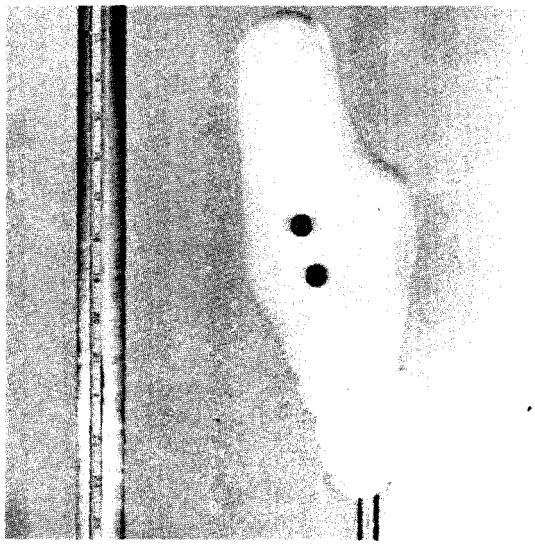


The socket straps are mounted to the model before shaping for illustrative purposes only. Note the joint clearance from the model at the spacer area which determines the socket wall thickness.

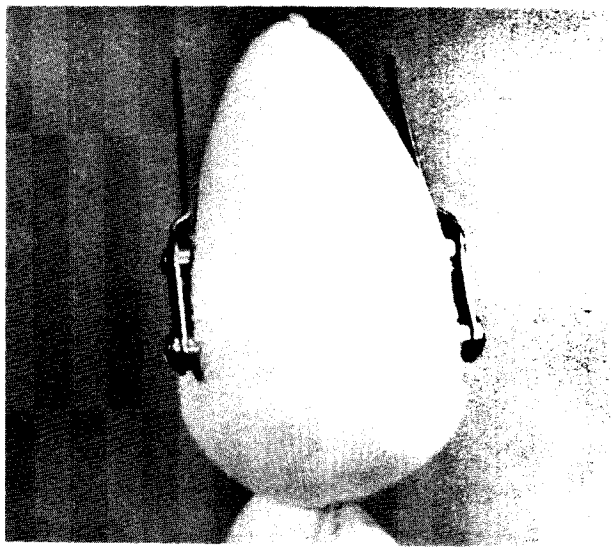


In the illustration, the upper arm and forearm straps have been assembled to the model. The upper arm straps are set toward the posterior at almost a 90° angle to the ulna area. The forearm straps project the angle of flexion of the forearm in relation to the stump. Flex and extend the joints through their full range- of motion. They should move freely. If they do not move freely, locate the source of the problem and correct it. In some cases, the distal joint spacer may have to be repositioned*

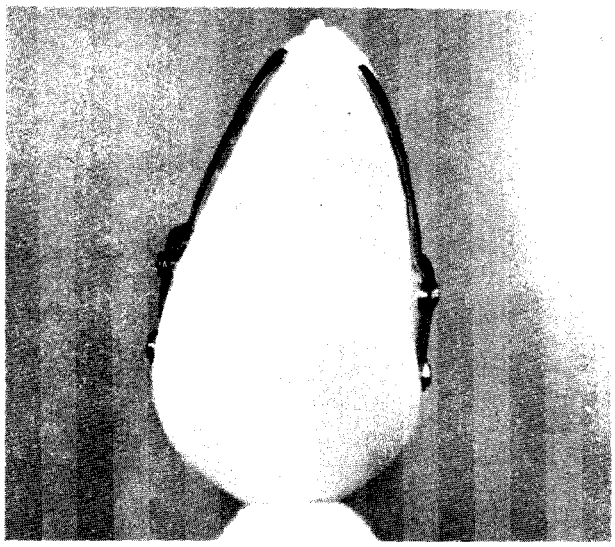
Remove the joints from the stump model. Apply a one layer dacron bag and one layer of nylon stockinette to the model. Locate the joint spacers and cut the material away from them.



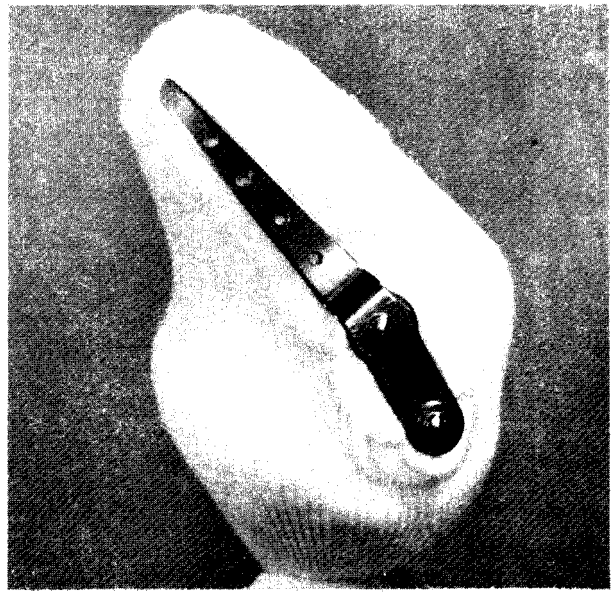
Drill holes along the straps and reassemble the socket straps to the model. The perforation through the straps will increase the bond of the straps to the socket. Mount the socket straps to the model using an 8-32 oval head screw in the larger hole.



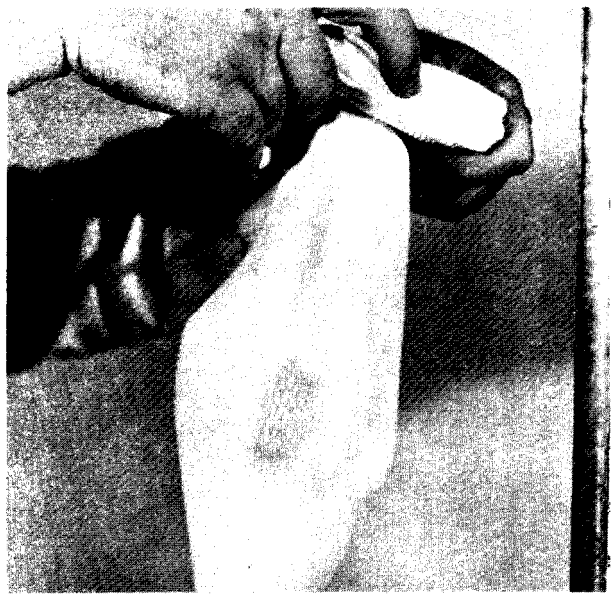
Shape the straps to the contour of the model. They should be loose enough around the model to allow the resin to penetrate under the straps.



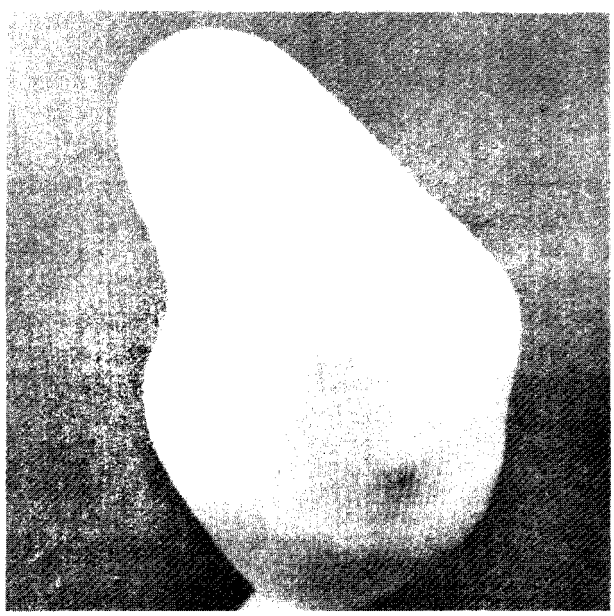
Fill in all of the gaps under the straps with pieces of dacron material.



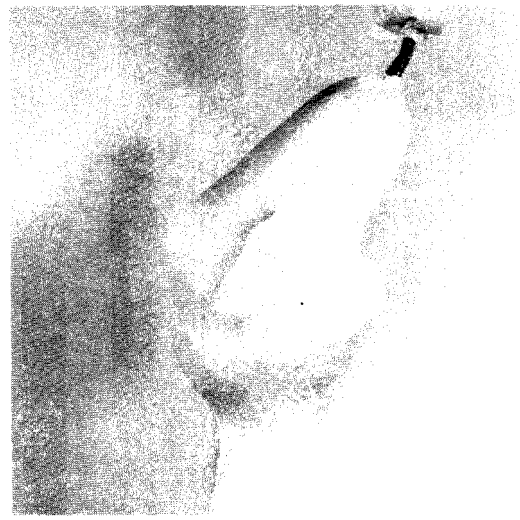
Apply two layers of nylon over the straps. If unusually sharp contours still show, pack additional dacron material around the spacer.



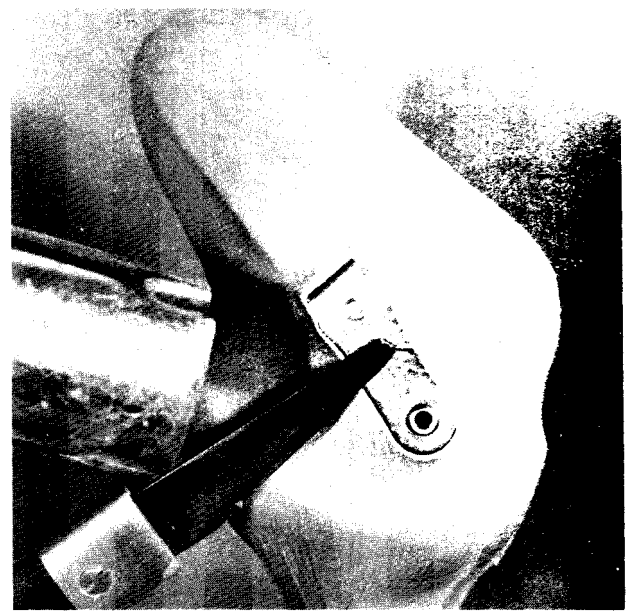
Pull the nylon down snugly and tie it at the base of the model.



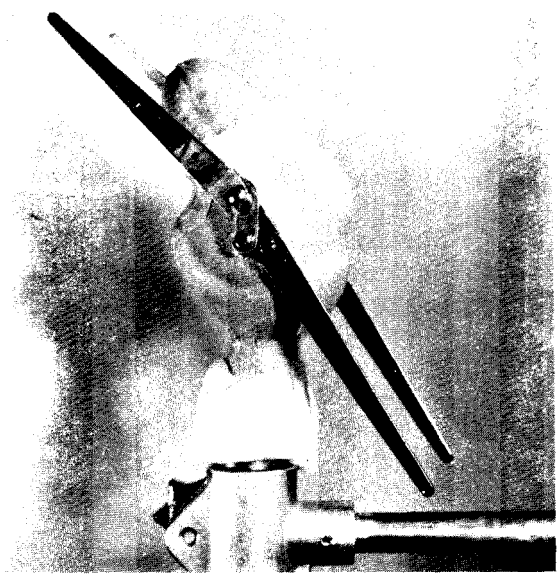
Laminate the socket (see page Chapter IV, Materials).



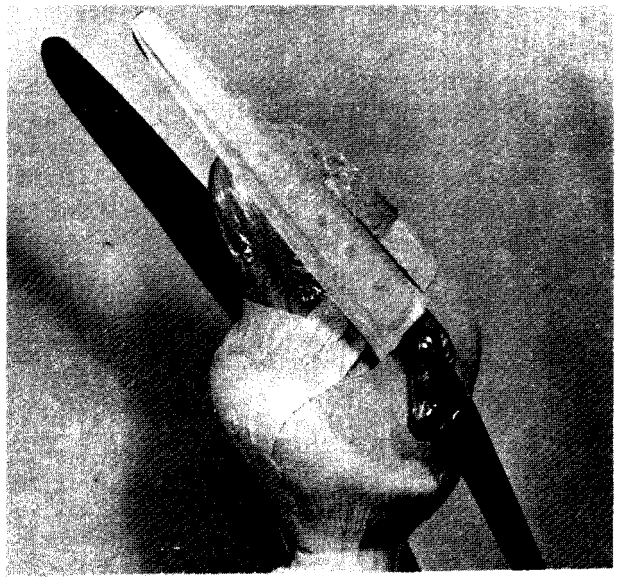
Remove the plastic from the joint surfaces of the straps. If the plastic is heated in the local area with a heat gun, a knife may be used to remove it.



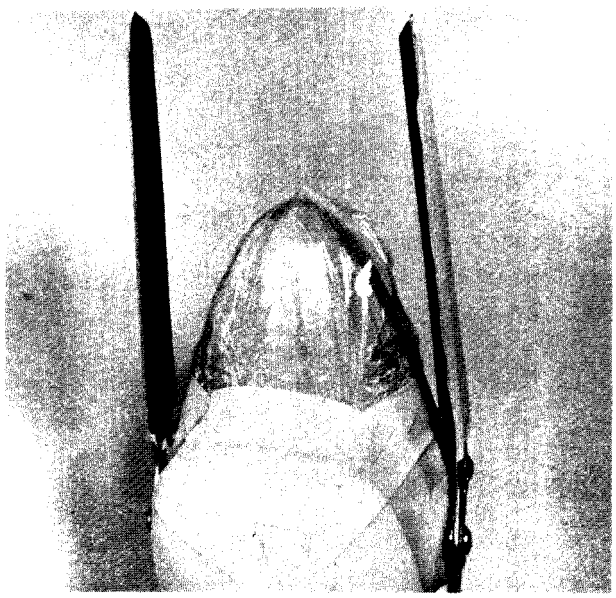
Apply the upper arm and forearm straps to the socket in the fully extended position. Apply a parting agent over the socket and joint axis area. PVA, saran wrap or hi-glow may be used. Do not put the parting agent on the portion of forearm straps that will be imbedded in the forearm extension.



Apply a spacing material to the inner side of the arm strap. A piece of neoprene or similar material l/S-to 3/16-inch thick may be used. Lay the material on the forearm strap and trace around it. Cut around the tracing 3/16-inch outside the line. Sand a small bevel around the edges. Tape the material to the back of the joint with the bevel toward the socket. Place the material so that the margin is equal around the edges of the metal.



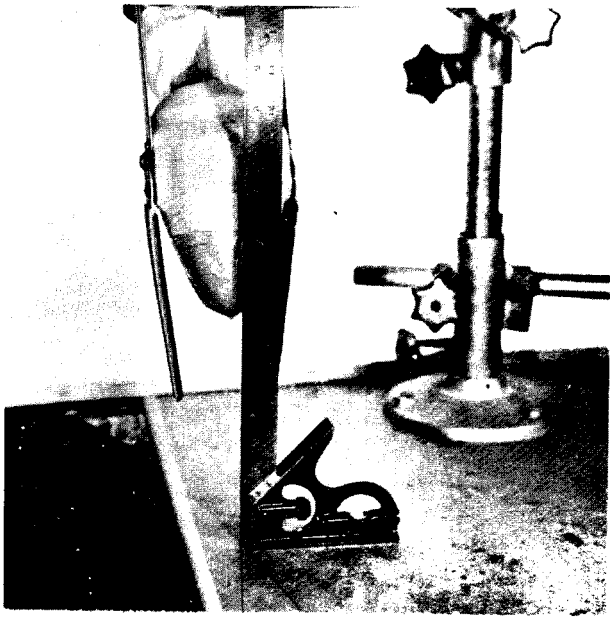
This procedure forms a channel in the wax or foam of the forearm extension buildup so that resin will flow under the forearm straps.



To determine the length of the forearm, obtain the lateral epicondyle to thumb tip measurement from the prosthetic information form. 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 measurement of the greatest dimension.) This new figure is the length of the forearm.

Scribe a line perpendicular to the joint axis bisecting the posterior aspect of the socket. Secure the socket in a holding device and align the joint axis parallel to the flat table surface using the combination square as shown in the illustration.

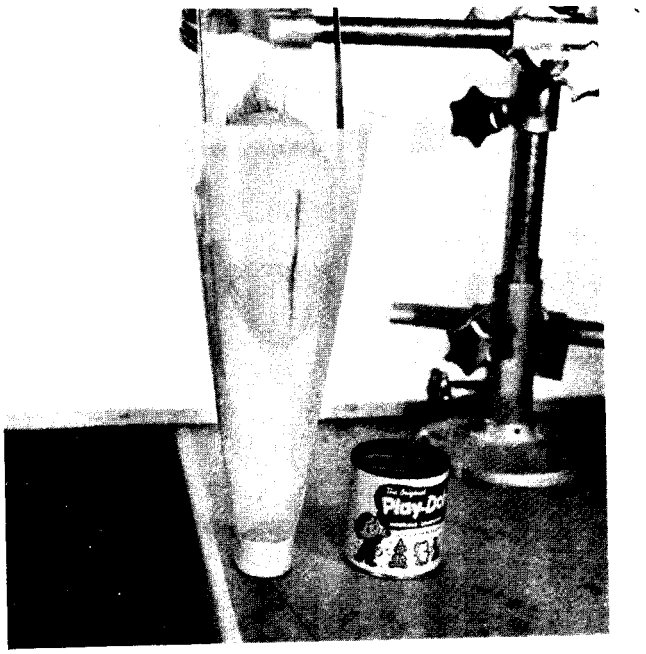
The Milmo alignment jig is being used in the illustration but any suitable holding fixture may be used.



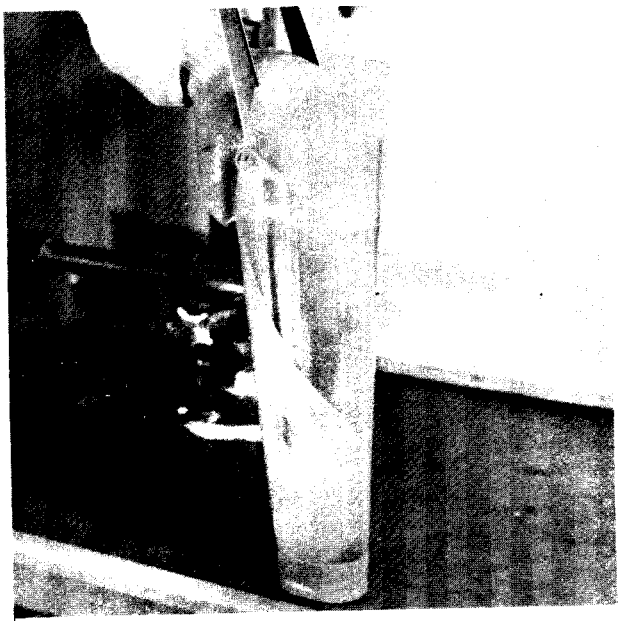
Align the forearm straps perpendicular to the level surface. Center the wrist unit under the forearm straps and scribe the position. If an oval wrist unit is used, rotate the top internally about 20 degrees.

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 lamination.

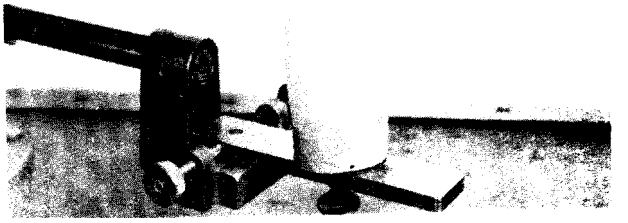
Make a cone for the forearm extension (see page Chapter IV, Materials). Attach the cone securely to the wrist unit. Temporarily replace the wrist unit and cone to the scribed position or in the holding device. Adjust for size and length.



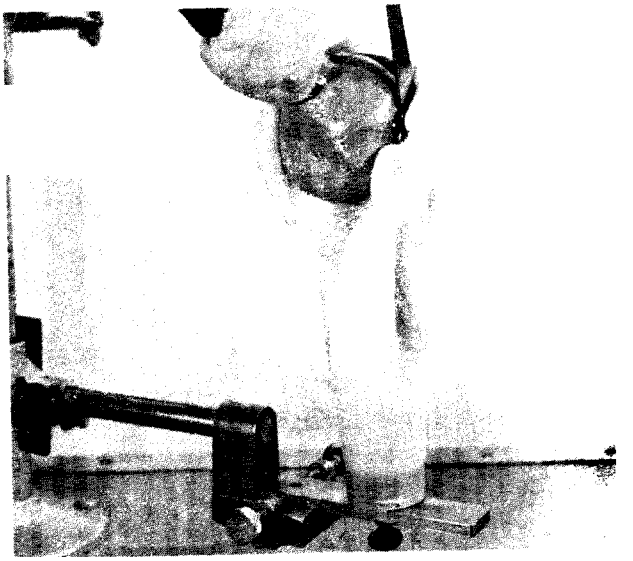
The forearm straps can now be tapered to the direction of the wrist unit. They should be flush against the sides of the cone. Trim the anterior edge of the cone to form to the anterior socket brim,



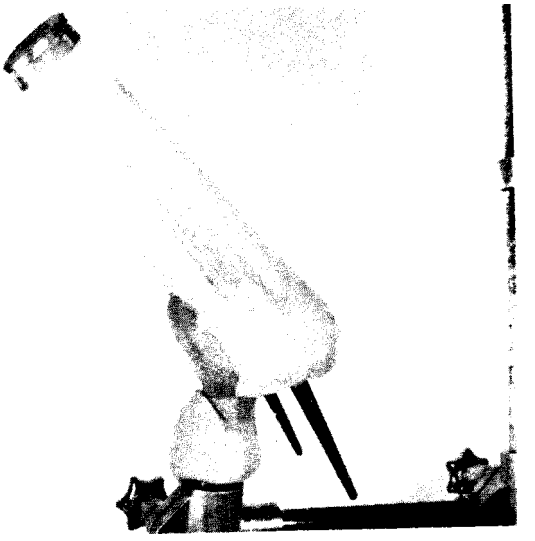
The forearm is now ready to be formed. Beeswax, polyurethane or a similar suitable material may be used. If wax is used, make the cone form from shippersboard or some similar heavy cardboard material.



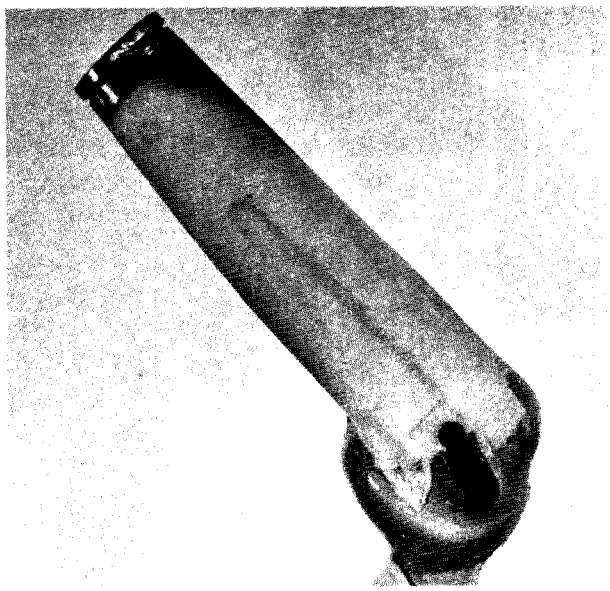
Mix one quart of polyurethane foam and pour this into the cone.



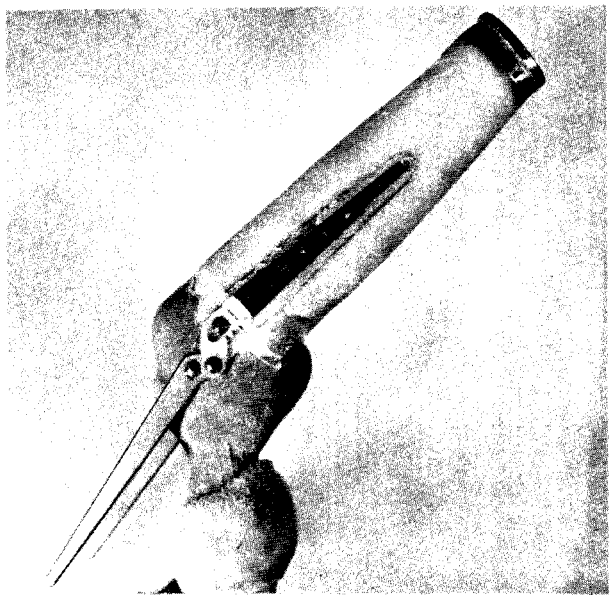
Remove the polyethylene cone and the masking tape from the wrist unit.



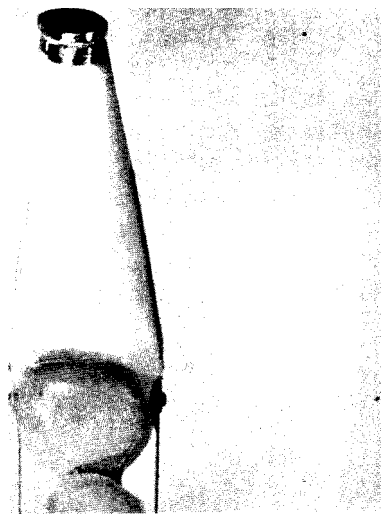
Cut away any excess material around the joints and socket area. Shape the material so it is even with the forearm strap.



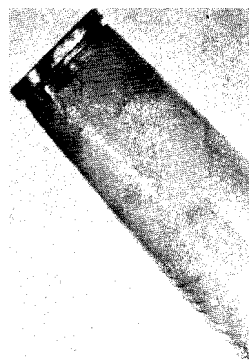
Shape the forearm to a gradual taper and blend it into the wrist unit.



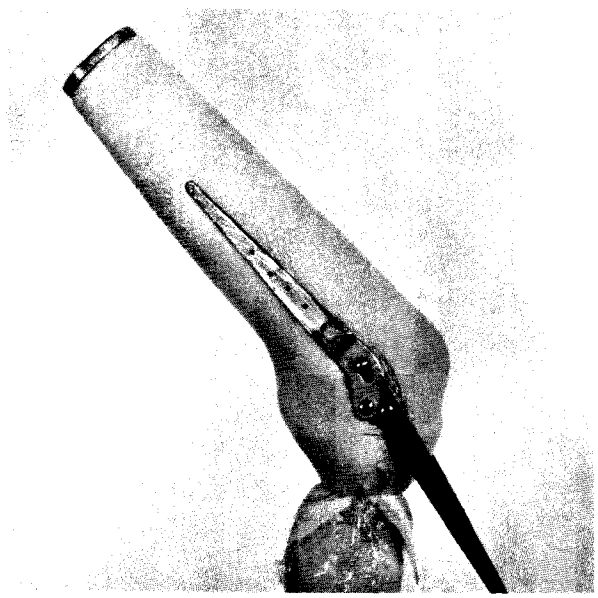
Shape the anterior area over the socket to within 1/8-inch of the socket surface at the brim.



Remove the hinges from the buildup. Remove all excess material in the channel formed by the spacer material and all material from the forearm straps.

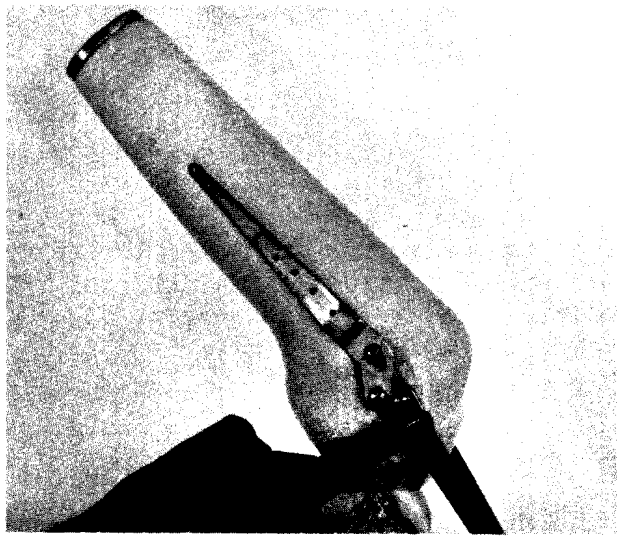


Cover the entire assembly with a parting agent, such as a PVA bag or saran wrap. Tape the material to the proximal edge of the wrist unit. The knurled edge of the wrist unit should not be covered.

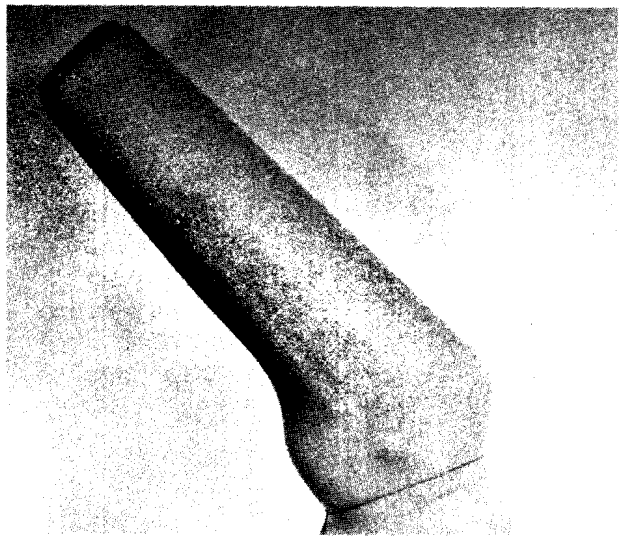


Apply two layers of nylon stockinette. Tie the first layer with a string at the wrist unit groove and double the second layer back over the first. Pull the layers snugly and tie the stockinette at the mandrel. Cut the nylon away from the joint surfaces on the socket. Assemble the multiple action hinges to the socket.

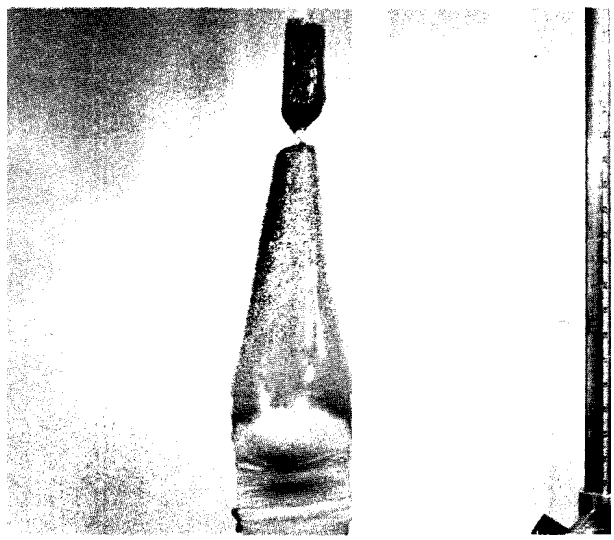
Cover the joint heads and screws with silicone paste or a similar parting agent to prevent the resin from adhering.



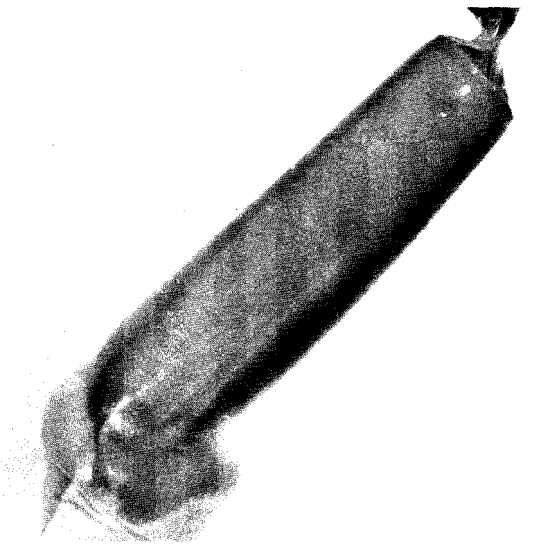
Apply two more layers of nylon stockinette, tying the first layer into the wrist unit groove and doubling back the second layer. Tie the stockinette at the mandrel.



Prepare a PVA bag for the lamination and pour the resin.



After the resin has saturated the nylon stockinette to the proximal brim of the socket, stretch tape to prevent the resin from going any farther and to form a seal against the air.



After the resin has set, trim around the proximal socket at the level of the anterior brim and the distal joint screw on the medial and lateral sides of the socket. Remove the joint screws to release the forearm from the socket.