

## CHAPTER 5

### HANDPROSTHESES

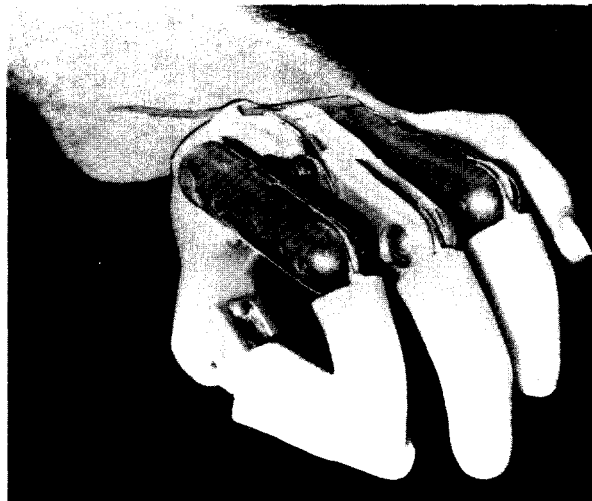
#### Introduction

The mechanical partial hand prosthesis described in this chapter is designed to be fitted in cases where the amputation is proximal to the distal heads of the metacarpals.

1. The Robin Aids partial hand is used for partial hand amputations except in the following cases:
  - \* If the amputation is distal to the distal heads of the metacarpals of the fingers, the Robin Aids mechanical fingers are too long to meet the patient's thumb for prehension and appearance.
  - \* With the thumb and index and/or middle finger remaining, a Robin-Aids partial hand is not needed because the amputee has prehension. In this case a passive hand can be used for appearance and lateral support of the index or middle finger.

The amputation for which Robin-Aids partial hands are used can be generally divided into the types below. A simple shoulder harness is used to operate the prostheses.

With only the small finger remaining, a wrist length socket is used for mobility and light duty, a mid-forearm length socket for stability or heavy duty.



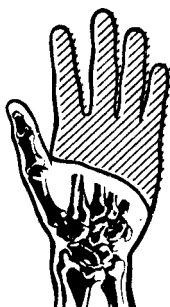
In the absence of the thumb, index and long finger prehension is solely mechanical. The ring and little fingers provide sensation'. Dependant upon activities a long or short socket is provided.



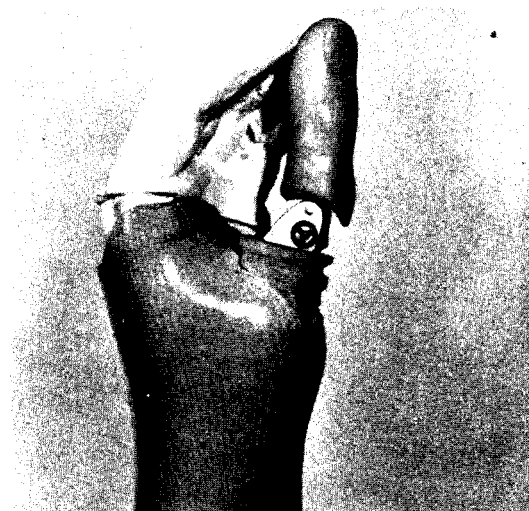
In the transmetacarpal or transcarpal prehension is mechanical and in addition lacks sensation. The transcarpal is always fitted with the long socket.



When only the thumb is remaining, sensation and active prehension in opposition to the four mechanical fingers being adjustable to the various contours of grasp afford the patient a superior performance level to the above applications.



With the thumb only amputated, it is possible to use the thumb portion of a Robin-Aids partial hand to make an opposition post for the fingers.



When the amputation is proximal to the MP joint, a two position thumb is used. Shown to the right is the wide position of the Robin-Aids thumb.



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Procedure for fabricating a partial hand prosthesis for an amputation with only the thumb remaining.

A. Information and Measurements (taken at first visit of patient)

List of Materials:   goniometer  
                          tape measure  
                          straight edge ruler

1. Complete the applicable portions for the partial hand prosthesis on the Prosthetic Information form.

The name of the clinic and physician should be on the form. The physician should be consulted when medical problems arise and the clinic may have to be consulted when problems with financing, therapy, training, etc. occur.

Under 'Condition of Stump' examine the stump to determine if any scars, neuromas or any other areas are sensitive and will need relief in the socket. Note the condition of the remaining bones and if there are any bony prominences which will need relief. Check the muscles to determine if they are adequate to control a prosthesis, and measure the ranges of motion (wrist flexion/extension and deviation) so that the socket can be made to allow for as much residual function as possible.

Under "Rx (prescription) for Prosthesis" note the type of socket, components and materials that will be used for the prosthesis.

2. Only two measurements need to be taken to make a partial hand prosthesis.

Measure the circumference of the sound hand across the metacarpal-phalangeal joints to determine the size of the Robin-Aids partial hand.

Position the thumb in opposition and measure how much the thumb web can be compressed by exerting pressure with your thumb. This measurement is taken to get a good socket fit in the thumb web area.

X-rays often reveal information which is helpful in designing sockets for optimum function and comfort. The presence of bone spurs, over-growth, fusion of bones, bone chips, etc. can be detected in X-rays. Therefore, whenever available, examine X-rays of the stump.

B. The wrap cast.

List of Materials:   cotton sockinette (about 2 inches wide)  
                          scissors  
                          indelible pencil  
                          regular plaster bandage (about 2 inches wide)  
                          bandage shears  
                          parting agent for cast

There are 2 ways the cast is generally taken.

One method is to use plaster bandage. It is more difficult to get good coverage, but using plaster bandage has the advantage of being able to form the cast and position the hand. This method is commonly used and will be described in the step by step procedures below.

The other method is to use alginate. It is easier to get good coverage with alginate but it has the disadvantage of not being able to form the cast and position the hand. For more information on alginate, see page Materials, Tools and Techniques, Chapter

1. Sew across the end of a stockinette about 2 inches wide, cut hole to accommodate the thumb, and pull tightly over stump. The stockinette should extend just past the wrist or just past the forearm, depending upon the length of socket planned. Wet the stockinette so the plaster will adhere to it.



2. With an indelible pencil, mark the ulnar and radial styloids and any other areas that will need socket relief. These marks will transfer to the wrap and model. (An alternate method is to put pads over the areas that will need relief. The reliefs will then be incorporated into the wrap and model, and plaster buildups will not be necessary.)



3. Using a 2 inch wide regular plaster bandage, wrap the hand. The wrap should be 3 layers thick for strength and should be applied snugly but not so tightly that skin is bunched. Wrap only up to the proximal phalanx of the thumb.

4. With the hand in a functional position of opposition and the wrist extended, mold the thumb web area well.



5. As the plaster starts to harden, mold along the thenar crease at the base of the thumb. Position the thumb in opposition to the second metacarpal and extend as far as possible.



6. After the plaster hardens, use bandage shears to cut the cast along the radial side as necessary to remove the stump from the cast.



- 7 Make index marks on the cast so it can be positioned once off the patient. Gently remove the cast with as little distortion as possible.



8. As soon as the wrap is off patient, match the index marks and close the wrap. Seal the thumb opening with plaster bandage or strips.

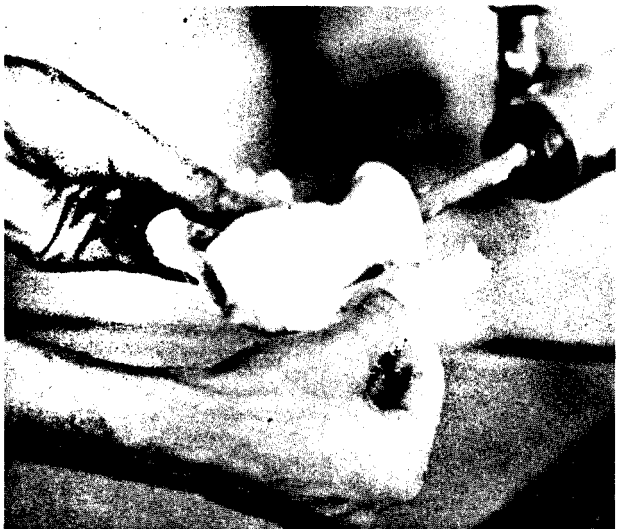


9. If the patient plans to wear a stump sock, then remove the stockinette from the cast. Next, put parting agent on the inside of the cast to get a smooth model.

#### C. The Model

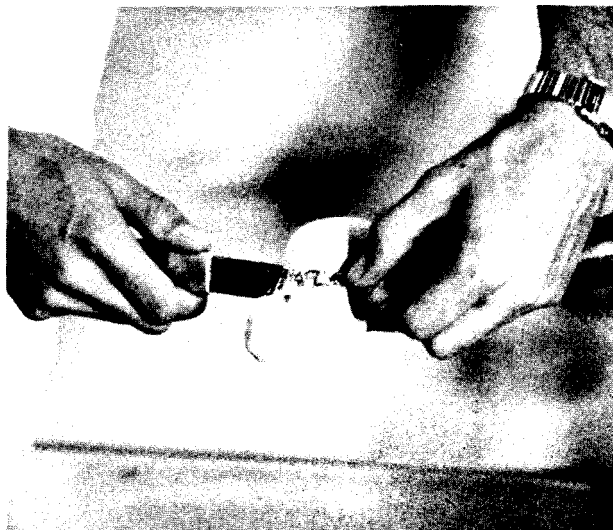
List of Materials: plaster  
mandrel  
knife  
straight edge ruler  
sureform files  
sandpaper or screen  
parting agent for model

1. To make the model, pour a smooth mix of water and plaster into the cast. Avoid air bubbles by pouring along side of cast and tapping once poured. Insert a mandrel into the plaster before it hardens to hold the model for future work.
2. Soon after the plaster hardens, carefully remove the wrap cast.





3. Modify the model to provide a snug socket fit, reduce the thumb' web area, the amount measured and recorded on the prosthetic information form.



4. Remove small amounts of plaster along the first dorsal interosseus muscle and the thenar areas. This compresses soft tissue to provide uniform socket pressure.

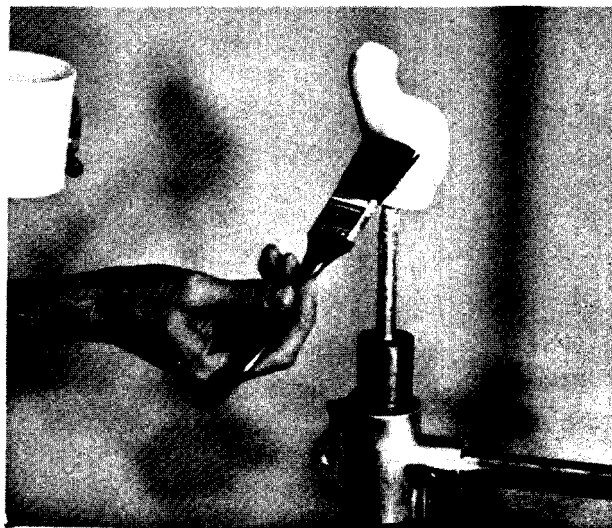


5. Remove all ridges and fill any voids with plaster to make a smooth model.

6. Make approximately 3/16 inch plaster buildups over the styloids and any other areas that need relief. Blend buildups into the model and smooth.



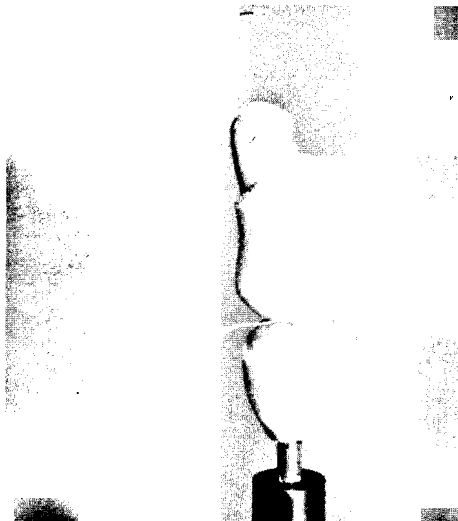
7. Put a parting agent on the model to get a smooth finish on the plastic socket and to seal the model.



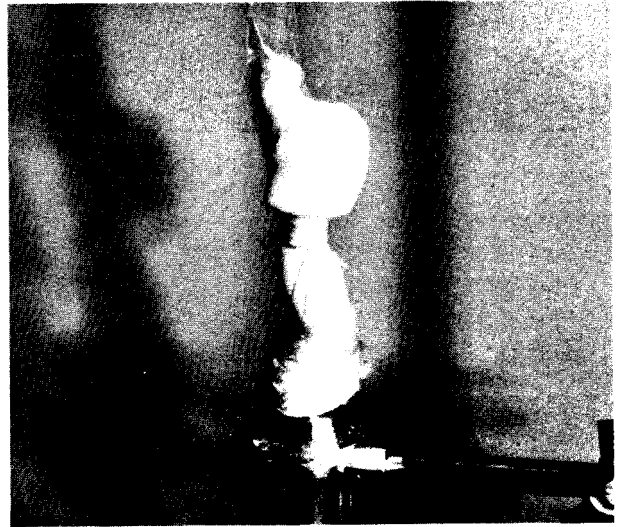
#### D. The Plastic Socket

List of Materials:    dacron felt  
                               nylon stockinette (about 2 inches wide)  
                               string  
                               PVA  
                               heat pad  
                               polvester resin, catalyst, promoter and color  
                               knife  
                               rubber mallet  
                               sander

1. Make a bag of dacron felt and pull over model. Sew across the ends of about 2 inches wide nylon stockinette to make 2 more layers and pull over model. All 3 layers should extend past the proximal end of the model.



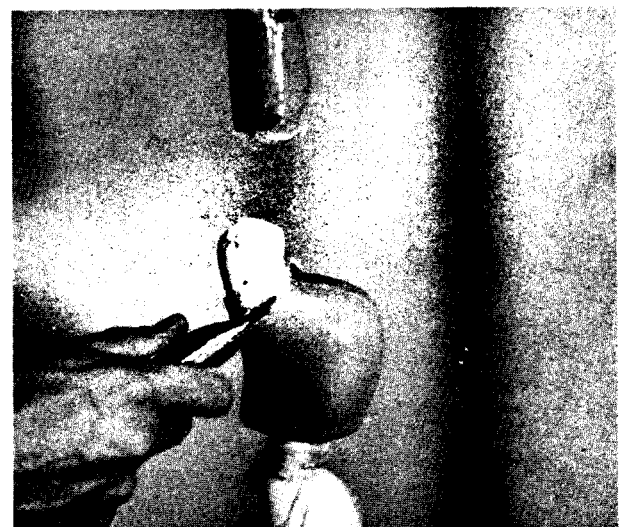
2. Make a PVA bag to fit the model. Dampen it and pull it down tightly over the model so there are no wrinkles. The use of vacuum is always recommended to get a thin but strong socket; however, the lamination of small sockets can be accomplished by the tightness of the PVA bag and by stringing the resin.



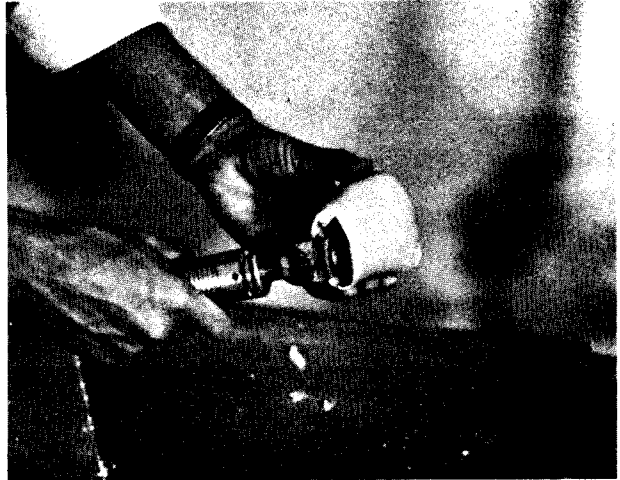
3. Mix polyester resin. Pour into the top of PVA bag and work into stockinette. Tie off the top of the bag to remove some of the excess resin.



4. When the resin has hardened, cut out the thumb hole and trim the excess plastic from the proximal and distal ends of the socket.



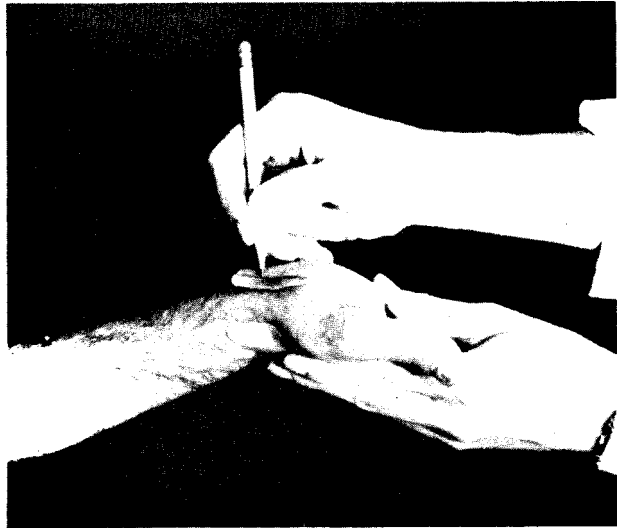
5. When the plastic has cooled, break out the plaster model and smooth the rough edges and distal end of the socket.



#### E. Fitting the Socket.

List of Materials: cast cutter  
sander  
straps  
heat gun  
Robin-Aids partial hand  
acrylic powder and liquid

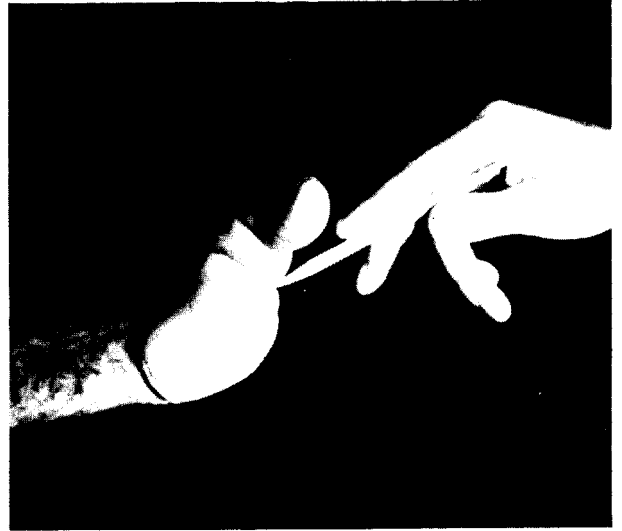
1. First cut a slot in the socket on the radial side. Try putting socket on stump. Enlarge opening as necessary to allow easy but snug entry and exit of stump. An alternate method is to make the thumb opening round and large enough to allow the MP joint to pass through.



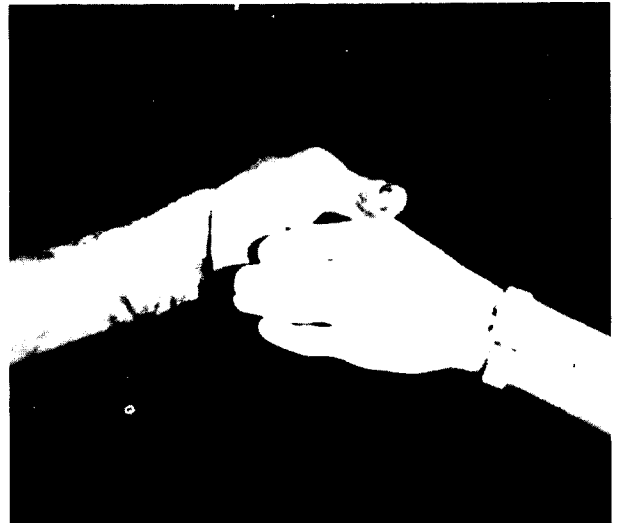
2. Trim the wrist area to allow full range of wrist motion. Then temporarily attach straps to the socket to keep it securely on the stump.



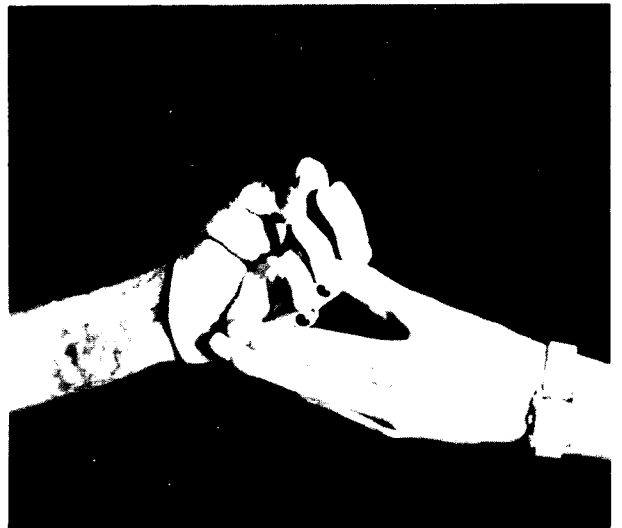
3. Trim the thumb hole to allow full range of thumb motion. The palmar side of the thumb hole should fall along the thenar crease.



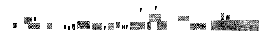
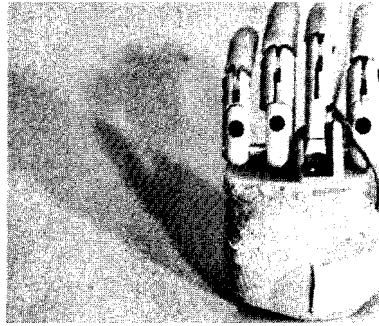
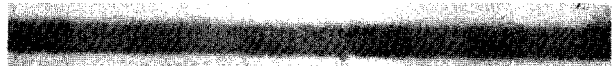
4. Apply force to the socket in various directions and examine the socket for comfortable fit in dynamic situations. Relieve any areas of discomfort by grinding away plastic or by heating and forming the socket. It may be necessary to put padding in the distal end in some cases.



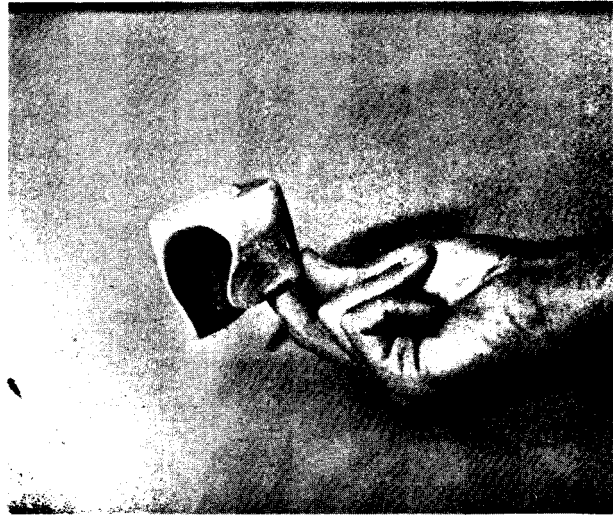
5. Once a comfortable and functional socket fit is attained, remove the thumb portion of a Robin-Aids bulk-head and align the bulk-head with fingers on the socket to give a position of 3-point prehension and so it can be blended into the socket for appearance. The bulk-head may be shaped by grinding to obtain a better placement on the socket.



6. Once an optimum position is attained, attach the bulkhead to the socket using acrylic plastic.



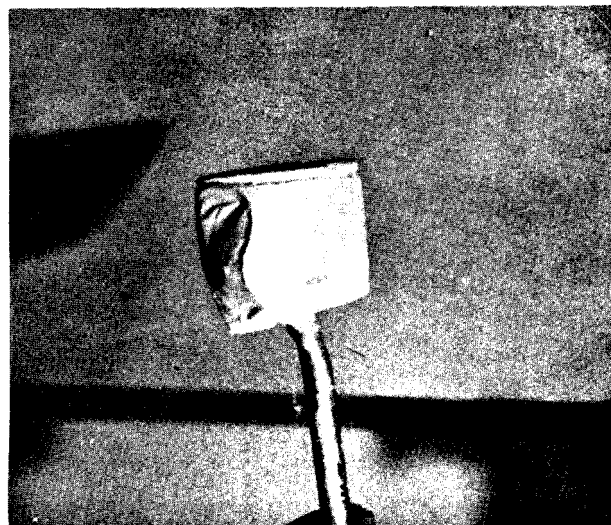
7. Remove the fingers, housing and all mechanism from the bulkhead. Fill in any spaces with acrylic, shaping to get good contours of the hand.



8. When the acrylic has hardened, smooth the surface so the bulkhead and socket blend together. Recut the groove around the bulkhead, if necessary, so the final lamination can be tied off there.



9. Put masking tape over the thumb hole and the slot and put a parting agent on the inside of the socket. Pour a mix of plaster and water into the socket, and insert a mandrel before plaster hardens.



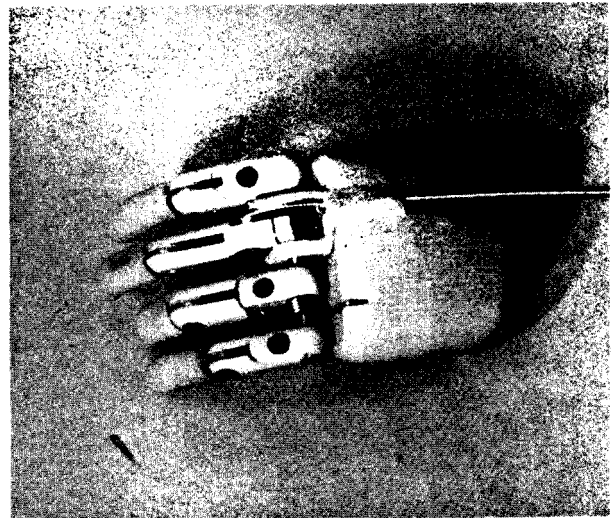
10. When the plaster hardens, remove the masking tape and trim the plaster away from the edges of the socket so that the final lamination will seal these edges. Next, put a parting agent on the plaster and put masking tape over the screw holes in the bulkhead. Do not put parting agent on the socket.

11. Pull about 2-inch wide nylon stockinette over the bulkhead and socket. With string tie off the stockinette on the groove and double over so there are 2 layers for the final lamination, which is done to more securely attach the bulkhead to the socket.



12. Make PVA bag, mix resin, and laminate as before.

13. After the final lamination has set, break out the plaster and trim the socket to the lines previously established. Re-attach the fingers and mechanism to the bulkhead. Cut a groove in the socket to conceal the cable housing. To anchor the cable housing, apply a parting agent such as silicone grease to the inside of the housing so that the acrylic will not clog the housing. Apply acrylic resin over the housing and blend into the socket. Use the full length of the housing supplied with the partial hand.



14. Cut a small groove in the socket to receive the spring that provides prehension force for the fingers. Re-attach the straps to hold the socket on the stump.

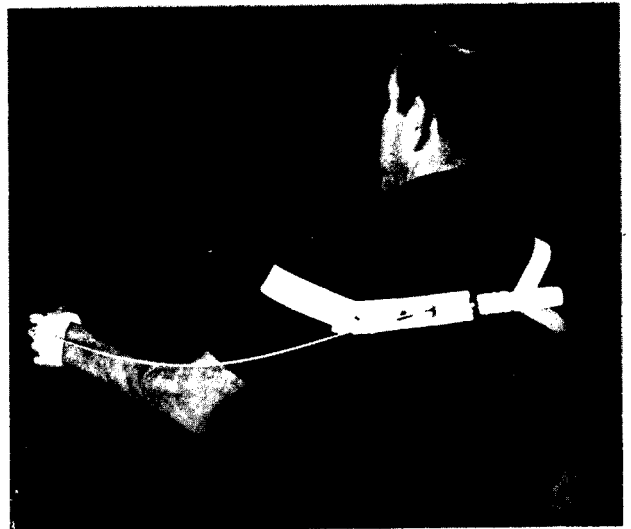


## F. Harnessing

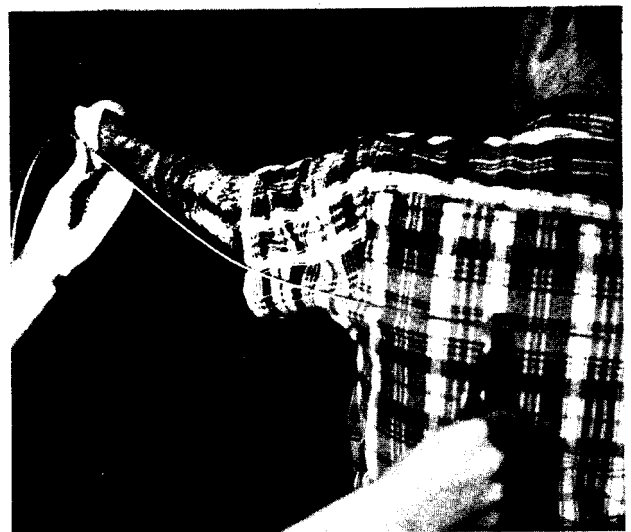
List of Materials: diagonal shears  
 plastic powder and liquid  
 dacron webbing (1 inch and 1 1/2 inch wide)  
 plastic tubing for axilla loop  
 Yates clamps  
 buckle (1 inch wide)  
 cross-bar and attachment  
 adjustable hanger

The basic type of harness to use with a partial hand prosthesis.

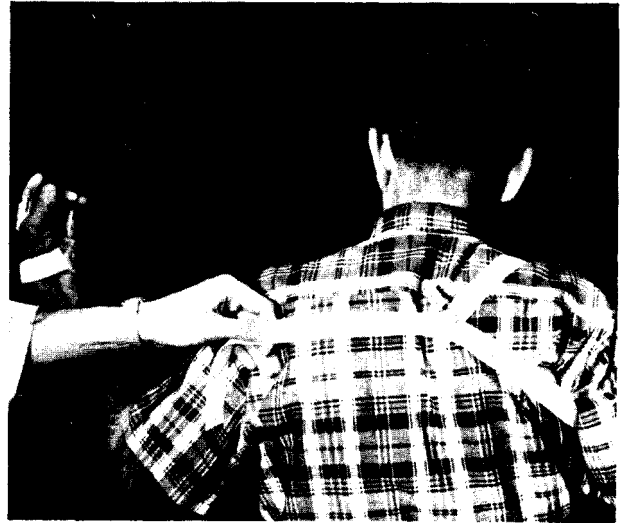
The shoulder to humeral loop. The double shoulder loop is preferred by some amputees.



1. Have the patient reach forward. Hold the cable housing from the hand along the arm and cut it at the point 1 inch lateral to the vertebral border of the scapula. Do not cut the cable.



2. Make the opposite shoulder loop with 1 inch wide dacron webbing. It should extend about the vertebral border of the scapula. Place plastic tubing over the dacron for comfort in the axilla area. Temporarily fasten with a clamp.



3. Attach a buckle using 1 inch wide dacron webbing and a clamp for temporary fastening. Allow the webbing to extend across the back to the amputated side of the body.



4. Make the humeral loop of 1 1/2 inch wide dacron webbing and clamp as shown. Let the webbing extend to the opposite side to provide a backing so the control cable will not be on the skin.



5. Form the humeral loop so **that** the webbing extends horizontally across the back and as close to the axilla as possible. Cover the webbing with plastic tubing.



6. Thread a cross-bar on the housing one inch from the end. Clamp a cross-bar attachment on the humeral loop webbing, and put the cross-bar in the attachment. Fasten an adjustable hanger to the cable as illustrated.



7. Put the free end of the webbing from the shoulder loop through the hanger and back to the buckle to hold in place.

8. Remove the adjustable hanger, cut the cable, and swage or solder a permanent hanger to the cable. Then attach the harness to the control system and the prosthesis is now functionally completed!



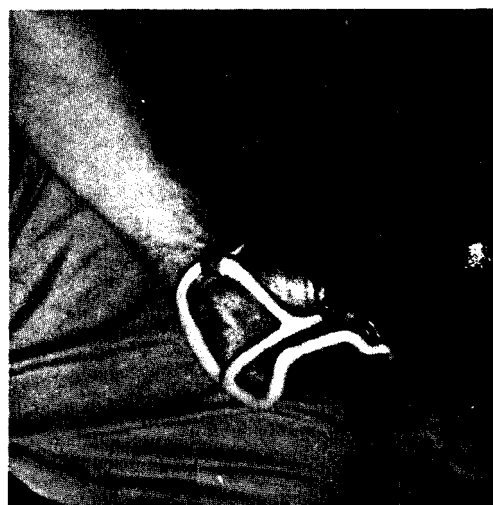
To cosmetically finish the prosthesis, a glove is installed over the hand. Some patients prefer the thumb portion of the glove to be removed for improved sensation.

Some patients prefer maximum cosmetic effect and give up the sense of feel. (Details about cosmetic gloves are covered in Cosmesis- Chapter 8.)

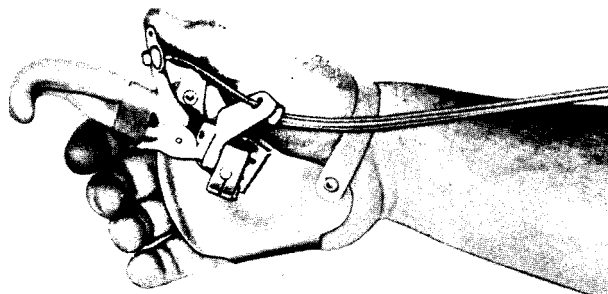
### Special Devices

It is always possible to make special devices to fit the needs of particular variations of the partial hand amputation.

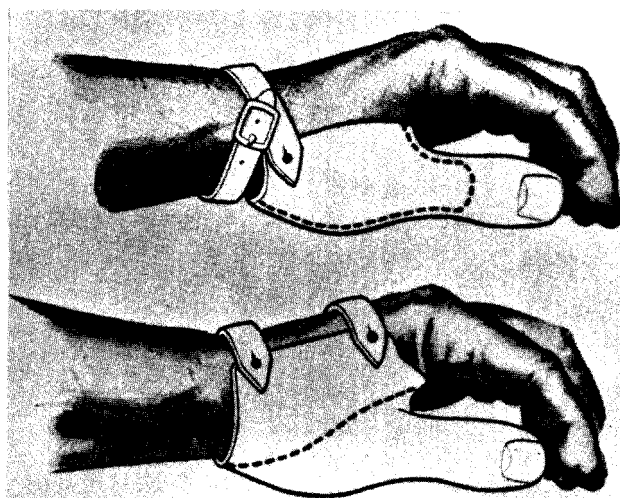
The device shown in the illustration was bent from steel rod and coated with plastisol. The patient can oppose the thumb to provide prehension and can use the hook shape for lifting.



The handi-hook is commercially available. It is used in non-operative situations, absence of sensation, extensive scarring or patient's preference.



When the thumb is missing, a simple thumb prosthesis can be fabricated. The diagram at the right shows both a transmetacarpal and a total thumb amputation. This variation of the hand prosthesis is used for light work situations.



The thumb amputation prosthesis variation shown is used when heavy duty use is anticipated or in the presence of a weak wrist. The wrist and forearm extension offers added stability.

