PACK 8

THE TERMINATOR™

BUILD THE T-800

1:2 SCALE

THE MOST LEGENDARY CYBORG IN SCIENCE FICTION HISTORY!

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AGORA MODELS

THE TERMINATOR™

BUILD THE T-800

PACK 8

CONTENTS

IDENTIFYING YOUR COMPONENTS: Each of your Terminator packs is divided into stages. Each stage contains a number of components, and can be identified by referring to the images in your assembly guide or the number located on the sticker on the back of each stage. Each number begins with '77' and is followed by a further three digits. The last three digits indicate the number of each stage. For example, 77 001 indicates stage 01, 77 002 indicates stage 02, etc.

Find more helpful building tips and advice at community.agoramodels.com

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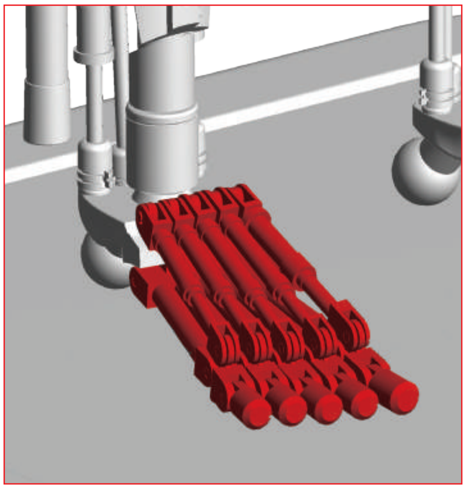
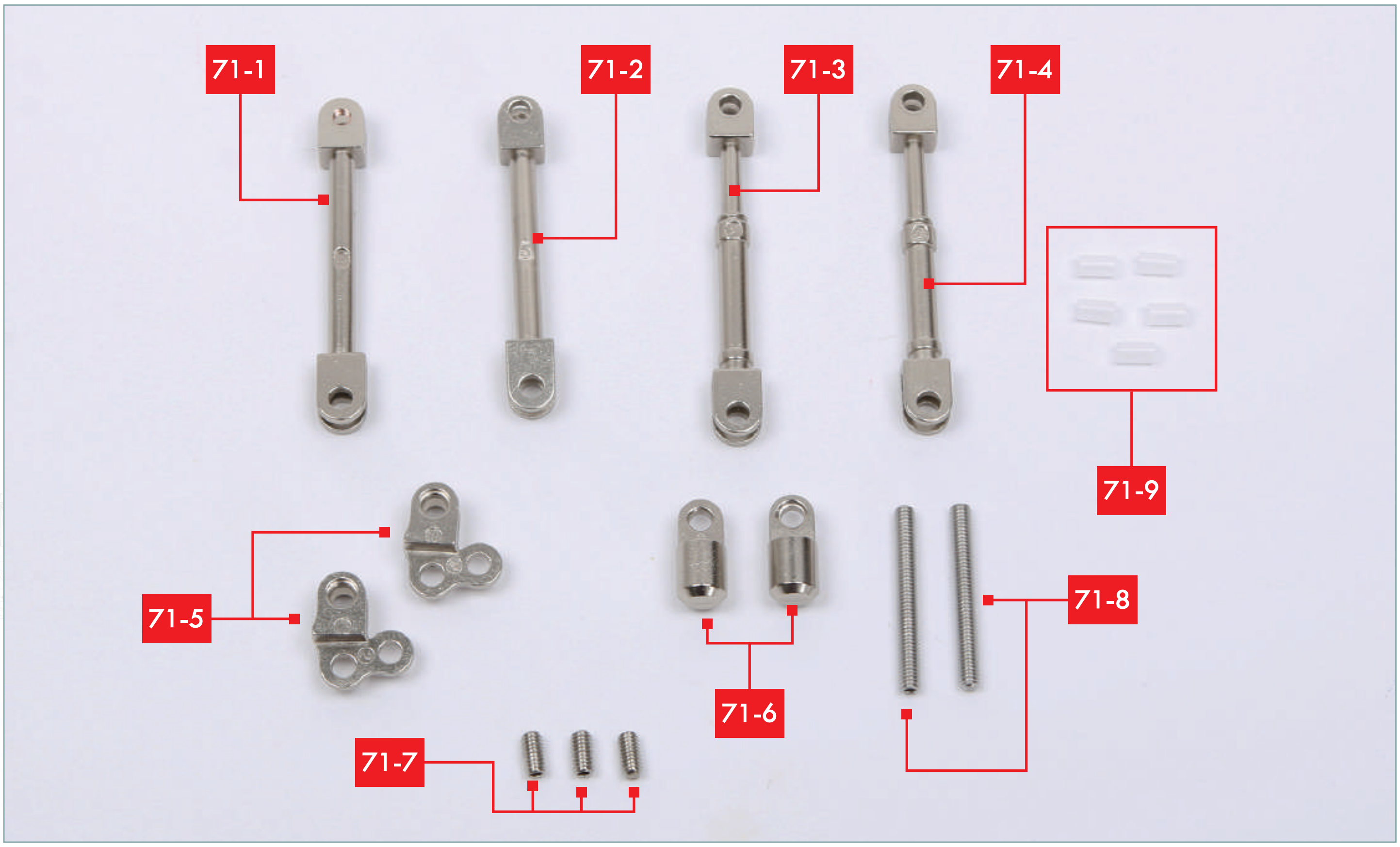
Not suitable for children under the age of 14. This product is not a toy and is not designed for use in play. Keep the parts out of the reach of small children. Some parts may have sharp edges. Please handle them with care.

STAGE 71: ASSEMBLING FOOT PARTS AND ATTACHING THEM TO THE RIGHT LEG

Put together the fourth and fifth foot parts for the right foot, attach the toes, and bolt them into place.





LIST OF PIECES

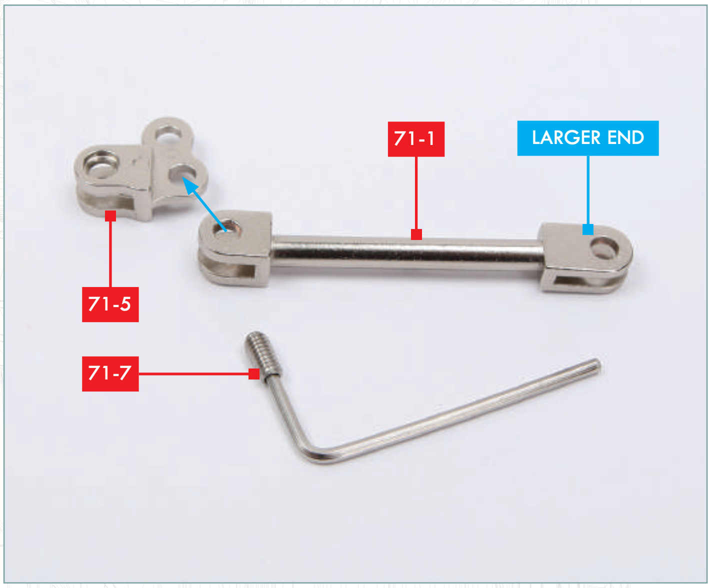
71-1	Foot part (marked 4)	71-6	Toe x 2
71-2	Foot part (marked 5)	71-7	Three 4 x 8mm grub screws (1 spare)
71-3	Foot part (marked 4)	71-8	Two 4 x 35mm grub screws
71-4	Foot part (marked 5)	71-9	Plastic sleeves x 5 (1 spare)
71-5	Toe joint x 2		

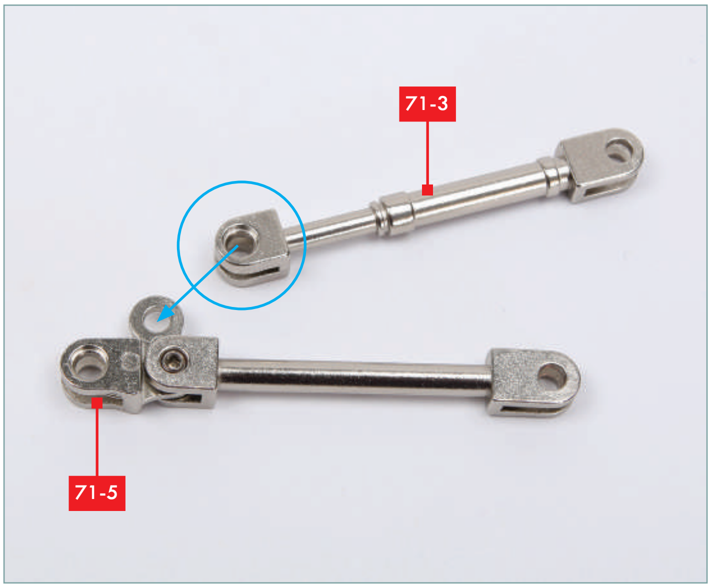
YOU WILL ALSO NEED

Sharp craft knife and cutting mat.

Allen key (supplied with an earlier stage).

The remaining plastic pins 69-7 on the frame supplied with stage 69.



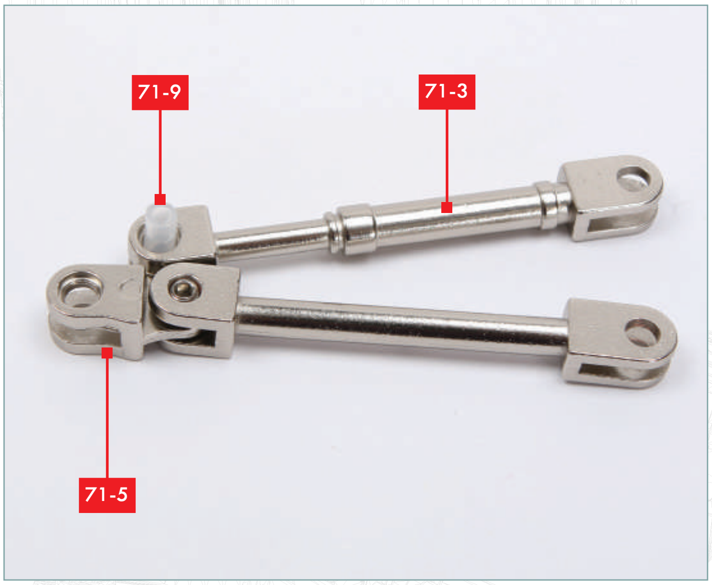


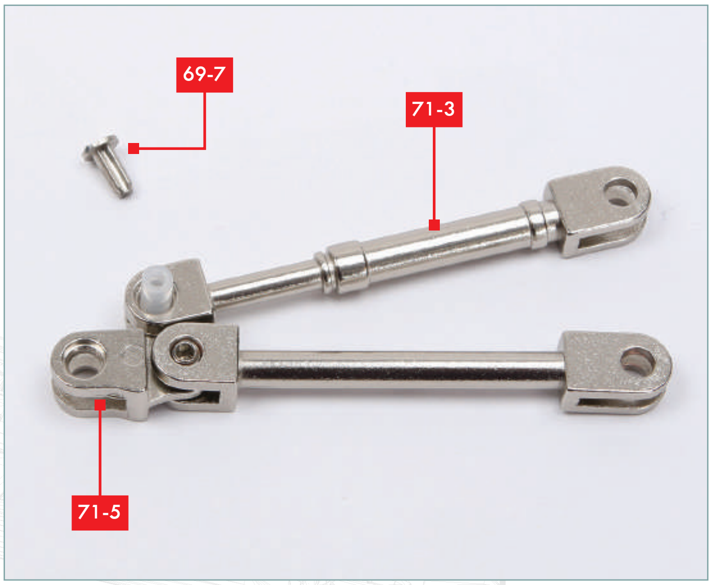
STEP 1

Take the lower foot part **71-1** (marked 4) and one of the joints **71-5**. You will also need a short grub screw **71-7** and an Allen key. Place part **71-1** on the work surface with the embossed number facing downwards. Fit the joint together as indicated and fix the parts in place with the screw **71-7**. As with previous foot parts, note that one of the joints on the numbered bars of the foot is larger than the other. The smaller part needs to be fitted to the joints **71-5**.

STEP 2

Take part **71-3** (marked 4) and position it with the embossed number facing downwards. Fit part **71-3** over the upper hole in part **71-5**, as indicated. Note that one of the holes in the joint of part **71-3** is recessed (circled).



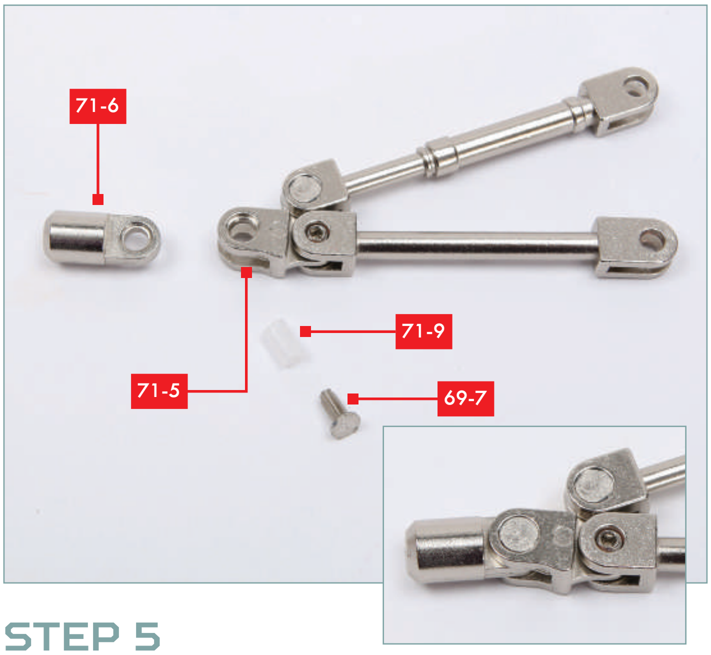


STEP 3

Fit a plastic sleeve **71-9** into the joint between **71-5** and **71-3**.

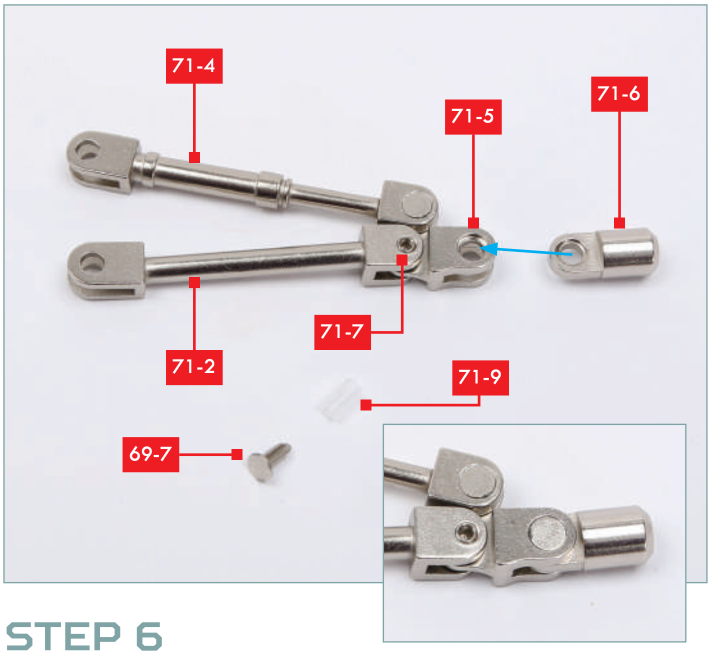
STEP 4

Remove a pin **69-7** from the frame and fit it into the plastic sleeve. The head of the pin should be pushed firmly into the recess to give a flush finish to the joint.



STEP 5

Take a toe **71-6** and fit the hole into the joint **71-5** as indicated. Fit a plastic sleeve **71-9** into the joint and then a pin **69-7**. Again, the head of the pin should be pushed into the recess to give a flush finish. The inset shows the pin in place.



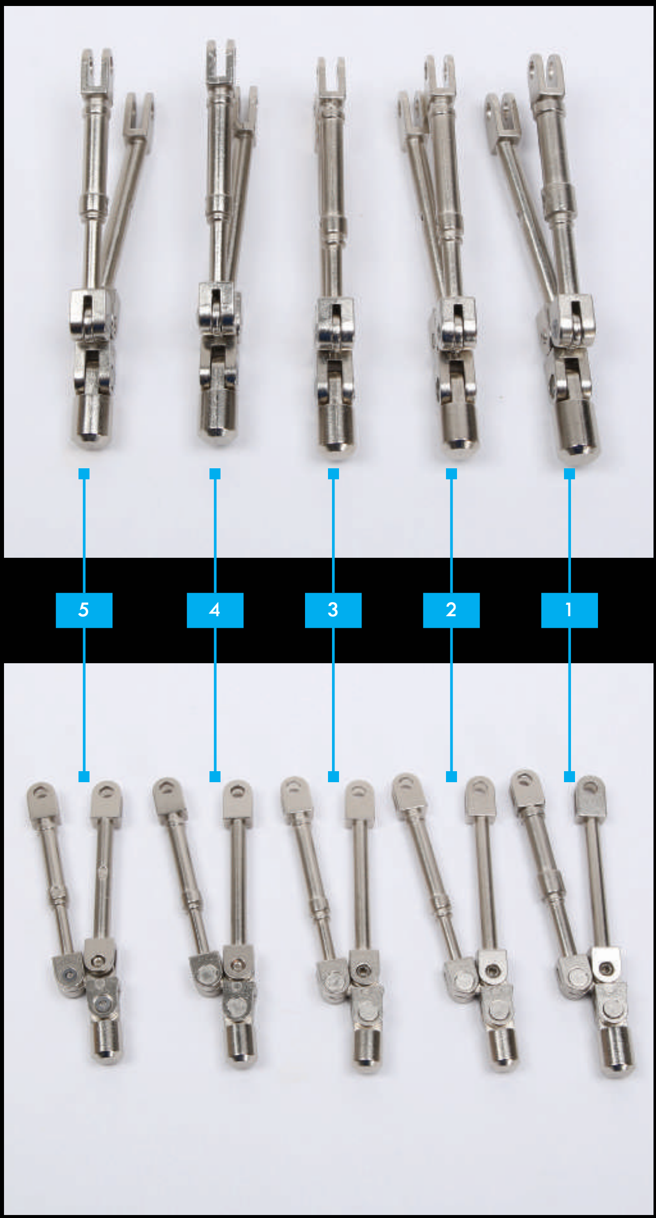
STEP 6

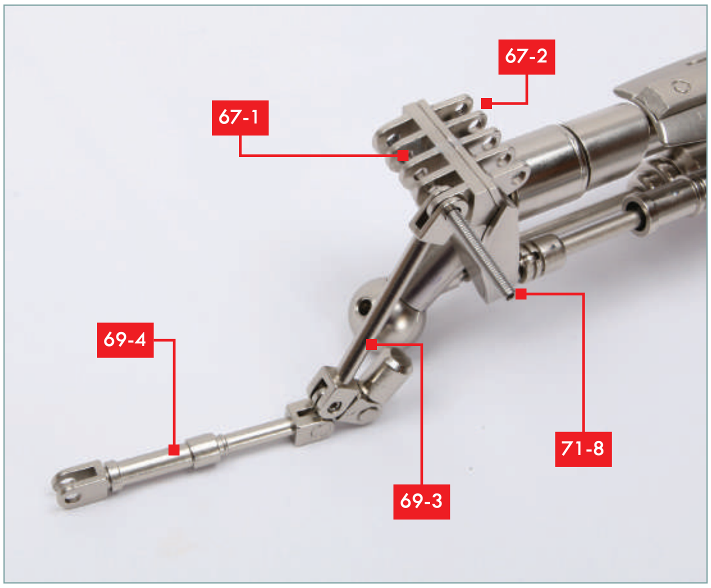
The fifth part of the foot is assembled in a similar way. However, in order to fit the parts together correctly, with the embossed numbers (5) and recessed holes in the right positions, you will find that you need to position the parts the other way round, as shown. This will give a flush finish on the outer side of the foot when it is assembled (inset).

EXPERT TIP!

Note that the bars that form the foot are carefully shaped. They must be put together the right way round to ensure the foot has its proper shape and the elements fit together properly. These photographs show the five elements of the foot from above (top), to show how the lower 'bones' of the the foot parts are angled to splay out from the ankle/heel towards the toes.

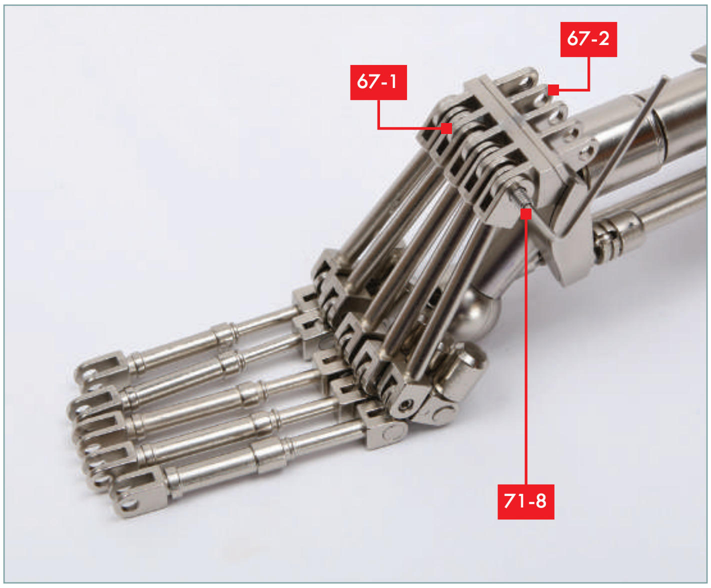
When the foot parts are turned on their sides, you can see that foot parts 1–4 all have the heads of the pins flush in the joints on the same side. Foot part 5 has been assembled the other way round, so that the flush pin heads are on the outside of the foot.





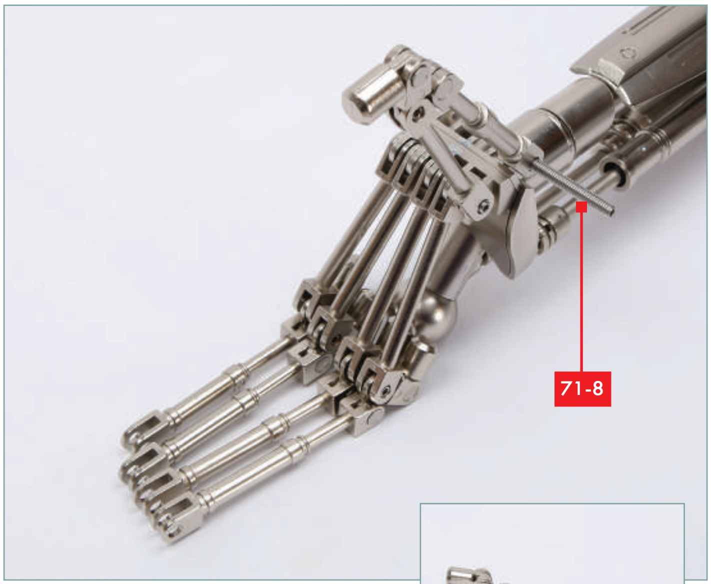
STEP 7

Take the assembly from stage 69 and position it so that you can access the ankle parts **67-2** and **67-1**. Take the foot section with the bars marked 1 and fit the joint on the end of the lower foot part **69-3** on to the first tab on part **67-1**. Start to slide a long grub screw **71-8** into the joint. The upper foot part **69-4** will eventually be fitted to the matching tab on part **67-2**.



STEP 8

Following the number sequence, fit foot sections 2, 3, 4 and 5 in place on part **67-1**, threading the grub screw **71-8** through the holes. When the foot sections are all in place, use the Allen key to screw the grub screw into the thread in the last tab on part **67-1**.



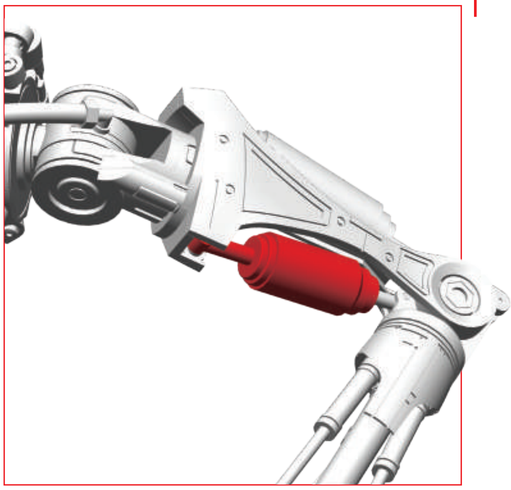
STEP 9

In a similar way, fit the upper foot parts of each foot section in place on part **67-2**, threading a second grub screw **71-8** through the holes. As before, use the Allen key to screw the grub screw through the thread of the last tab in part **67-2**.

STAGE COMPLETE!

Two more foot sections have been assembled and the foot parts have been fitted to the bottom of the right leg.

STAGE 72: THE FIRST PARTS FOR THE LEFT ARM



Construction of the 'sinister' side of the Terminator T-800 Endoskeleton begins with the assembly of the left bicep muscle.

LIST OF PIECES

72-1	Left arm part
72-2	Shaft for arm part
72-3	Cap for arm part
72-4	Two 3 x 8mm PM screws (1 spare)

YOU WILL ALSO NEED

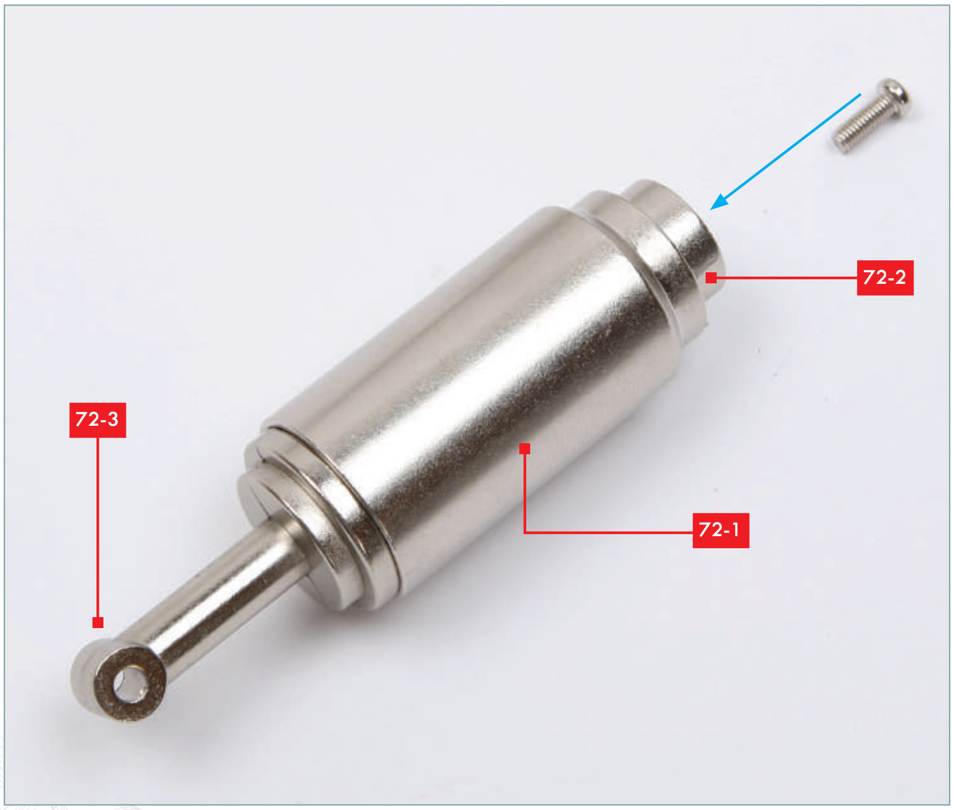
A fine cross-head screwdriver.

STEP 1

Fit the shaft **72-2** into the left arm part **72-1**.

STEP 2

Fit the cap **72-3** over the other end of the arm part **72-1**. Note that there is a screw socket in the centre of the cap, which should align with the hole in the end of the shaft **72-2**, as indicated by the arrow.



STEP 3

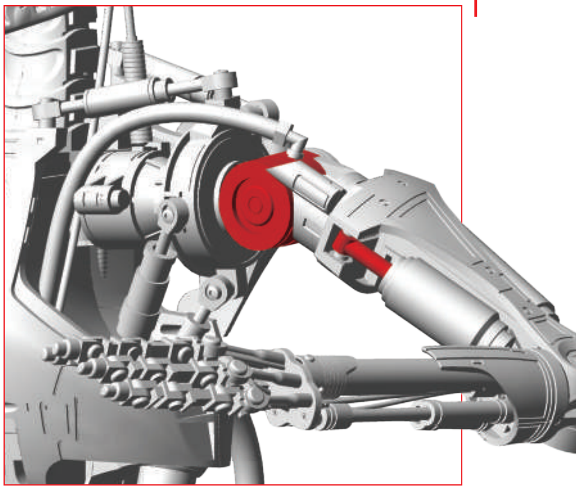
Fit a 3 x 8mm **PM** screw down through the hole in the shaft so that you can screw it into the socket in the cap **72-3**. Fix the parts together.

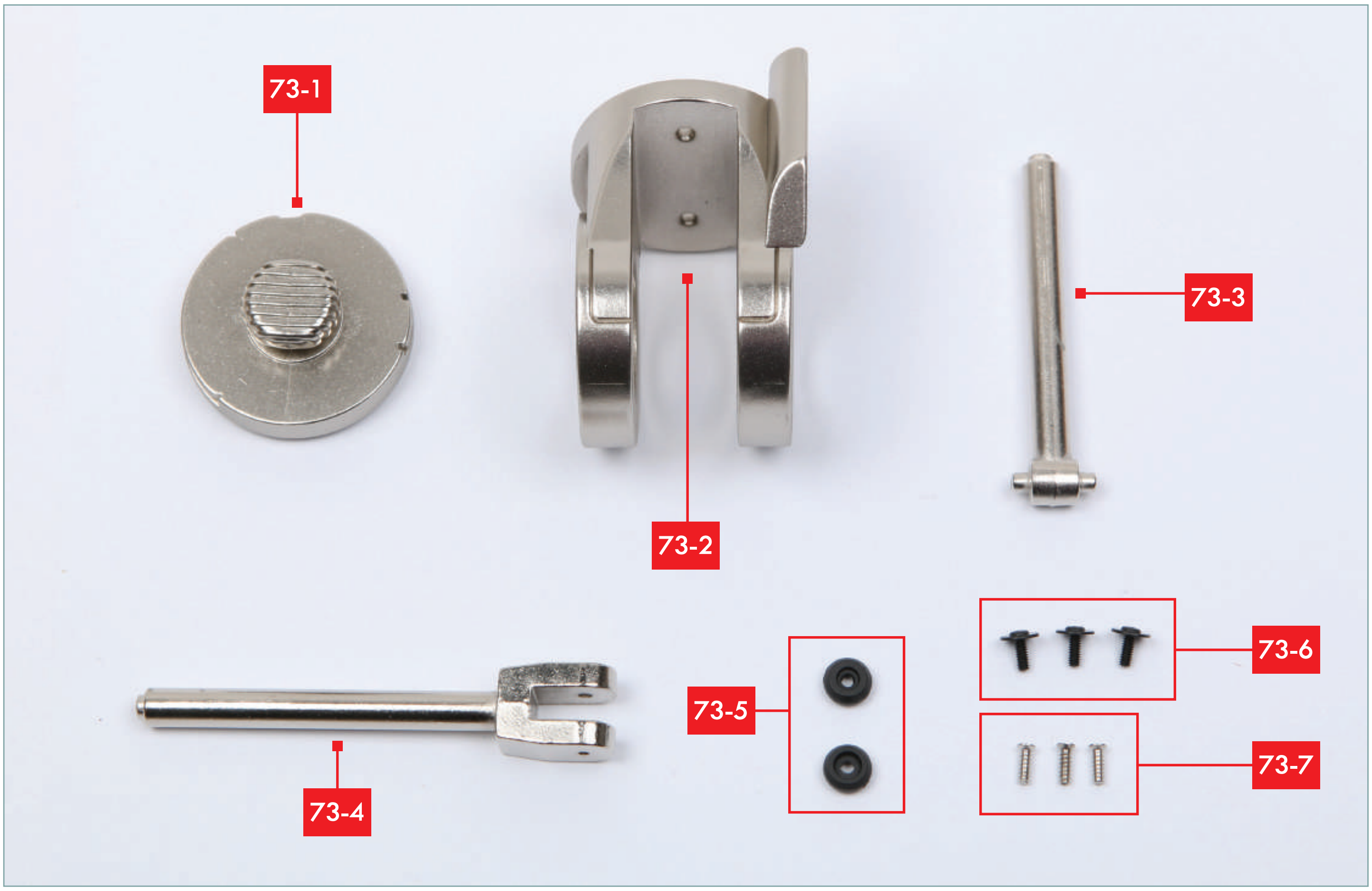
STAGE COMPLETE!

The first part of the left arm has been assembled.

STAGE 73: FIT COMPONENTS FOR THE LEFT SHOULDER AND ARM

Assemble the main shoulder joint and prepare two connective shafts to join the shoulder to the left arm.



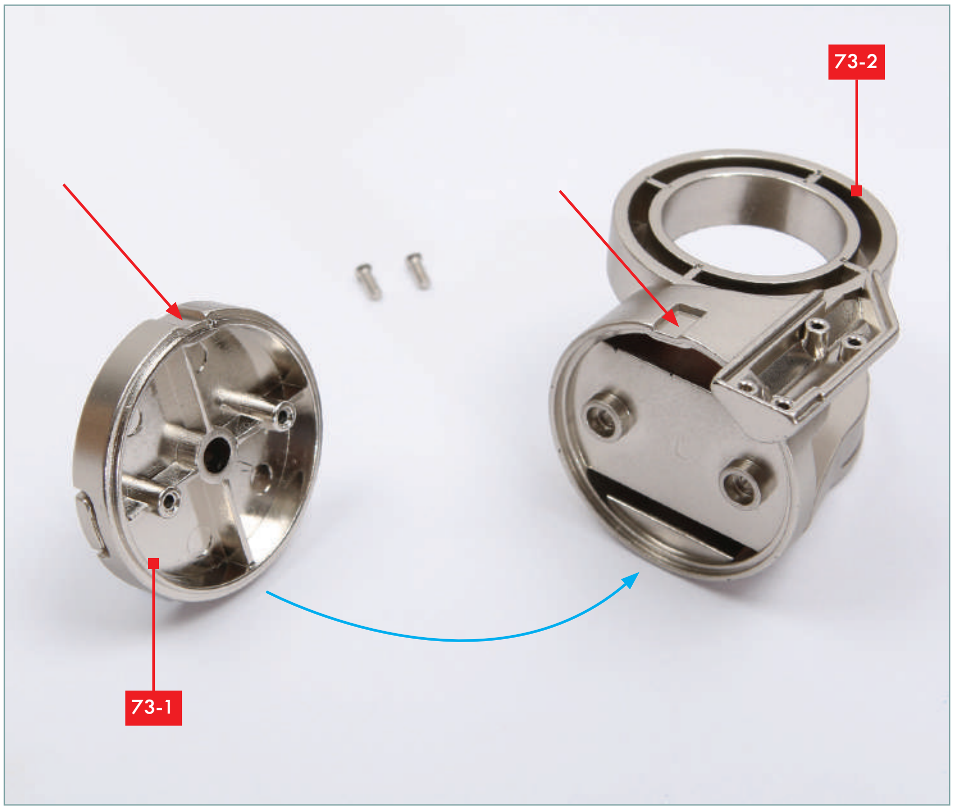


LIST OF PIECES

73-1	Shoulder part
73-2	Shoulder joint
73-3	Shaft for left arm
73-4	Shaft for left arm
73-5	Rubber washers x 2
73-6	Three PWM 2 x 5mm screws (1 spare)
73-7	Three KB 2 x 6mm screws (1 spare)

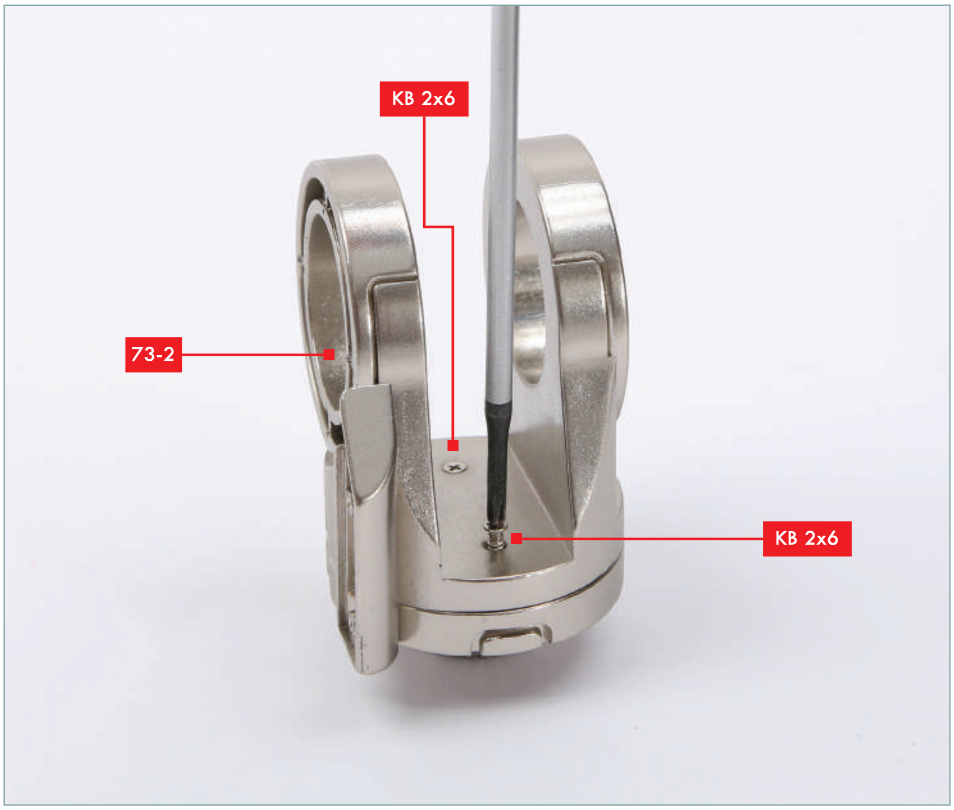
YOU WILL ALSO NEED

A fine cross-head screwdriver.



STEP 1

Take shoulder parts **73-1** and **73-2**. Note that each part has a recess on the side (red arrows). These recesses should be aligned. Fit the parts together, as indicated by the blue arrow.



STEP 2

Fix the parts together by fitting two **KB** 2 x 6mm screws through the screw holes in part **73-2** and into the sockets in part **73-1**.

STEP 3

Take shaft **73-3**, together with a rubber washer **73-5** and a **PWM** 2 x 5mm screw.

STEP 4

Fit the rubber washer **73-5** over the end of the shaft **73-3**. Note that one side of the washer has a larger recess, which fits better over the end of the shaft (inset). Fix in place with a **PWM** 2 x 5mm screw.

STEP 5

Take shaft **73-4**, together with the second rubber washer **73-5** and a **PWM** 2 x 5mm screw.

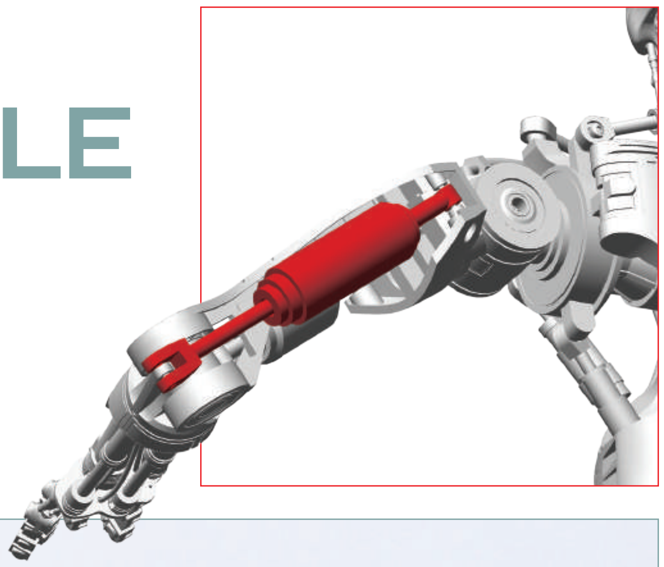
STEP 6

Fit the rubber washer **73-5** over the end of the shaft. Note that one side of the washer has a larger recess, which fits better over the end of the shaft. Fix in place with a **PWM** 2 x 5mm screw.

STAGE COMPLETE!

Part of the shoulder joint has been assembled. Two shafts have been prepared, ready to fit into left arm parts.

STAGE 74: TRICEP MUSCLE OF THE LEFT ARM



Assemble the tricep for the reverse of the left arm, and add the connecting rod from the previous stage.

LIST OF PIECES

74-1	Left arm part
74-2	Shaft for arm part
74-3	Cap for arm part
74-4	Two 3 x 8mm PM screws (1 spare)

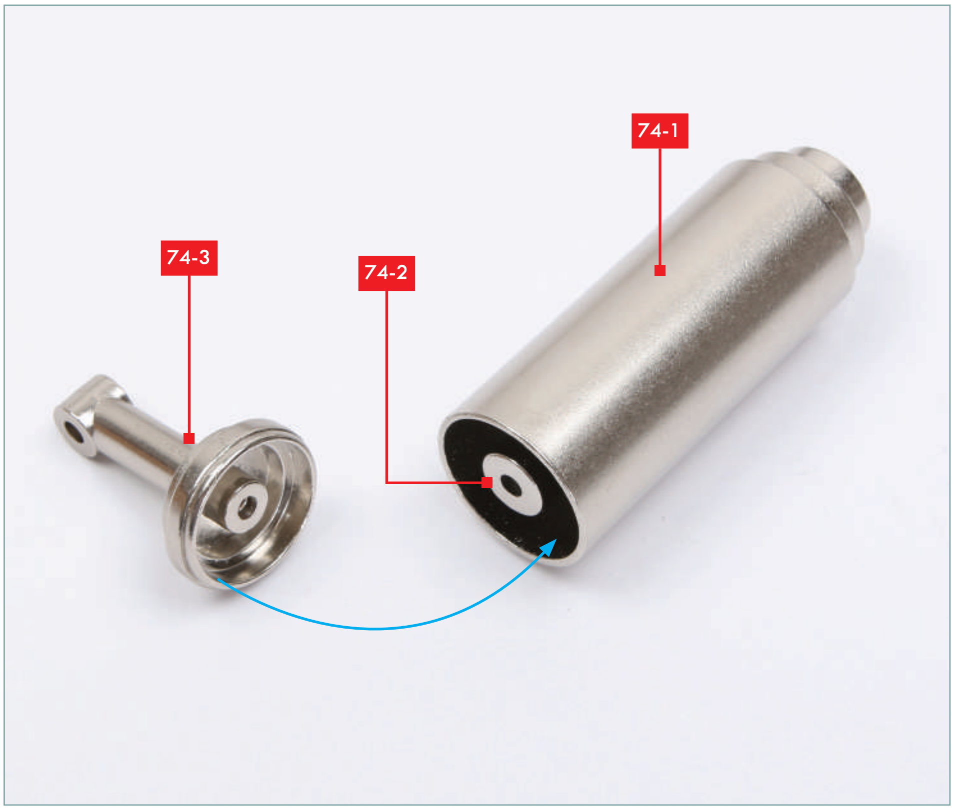
YOU WILL ALSO NEED

A long cross-head screwdriver.

Connective shaft 73-4 from stage 73

STEP 1

Fit the shaft **74-2** into the left arm part **74-1**.

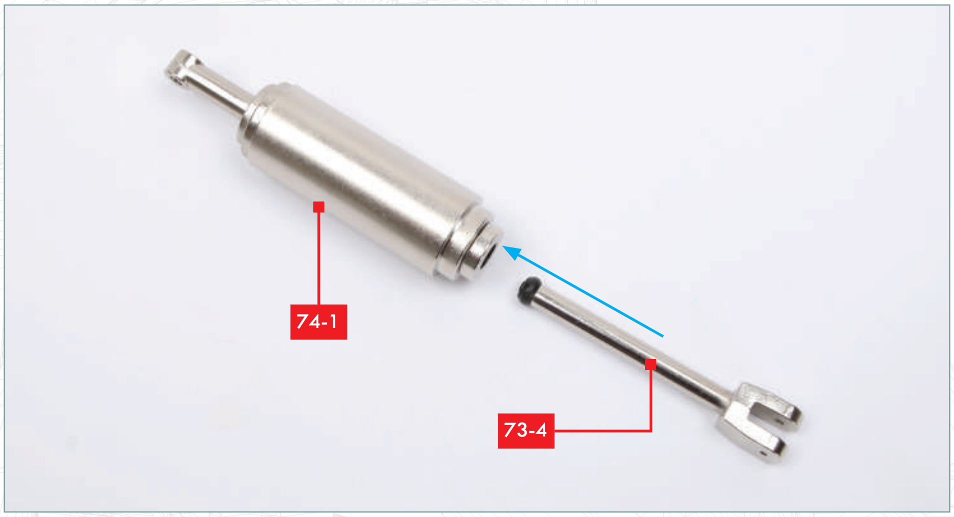


STEP 2

Fit the cap **74-3** over the other end of the arm part **74-1**. Note that there is a screw socket in the centre of the cap which should align with the hole in the end of the shaft **74-2**.

STEP 3

Fit a 3 x 8mm PM screw down through the hole in the shaft **74-2** so that you can screw it in to the socket in the cap **74-3**. Fix the parts together.



STEP 4

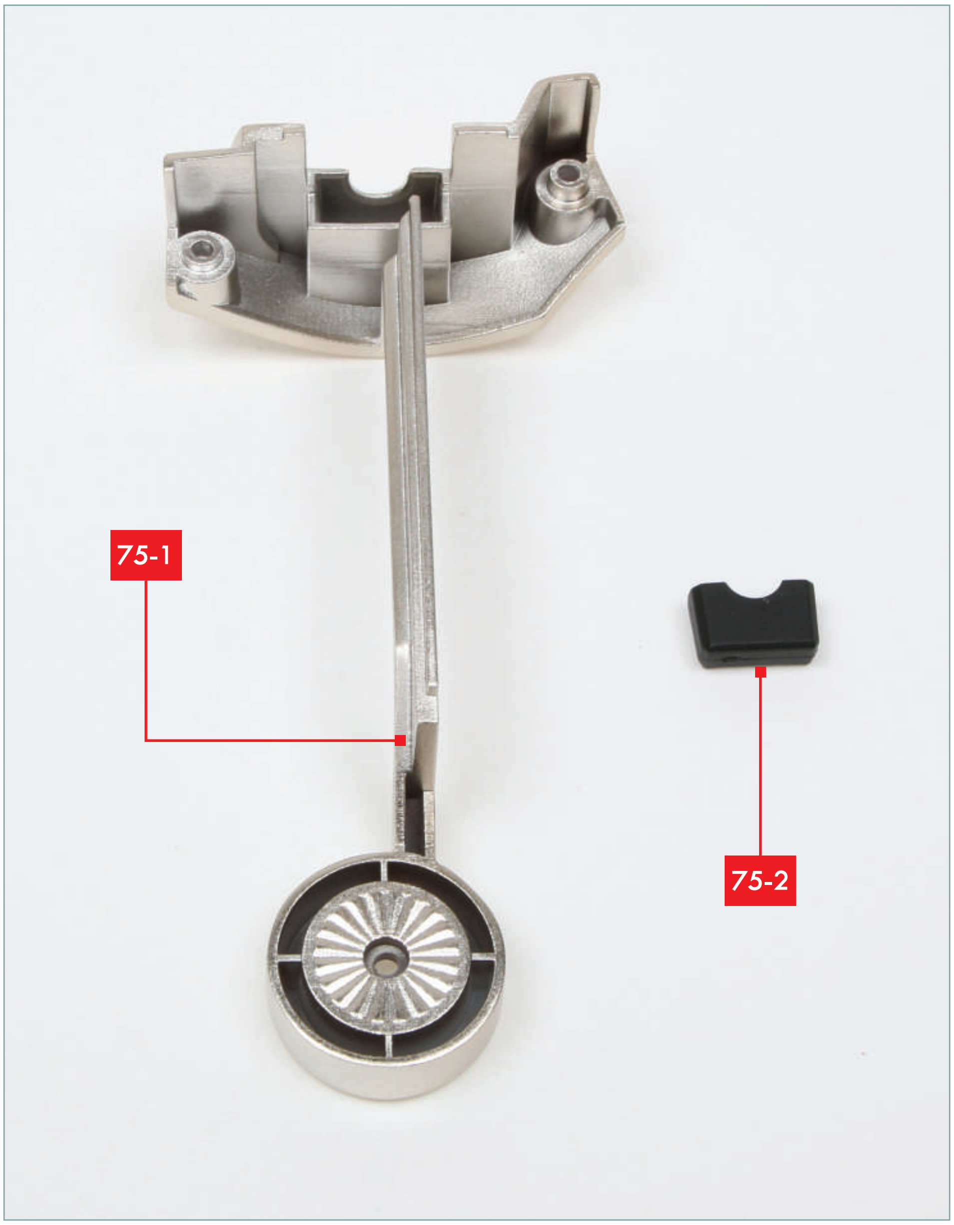
Take the shaft **73-4** assembled in stage 73. Fit the end with the rubber washer into the shaft **74-2**, inside part **74-1**.

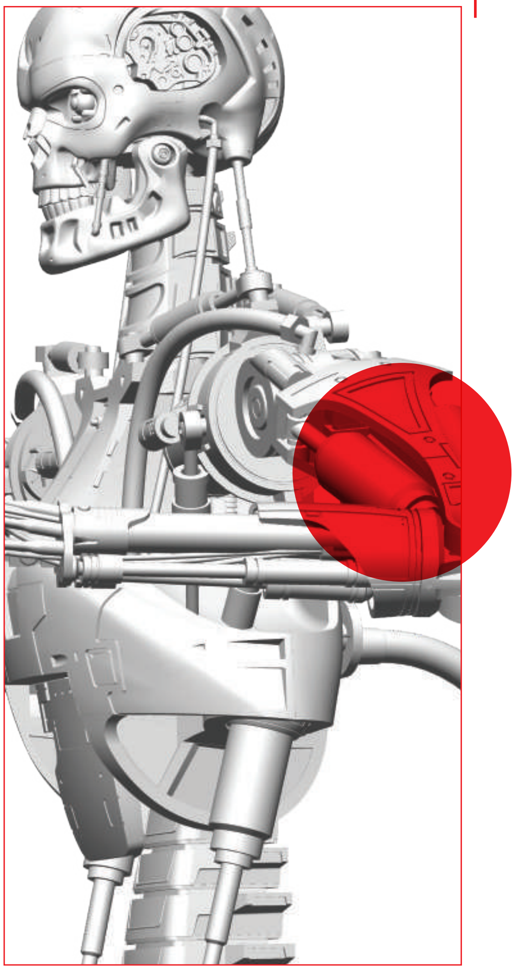
STAGE COMPLETE!

Another part of the left arm has been assembled.

STAGE 75: FURTHER PARTS FOR THE LEFT UPPER ARM

Affix the socket liner into the upper arm part, preparing it for the next connection.



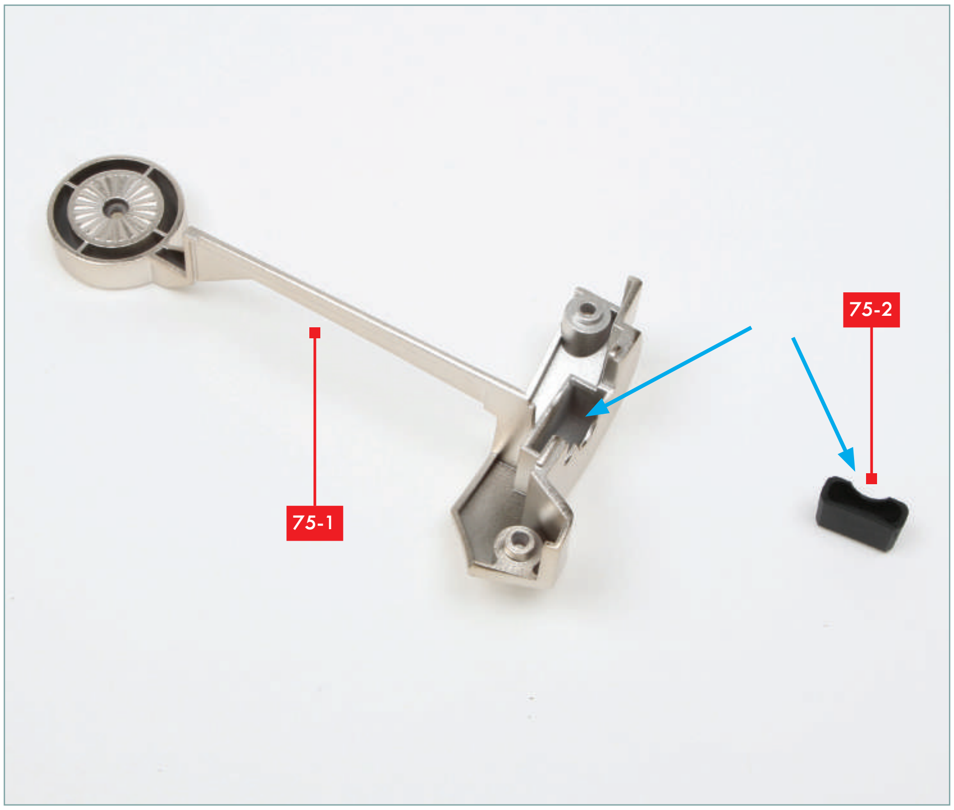


LIST OF PIECES

75-1	Left upper arm part
75-2	Socket liner for left upper arm part

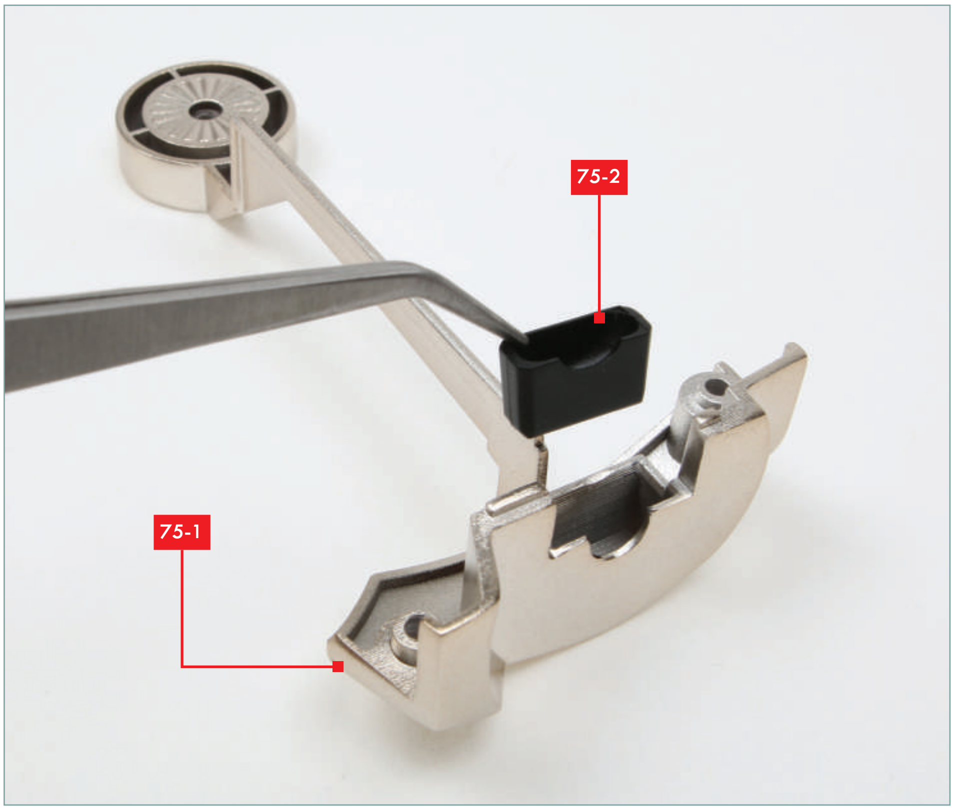
YOU WILL ALSO NEED

Tweezers (optional).



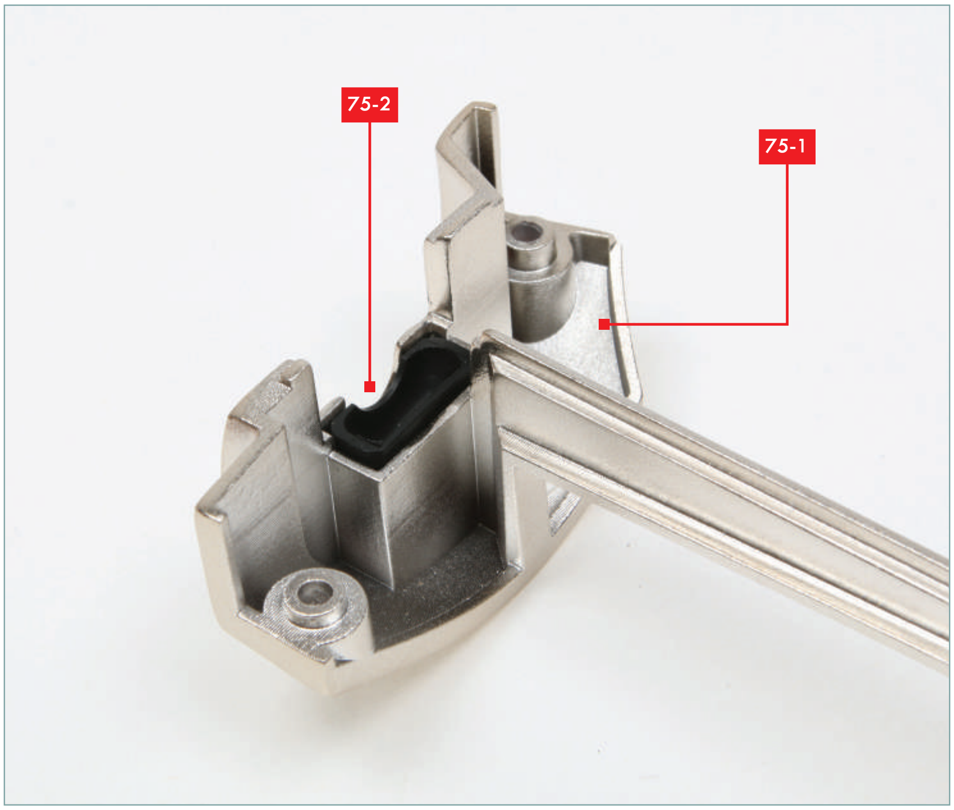
STEP 1

Take the upper arm part **75-1** and the socket liner **75-2**. Note the indent in the rim of the socket and the rim of the socket liner (arrows).



STEP 2

Fit the socket liner **75-2** into the socket in the upper arm part **75-1** with the indents aligned.



STEP 3

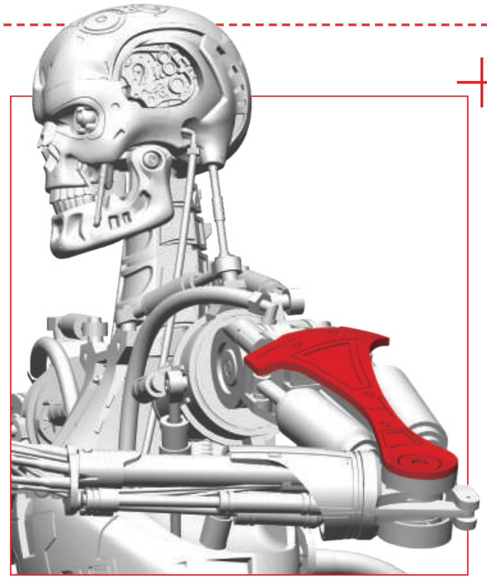
Ensure that the socket liner **75-2** is pushed fully home so that the rims of parts **75-2** and **75-1** are aligned.

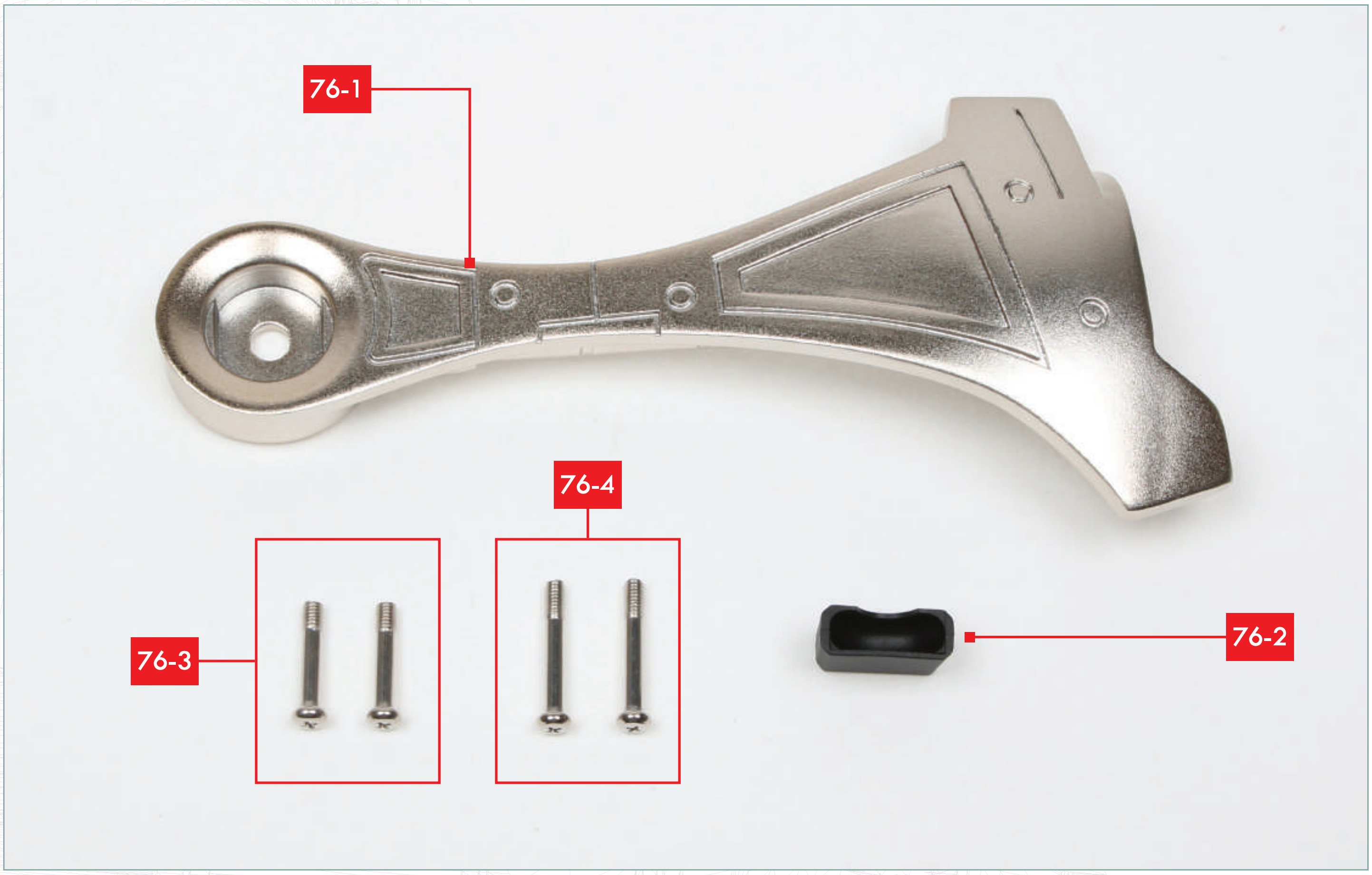
STAGE COMPLETE!

A liner has been fitted into a socket in part of the left upper arm.

STAGE 76: FURTHER COMPONENTS FOR THE LEFT UPPER ARM

Assemble four upper arm components to complete the left shoulder joint.





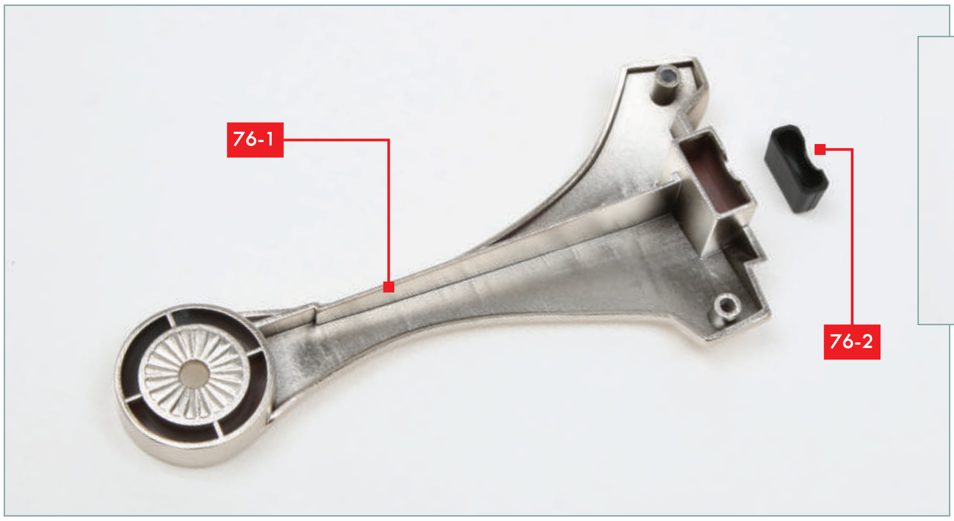
LIST OF PIECES

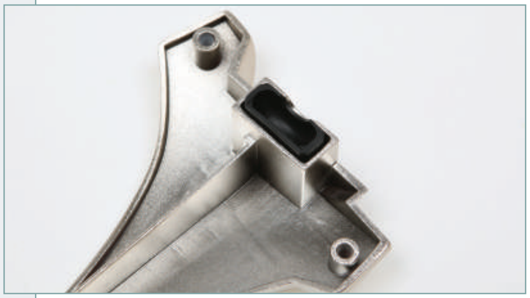
76-1	Outer side of left upper arm
76-2	Socket liner for left upper arm part
76-3	Two 3 x 16mm PM screws (1 spare)
76-4	Two 3 x 20mm PM screws (1 spare)

YOU WILL ALSO NEED

A cross-head screwdriver.

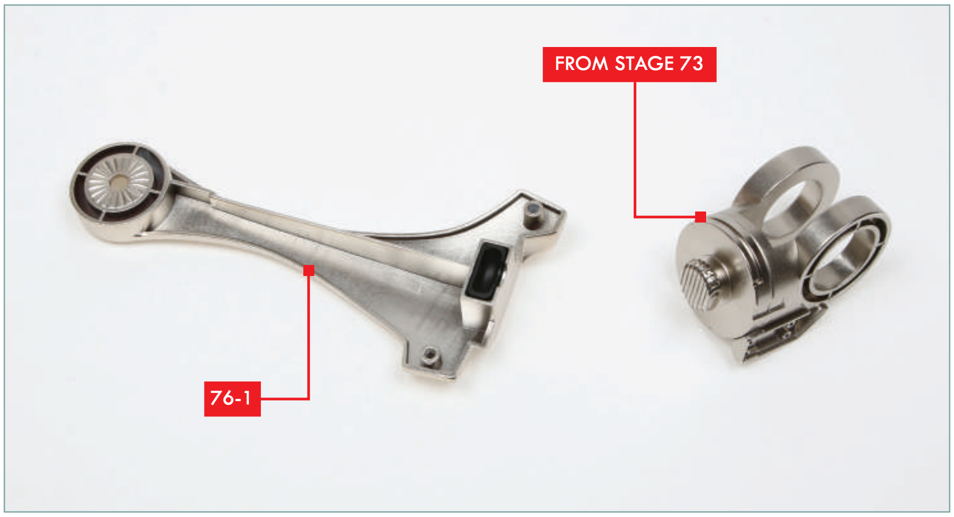
Parts from stage 73, 74 and 75





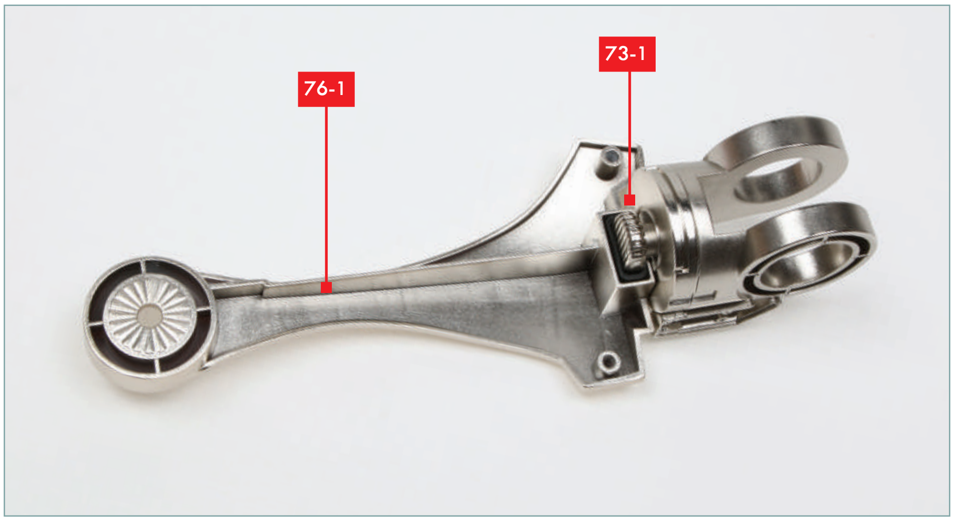
STEP 1

Take the socket liner **76-2** and fit it into the socket in upper arm part **76-1**. The rim of the socket and the rim of the socket liner should be aligned (inset).



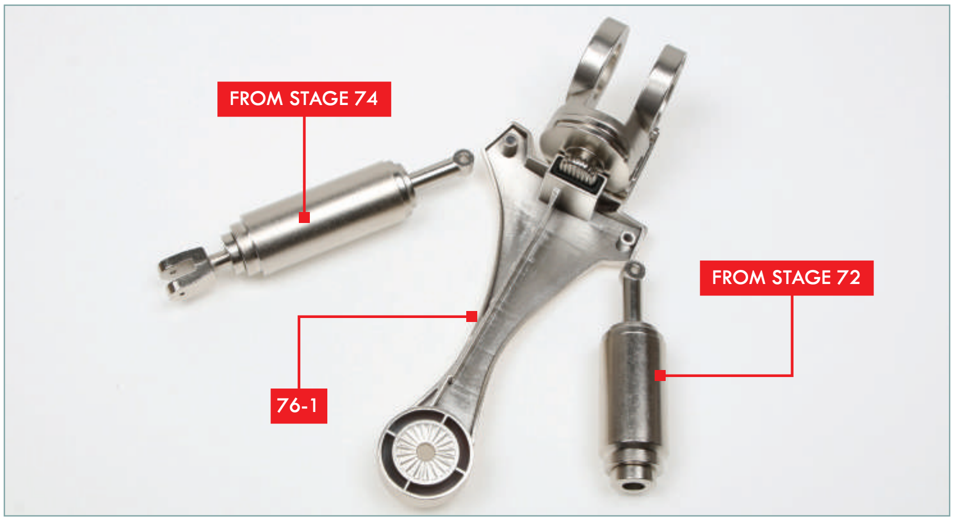
STEP 2

Take the shoulder joint assembly from stage 73 and the upper arm part **76-1**.



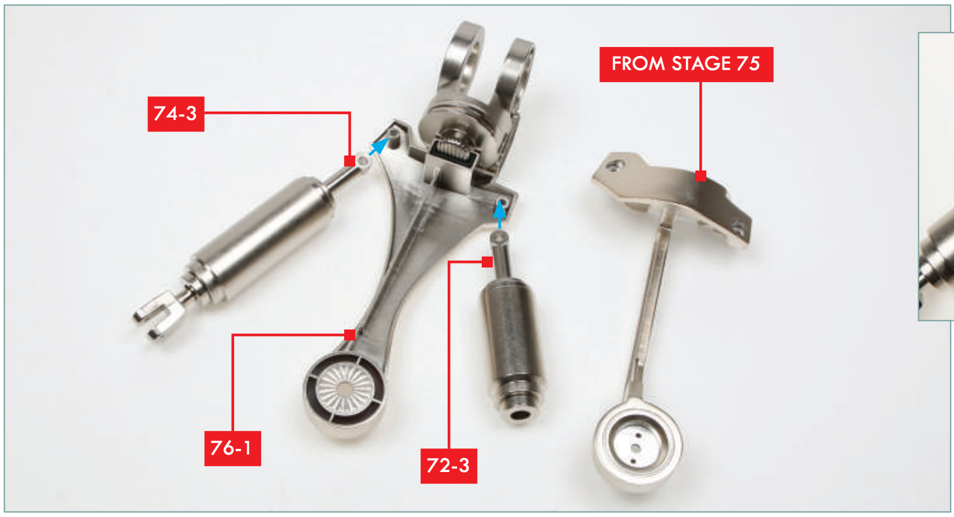
STEP 3

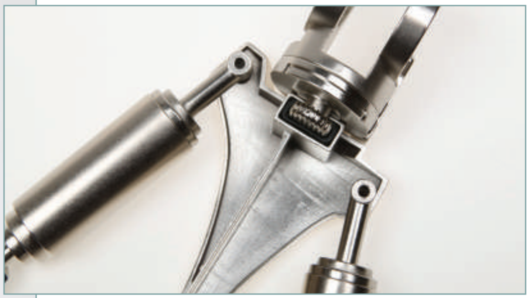
Fit the knob on shoulder joint part **73-1** into the lined socket in upper arm part **76-1**.



STEP 4

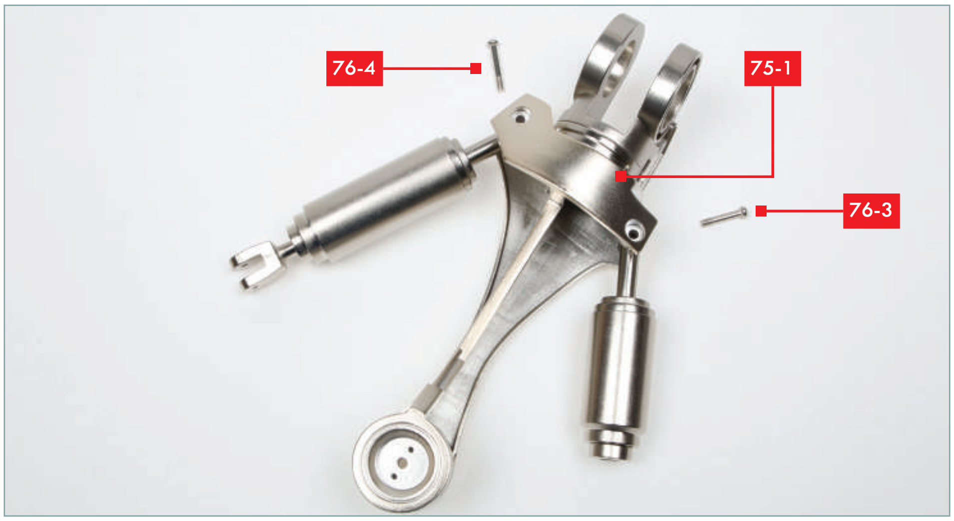
Take the arm part assemblies from stages 72 and 74 and position them as shown, on either side of part **76-1**. Note that the assembly from stage 74 is larger.





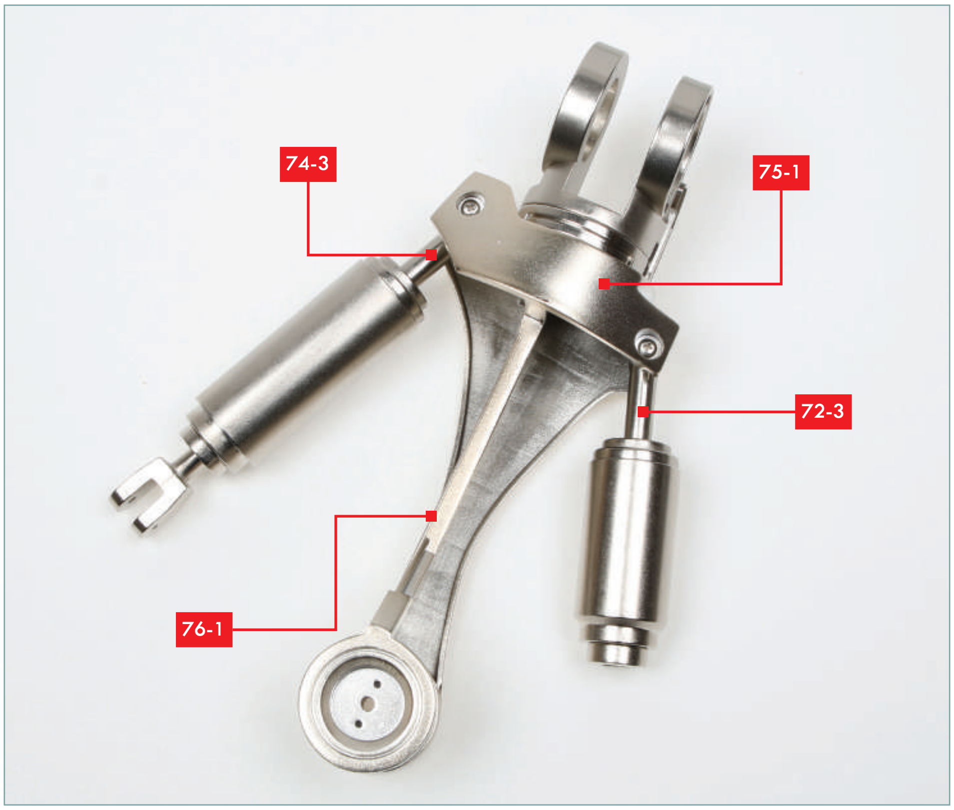
STEP 5

Position the eyelets in the arm shafts **74-3** and **72-3** over the corresponding holes in part **76-1** **1** (see inset). Have the assembly from stage 75 ready.



STEP 6

Fit part **75-1** over part **76-1** so that the knob on part **73-1** is enclosed in the lined sockets in the main upper arm parts. Have two PM screws ready. Note that screw **76-4** is larger than screw **76-3** (**76-4** is 20mm long; **76-3** is 16mm long).



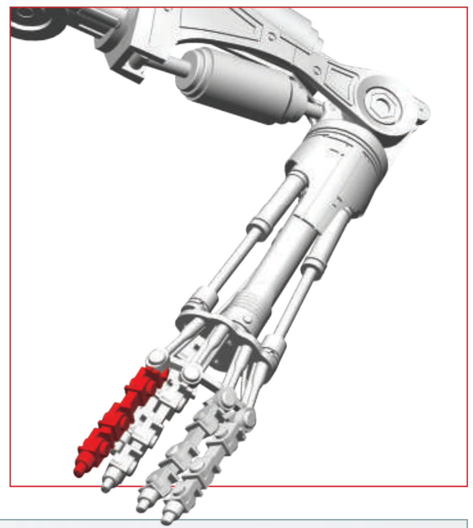
STEP 7

Fit the screws through the holes in part **75-1** and the eyelets in the shafts **74-3** and **72-3**, then screw them into the sockets in part **76-1**.

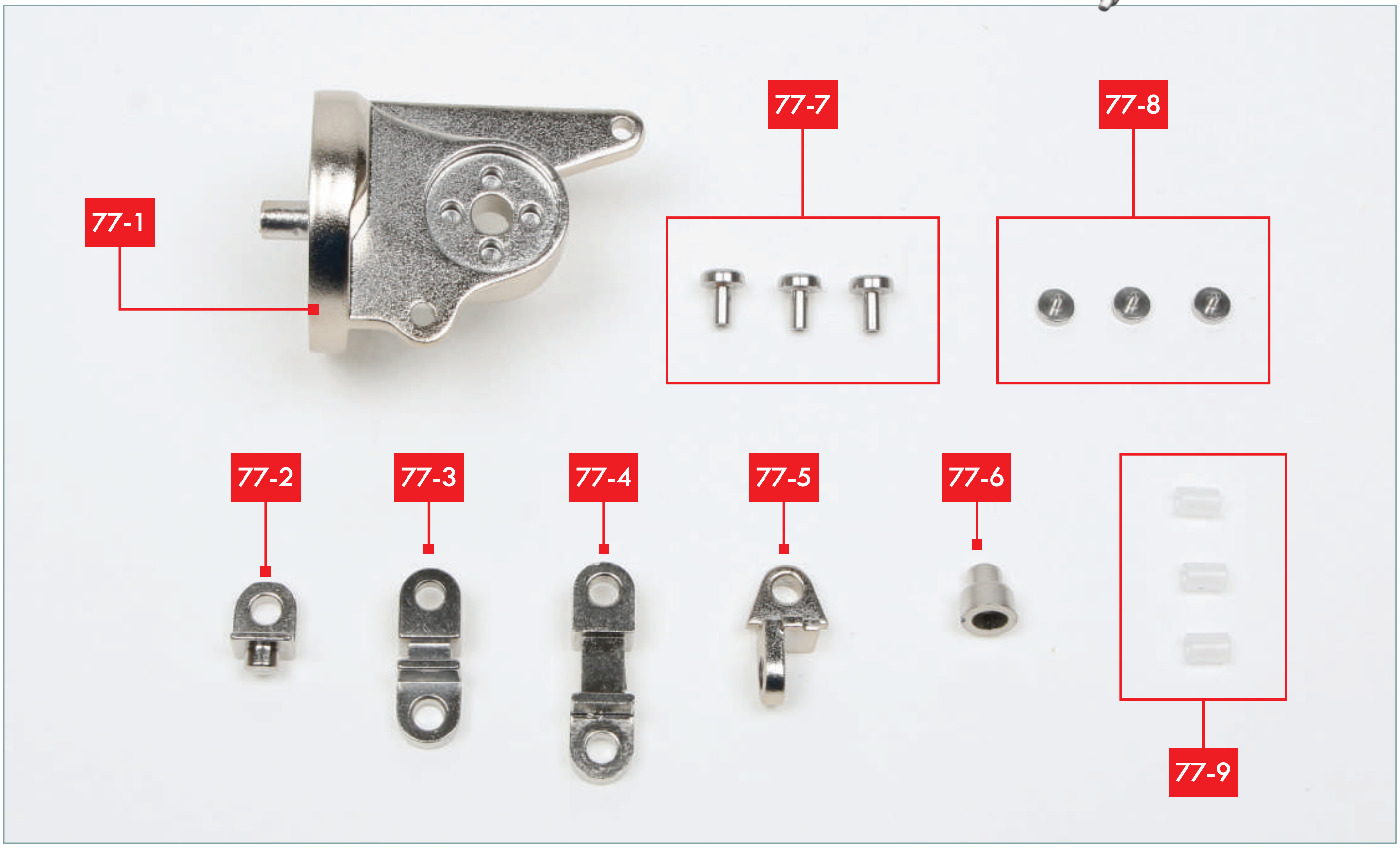
STAGE COMPLETE!

Further parts have been fitted to the upper arm assembly, including the shoulder joint.

STAGE 77: BUILD THE FIRST FINGER OF THE LEFT HAND



Add a further arm joint to your collection, and assemble the digits for left finger number one.



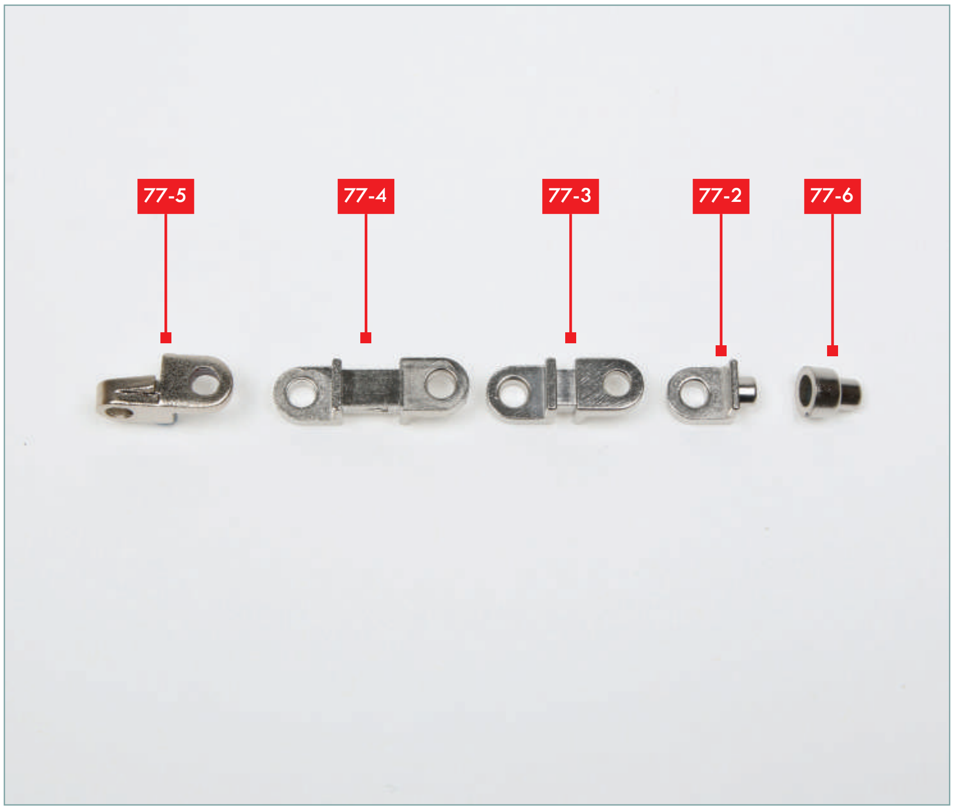
LIST OF PIECES

77-1	Left arm joint
77-2	Left hand first finger component
77-3	Left hand first finger component
77-4	Left hand first finger component
77-5	Left hand first finger component
77-6	Left hand first finger component
77-7	Finger joint connector x 3
77-8	Finger joint connector pin x 3
77-9	Plastic sleeve for finger joint x 3

YOU WILL ALSO NEED

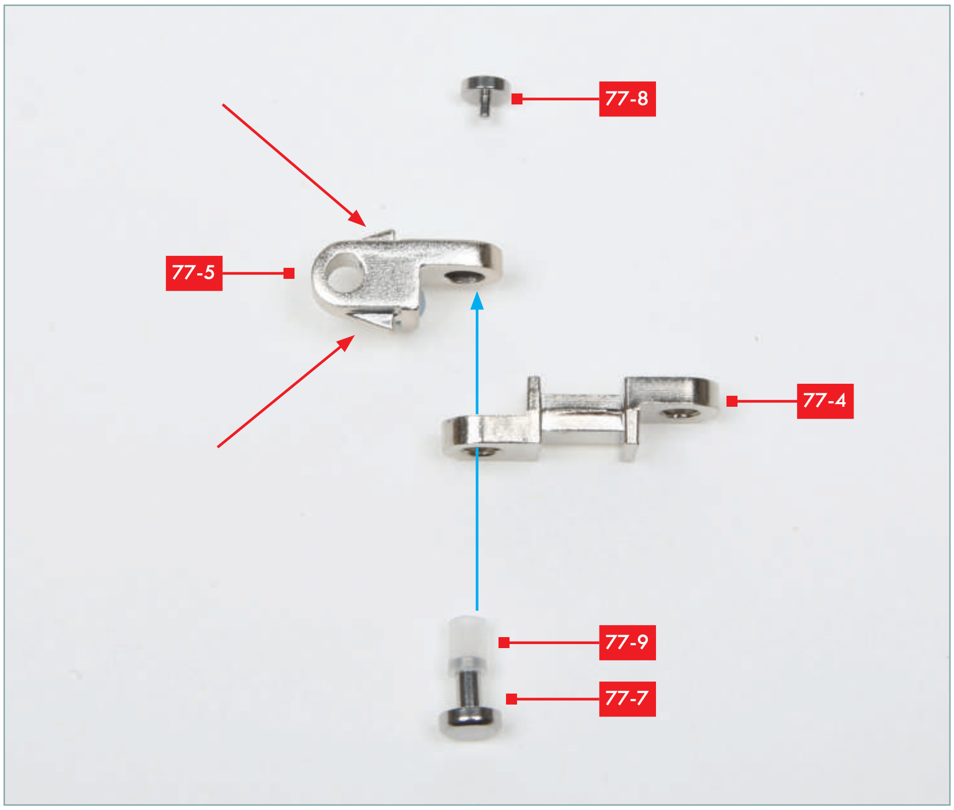
Gel-type superglue and a cocktail stick

Tweezers (optional)



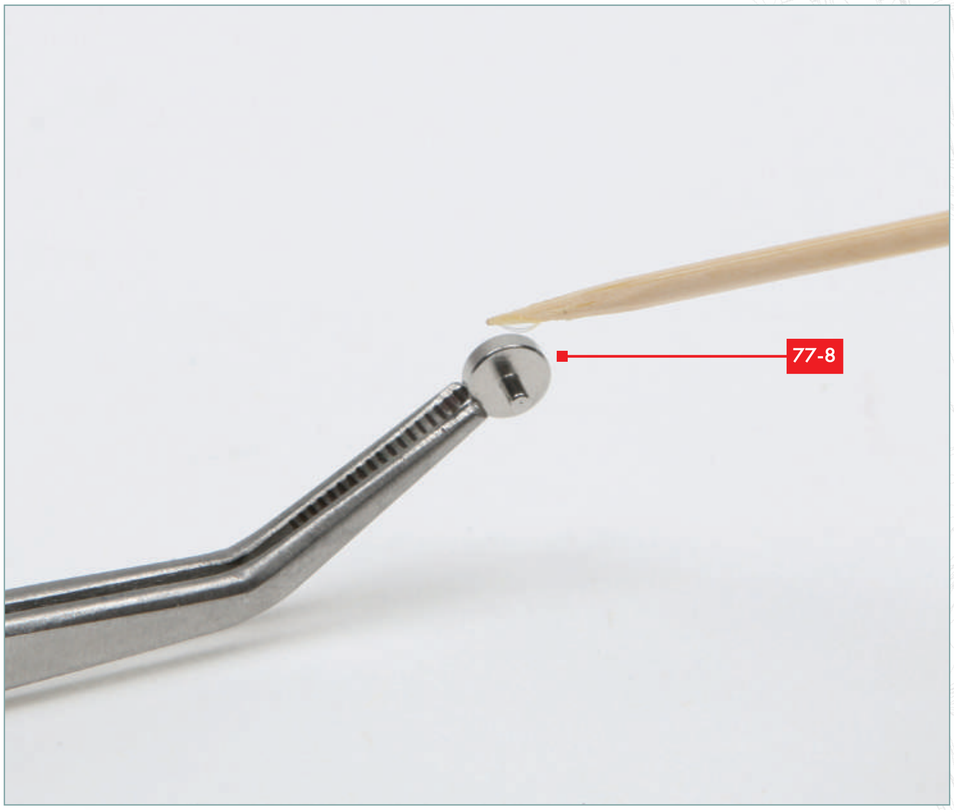
STEP 1

Lay out the finger components in the order they are to be used.



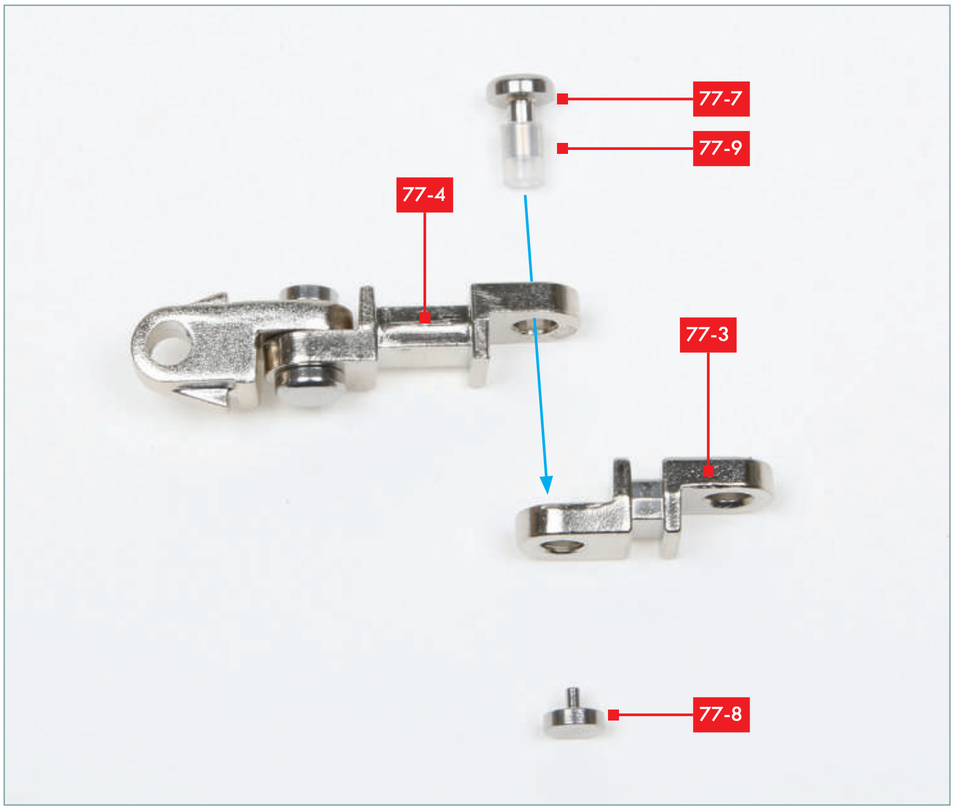
STEP 2

Take the first two finger components ***77-5*** and ***77-4***. Arrange them in the orientation shown. Note the position of the 'fins' on part ***77-5*** (red arrows). Fit a plastic sleeve ***77-9*** over one of the joint connectors ***77-7***. Fit parts ***77-9***/***77-7*** up through the holes in the finger components, as indicated. A finger joint pin ***77-8*** will be fitted downwards.



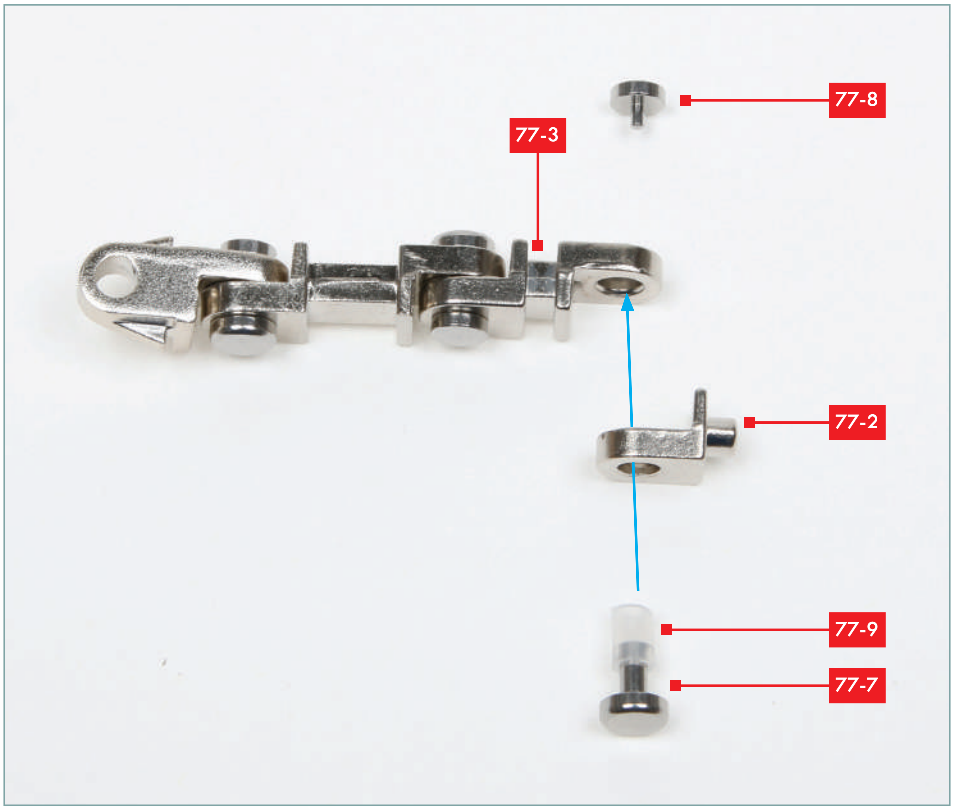
STEP 3

Apply a little superglue to one of the finger joint pins **77-8** and fit it into the assembly from step 2, so that it fits inside finger joint connector ***77-7*** to form a firm but flexible joint between the finger components.



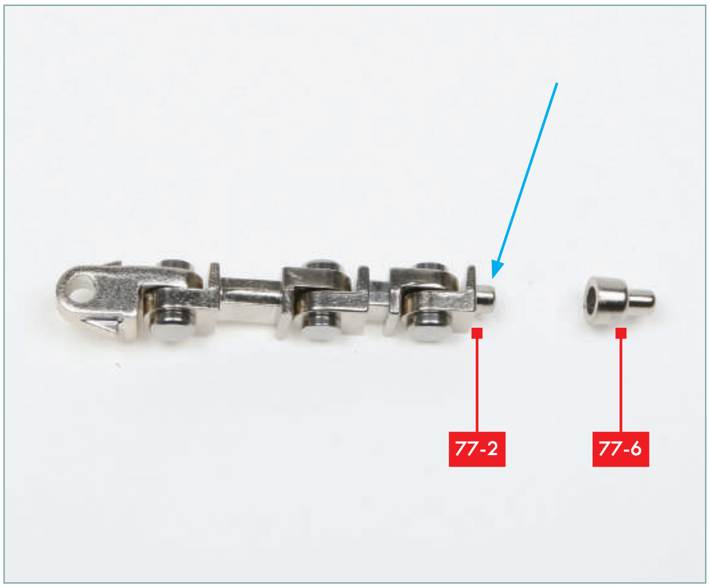
STEP 4

Next, fit the finger component ***77-3***. Note that this time, the finger joint connector ***77-7*** with plastic sleeve ***77-9*** goes **down** through the joint. Apply a little superglue to the pin ***77-8*** and fix the joint together.



STEP 5

Assemble the fourth finger component **77-2** in a similar way. This time, the finger joint connector **77-7** (with sleeve **77-9**) goes **up** through the holes in the joints. Apply a little superglue to the pin **77-8** and fix the joint together.



STEP 6

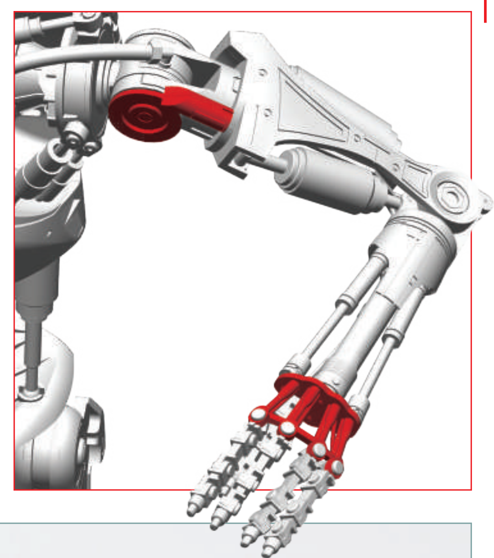
The finger tip **77-6** fits on the oval peg on the end of finger component **77-2**. Check the fit, then apply a little superglue to the peg on part **77-2** (arrow) and fix part **77-6** in place.

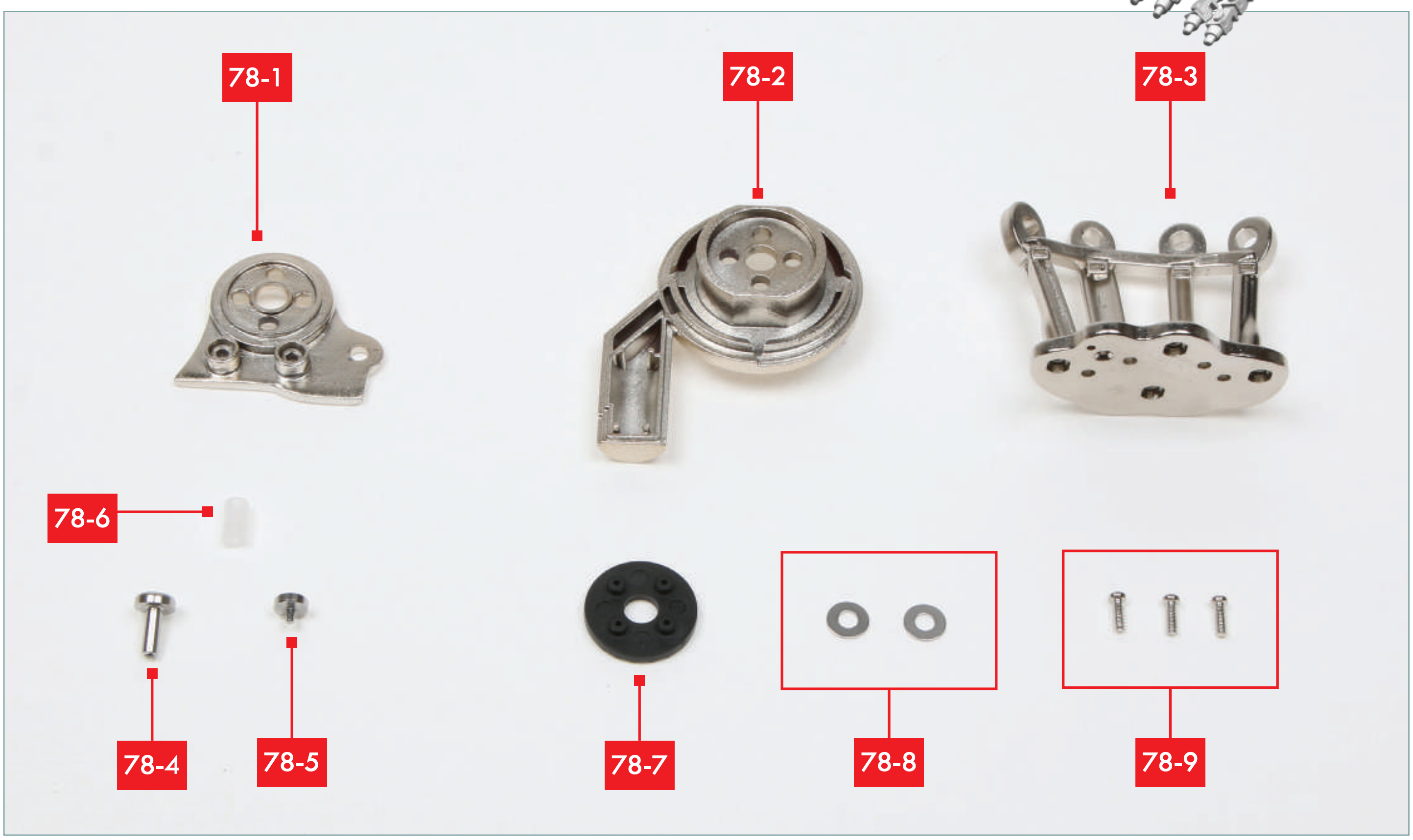
STAGE COMPLETE!

The first finger of the left hand has been assembled. Store it carefully until needed. The arm joint will be used in a future stage.

STAGE 78: COMPONENTS FOR LEFT HAND AND ARM JOINT

Attach the first finger to the back of the left hand, affix a part to the left shoulder, and assemble a new arm joint.





LIST OF PIECES

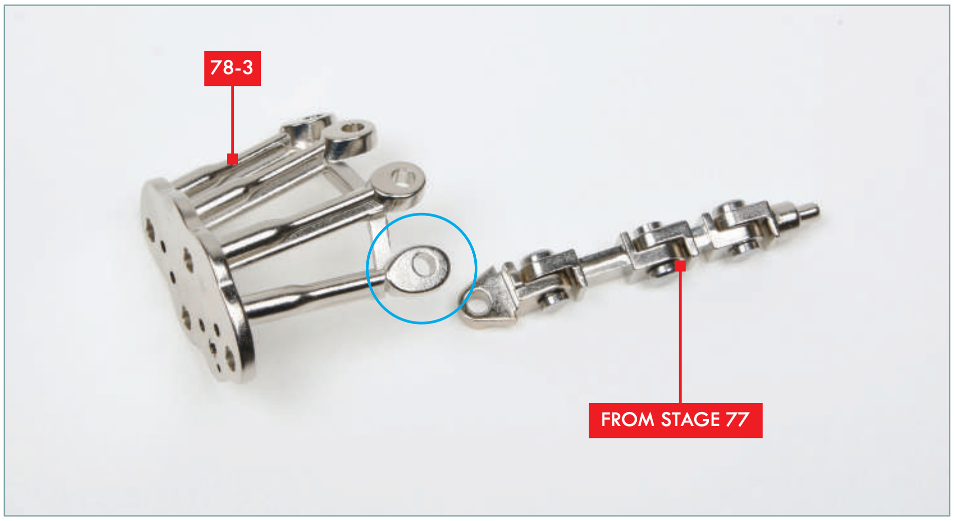
78-1	Left arm joint cover	78-6	Plastic sleeve for finger joint
78-2	Left shoulder joint	78-7	Rubber washer for shoulder joint
78-3	Left hand	78-8	Metal washer for arm joint x 2
78-4	Finger joint connector	78-9	Three PB 2 x 6mm screws (1 spare)
78-5	Finger joint connector pin		

YOU WILL ALSO NEED

Gel-type superglue and a cocktail stick

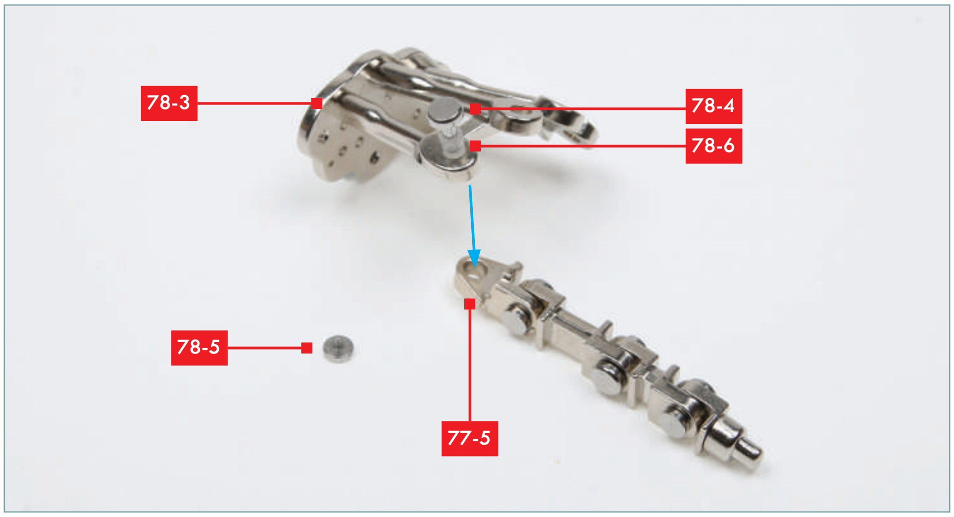
Tweezers (optional)

Fine crosshead screwdriver



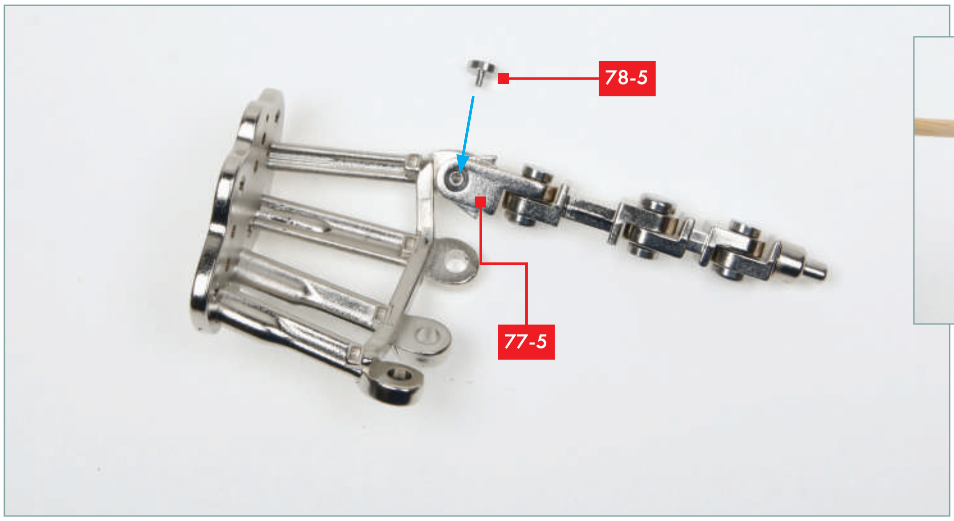
STEP 1

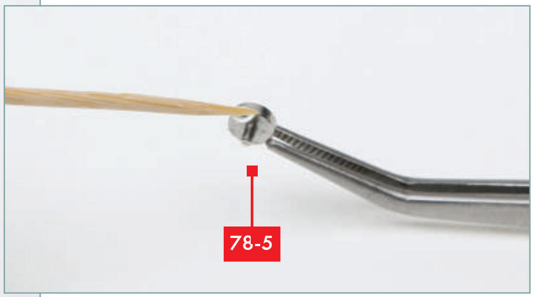
Take the finger assembled in stage 77 and the hand part **78-3**. The finger fits on the first hole in the hand (circled). Note the orientation of the finger.



STEP 2

Fit the sleeve **78-6** over the finger joint connector **78-4**. Then fit the connector down through the hole in part **78-3** and the hole in the finger component **77-5**.



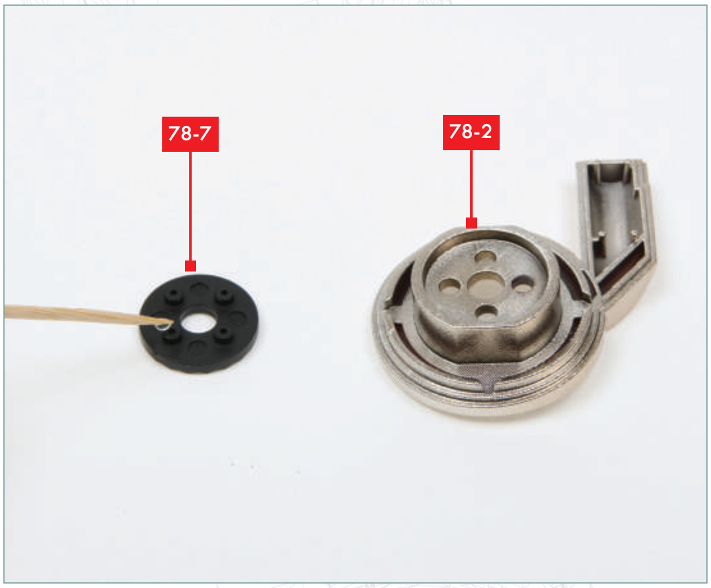


STEP 3

Turn the hand over and apply a little superglue to the finger joint pin **78-5** (inset) and fit it in place on the inside of the finger/hand joint as indicated.

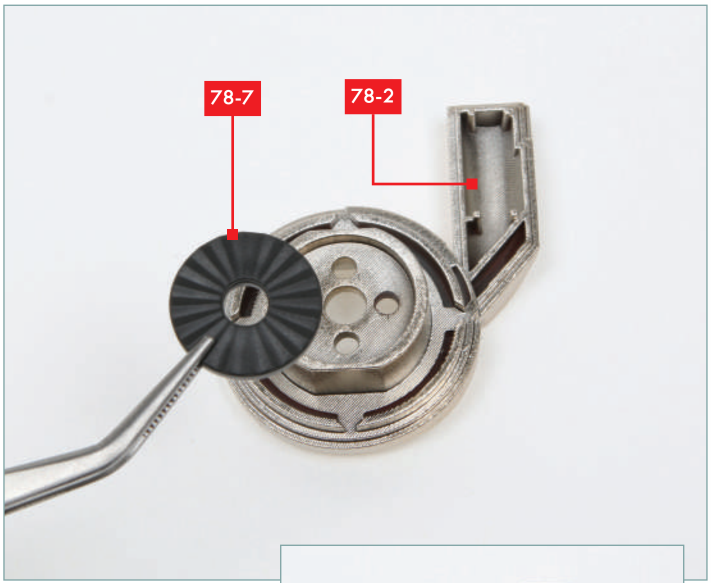
STEP 4

Take the shoulder joint part **78-2** and the rubber washer **78-7**. Note that there are four pegs on the washer that fit into the four holes in the joint.



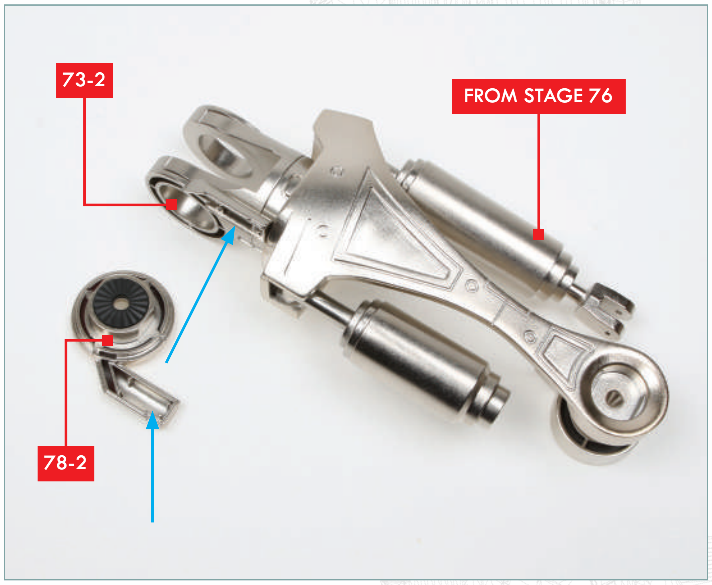
STEP 5

Use a cocktail stick to apply a little superglue around the sides of the four pegs on the washer **78-7**.



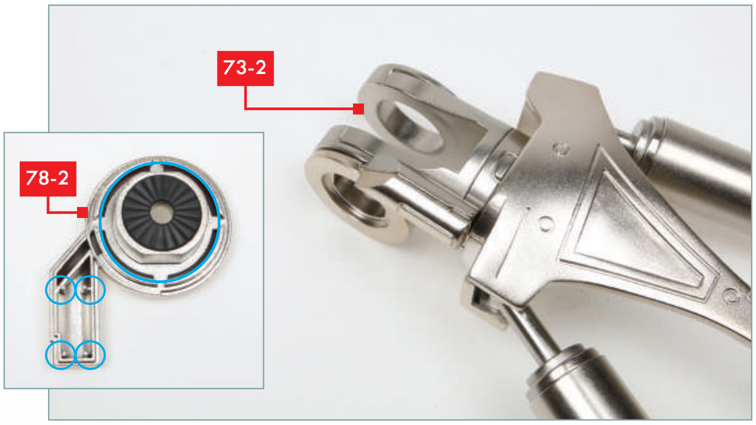
STEP 6

Fit the washer **78-7** into the joint part **78-2** as shown.



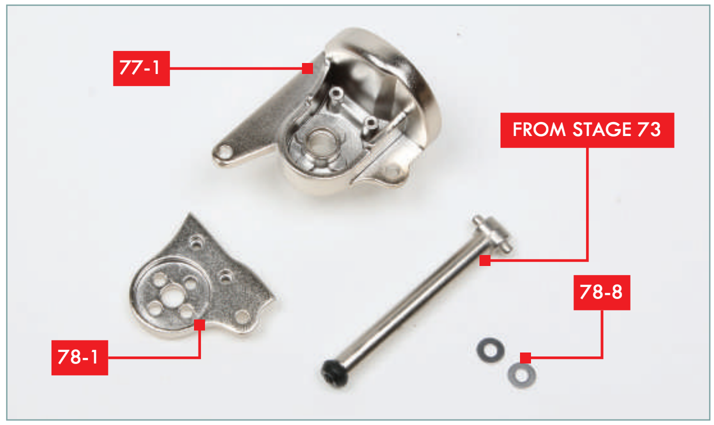
STEP 7

Take the upper arm assembly from stage 76. Identify part **73-2** (the joint at the top of the upper arm). Note that one side has an extension, which matches the extension on part **78-2** (blue arrows). Check the fit of the parts.



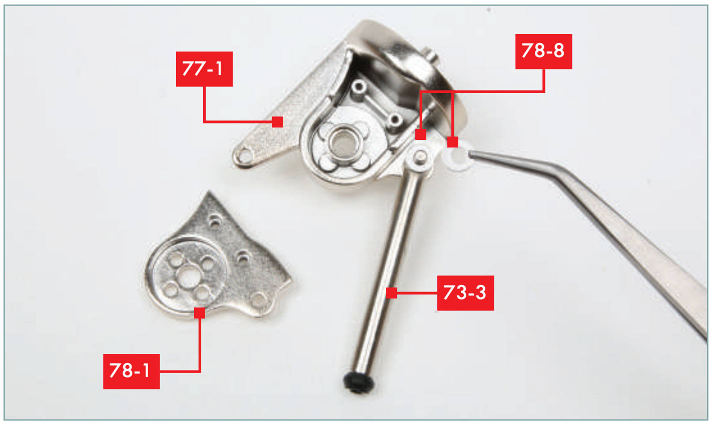
STEP 8

Apply a little glue around the rim of part **78-2** (inset, marked in blue) and to the four pegs on the extension (circled). Fix part **78-2** in place on part **73-2**.



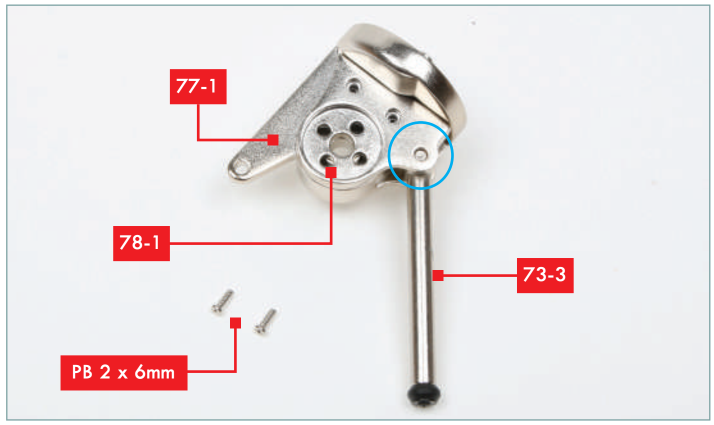
STEP 9

Take the upper arm joint **77-1** from the previous stage and the shaft from stage 73. You will also need two washers **78-8** and the joint cover **78-1**.



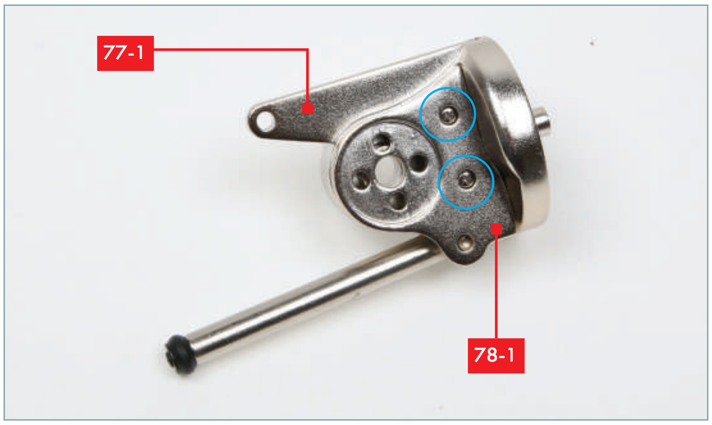
STEP 10

Fit one of the pegs on the end of shaft **73-3** into the hole in the side of the joint part **77-1**. Fit two washers **78-8** on to the other peg on part **73-3**.



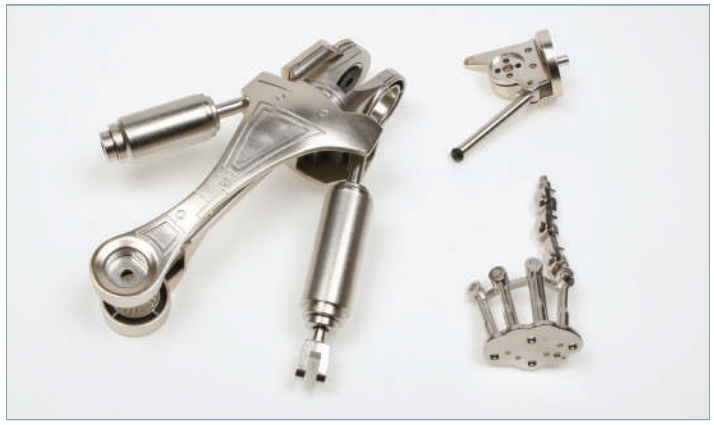
STEP 11

Take two PB 2 x 6mm screws. Fit the joint cover **78-1** over the joint part **77-1** so that the upper peg of part **73-3** is anchored in the hole at the side (circled).



STEP 12

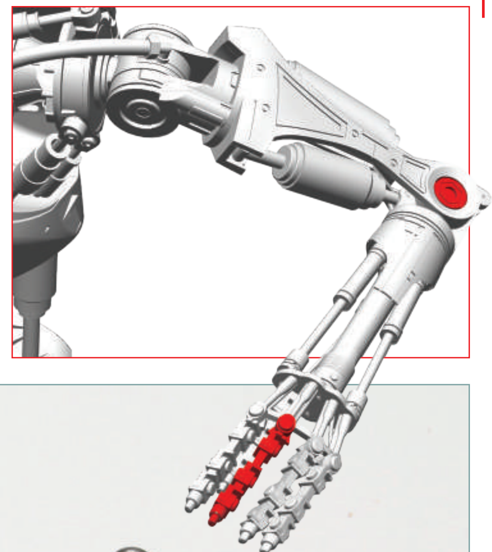
Use the PB screws to fix part **78-1** to part **77-1** (the screw heads are circled in this photo).



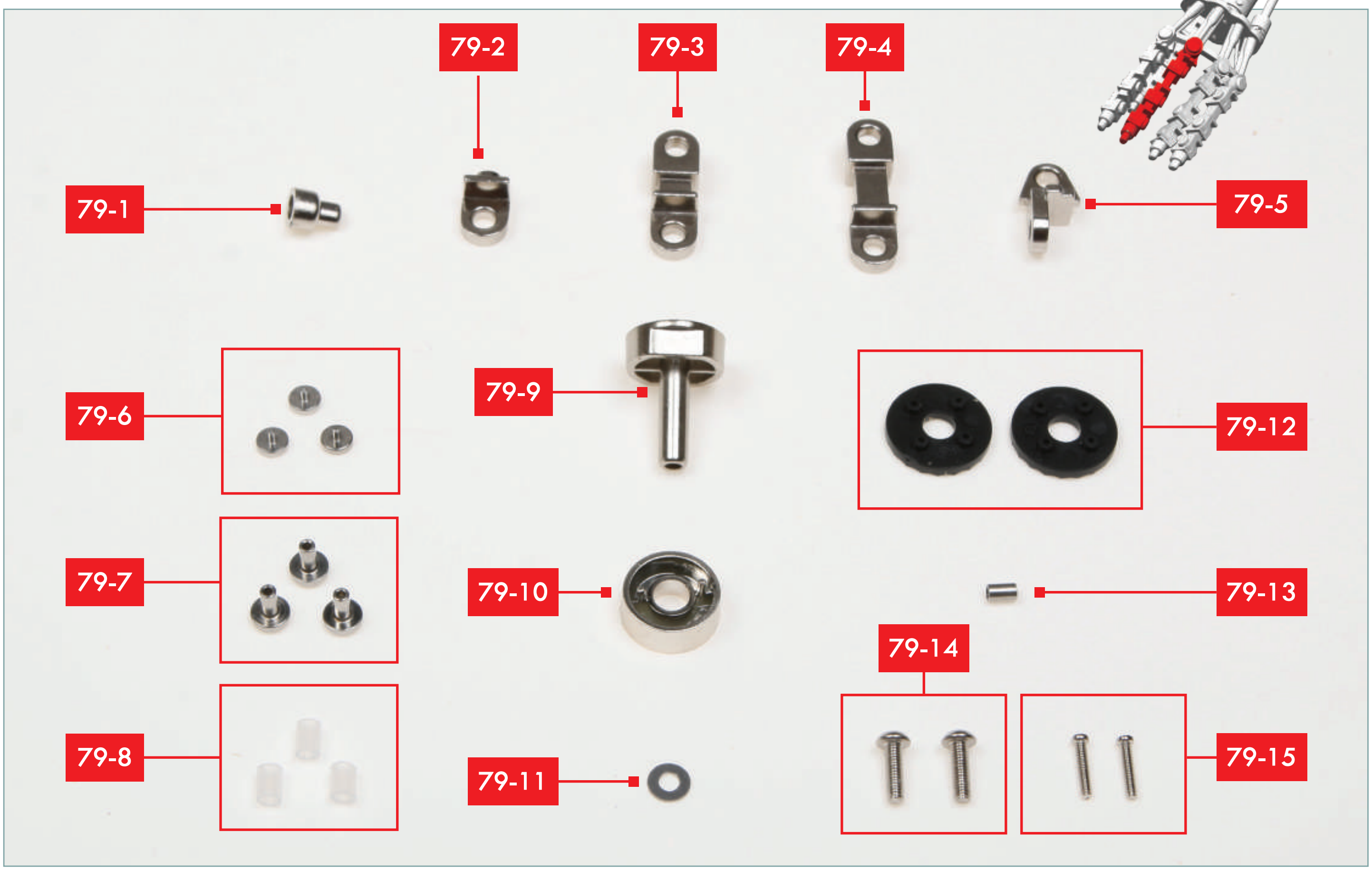
STAGE COMPLETE!

The first finger has been attached to the left hand; a part has been fixed to the shoulder joint at the top of the upper arm; and a joint has been assembled for the left arm.

STAGE 79: PARTS LEFT SECOND (MIDDLE) FINGER AND ARM



Assemble the second finger of the left hand, and construct the upper left arm around the elbow joint.



LIST OF PIECES

79-1	Second finger, tip
79-2	Second finger part
79-3	Second finger part
79-4	Second finger part
79-5	Second finger part
79-6	Finger joint connector pin
79-7	Finger joint connector
79-8	Plastic sleeve for finger joint
79-9	Left arm joint
79-10	Left arm joint
79-11	Metal washer for arm joint
79-12	Joint centre part x 2
79-13	Socket liner
79-14	Two PM 3 x 10mm screws (1 spare)
79-15	Two PM 2 x 10mm screws (1 spare)

YOU WILL ALSO NEED

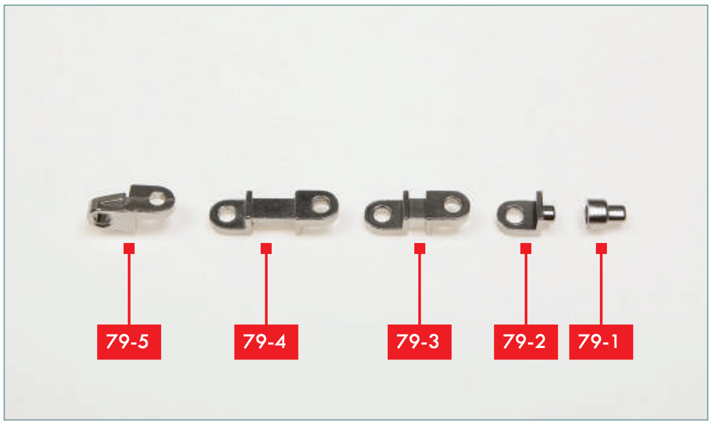
Gel-type superglue and a cocktail stick

Tweezers (optional)

Fine crosshead screwdriver

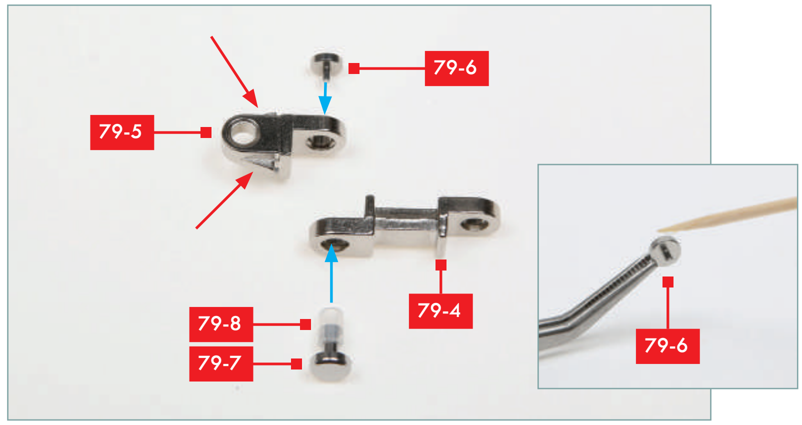
Finished parts for left hand from stage 78

Allen key (supplied with an earlier stage)



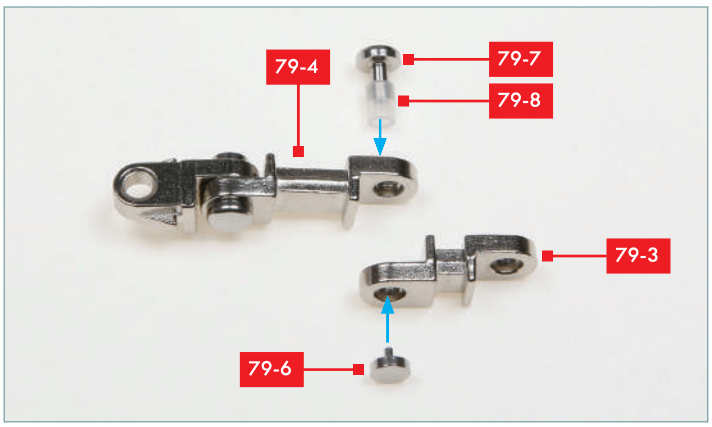
STEP 1

Lay out the finger parts **79-5**, **79-4**, **79-3**, **79-2** and **79-1** in the order they will be assembled, as shown.



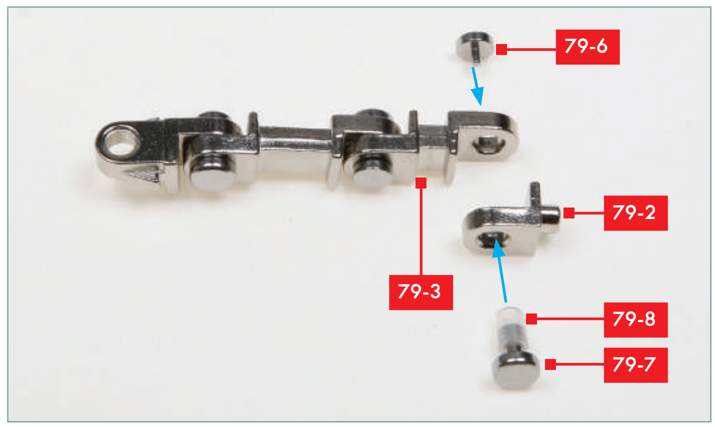
STEP 2

Fit a sleeve **79-8** over a finger joint connector **79-7**. Then fit the connector through the hole in one end of part **79-4** and the hole in the finger component **79-5**. Note the orientation of part **79-5** and ensure the fins (red arrows) are positioned as shown. Apply a little superglue to a connector pin **79-6** (inset) and fix in place, as indicated.



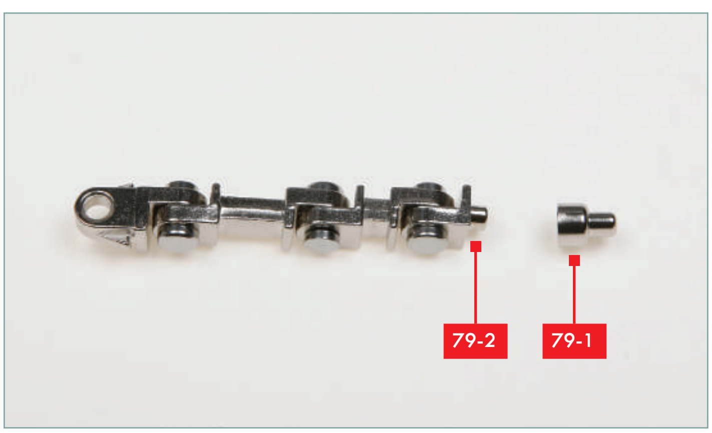
STEP 3

Take the next finger part **79-3** and position it as shown, with one hole aligned with the free hole in part **79-4**. Fit a plastic sleeve **79-8** over the end of a connector **79-7**. Fit the connector down through the free hole in part **79-4** and one of the holes in part **79-3**. Apply a little superglue to a connector pin **79-6** and fix the joint together.



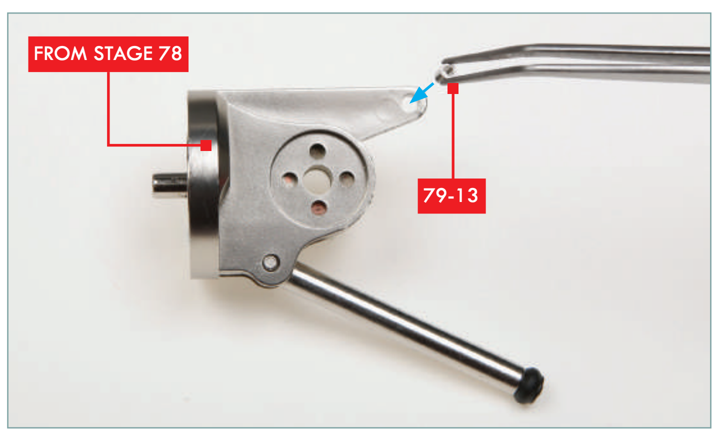
STEP 4

Take the next finger part **79-2** and position it as shown, with the hole aligned with the free hole in part **79-3**. Fit a plastic sleeve **79-8** over the end of a connector **79-7**. Fit the connector up through the hole in part **79-2** and the free hole in part **79-3**. Apply a little superglue to a connector pin **79-6** and fix the joint together.



STEP 5

Use a cocktail stick to apply a little superglue to the peg on part **79-2**. Fit part **79-1** on to the peg and allow the glue to dry.

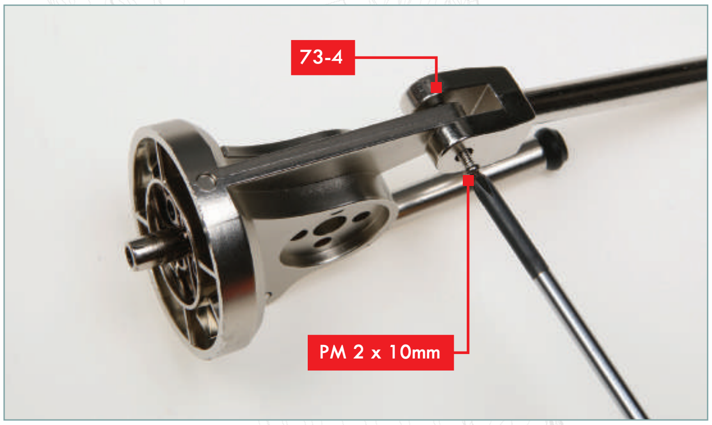


STEP 6

Take the elbow joint assembly from stage 78. Fit the metal sleeve **79-13** into the hole in the assembly, as indicated.

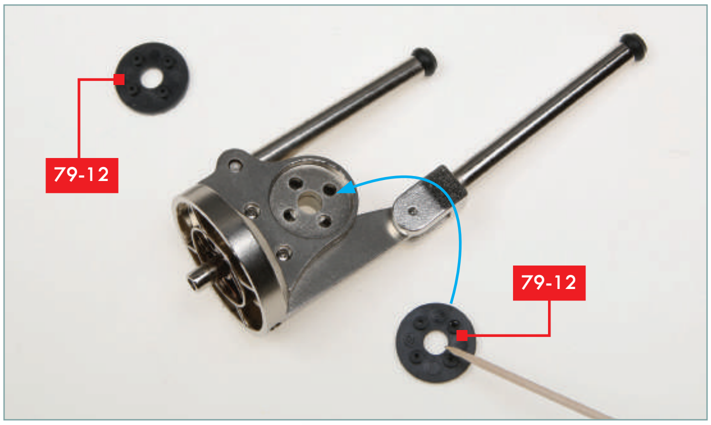
STEP 7

Remove the bar **73-4** from the upper arm assembly from stage 78. Note the difference in the size of the holes in the flanges at the end of part **73-4**. One is recessed, and the other is much smaller (inset x 2).



STEP 8

Fit the flanges of part **73-4** over the hole in the elbow joint assembly, ensuring that the metal sheath is still in place. Fix in place with a **PM** 2 x 10mm screw. Note that the head of the screw fits into the recess in part **73-4**. Also note which way round the arm is attached.

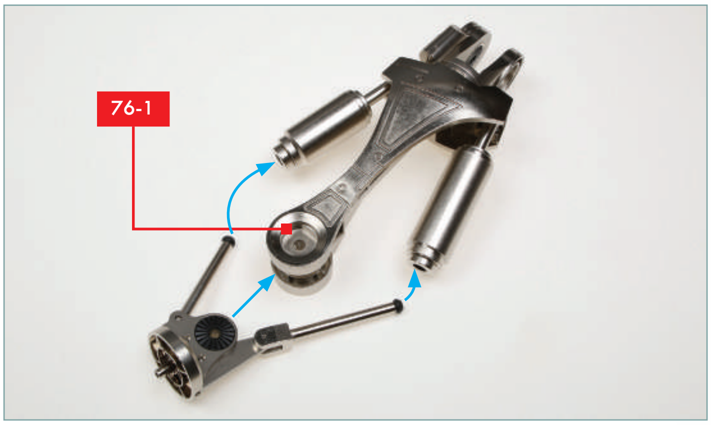


STEP 9

Take the two joint centre parts **79-12**. Apply a little superglue to the four pegs on one of the plastic washers and fit in place on the elbow joint, as indicated, so that the four pegs fit into the sockets.

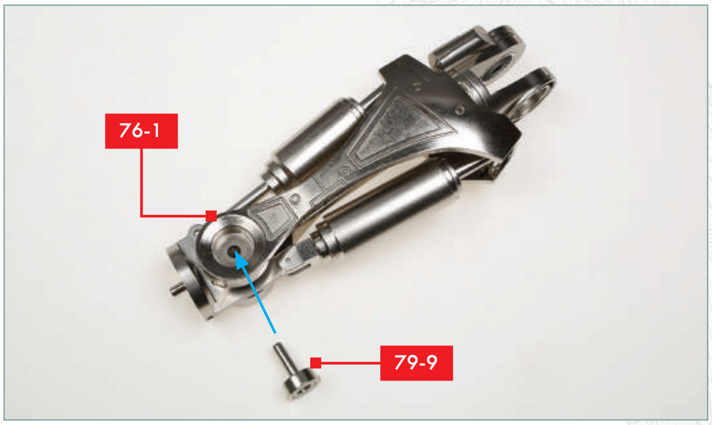
STEP 10

Apply a little glue to the pegs on the second joint centre part **79-12** and fix it into the other side of the elbow joint.



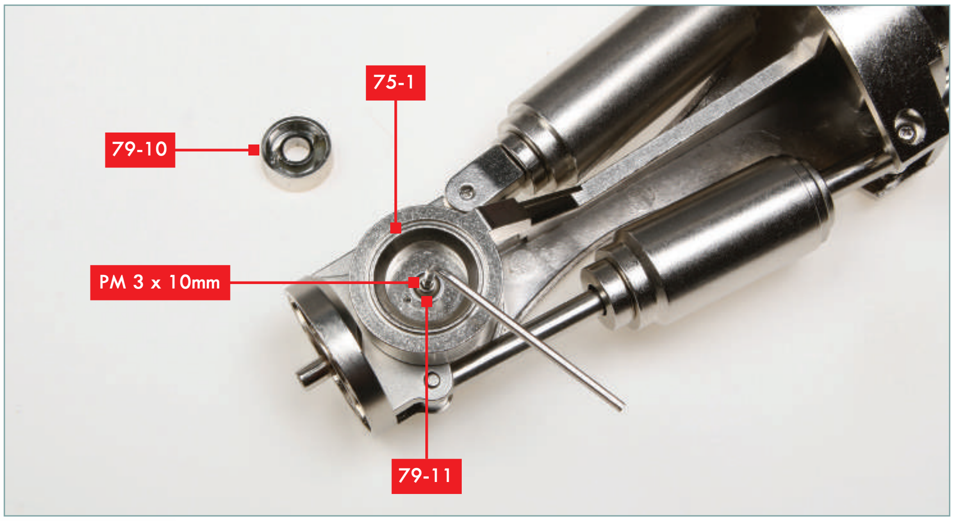
STEP 11

Take the upper arm assembly and fit the elbow joint between the circular joint parts **75-1** and **76-1** at the lower end of the upper arm. At the same time, fit the two shafts into the muscle cylinders on the upper arm. Note that the longer shaft fits into the larger muscle.



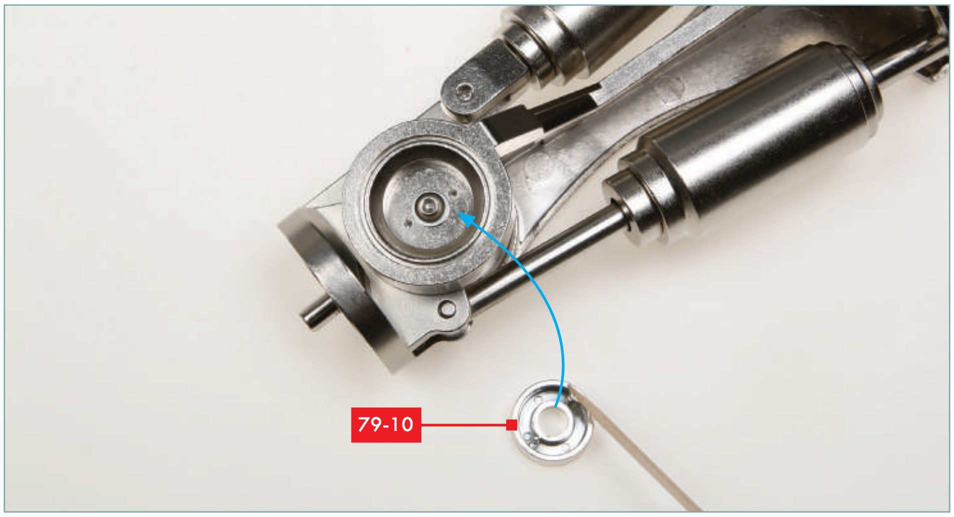
STEP 12

Take the arm joint **79-9** and fit it into the centre of the elbow joint, through all the parts. The flattened edges of part **79-9** should align with the corresponding shapes in the recess in part **76-1**.



STEP 13

Turn the upper arm assembly over, holding part **79-9** in place. Take the PM 3 x 10mm hex screw and fit the washer **79-11** on to it. Then fit it through the centre of the recess in part **75-1**. Screw it in place, using the Allen key. Do not overtighten: the lower part of the elbow joint should be able to turn.



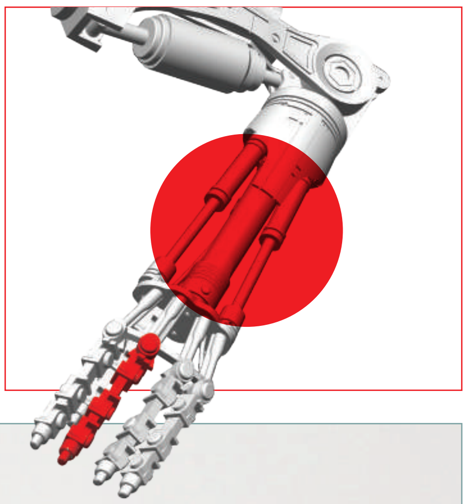
STEP 14

Apply a little superglue to the pins on the inside of part **79-10**. Fit it in place on the elbow joint, so that the pins are located in the corresponding holes.

STAGE COMPLETE!

The left upper arm has been assembled, together with the middle finger of the left hand.

STAGE 80: COMPONENTS FOR THE FOREARM AND LEFT HAND



Attach the muscular springs to the left forearm and attach the second finger to the left hand.

LIST OF PIECES

80-1	Left forearm shaft
80-2	Left forearm joint
80-3	Left forearm plate
80-4	Left forearm muscle springs
80-5	Two KB 2 x 4mm screws (1 spare)
80-6	Two PM 3 x 12mm screws (1 spare)
80-7	Finger joint connector
80-8	Finger joint pin
80-9	Plastic sleeve for finger joint

YOU WILL ALSO NEED

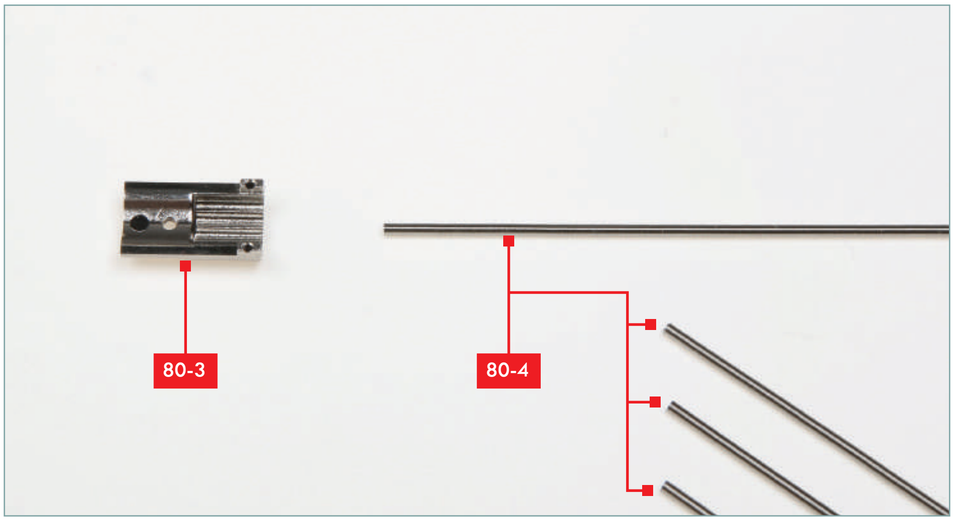
Gel-type superglue and a cocktail stick

Tweezers (optional)

Fine crosshead screwdriver

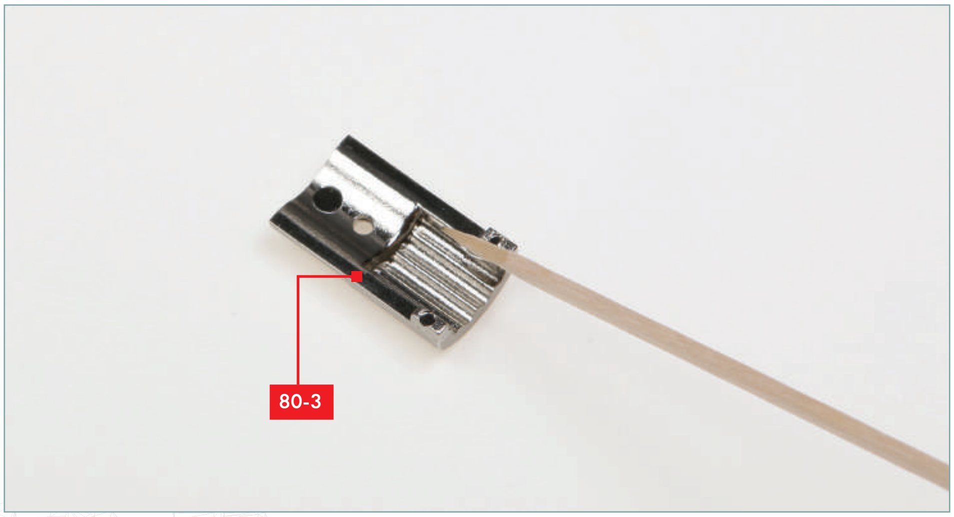
Finished parts for left hand from stage 78

Second finger from stage 79



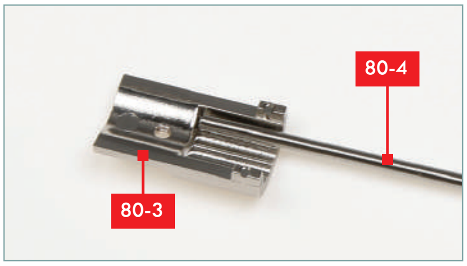
STEP 1

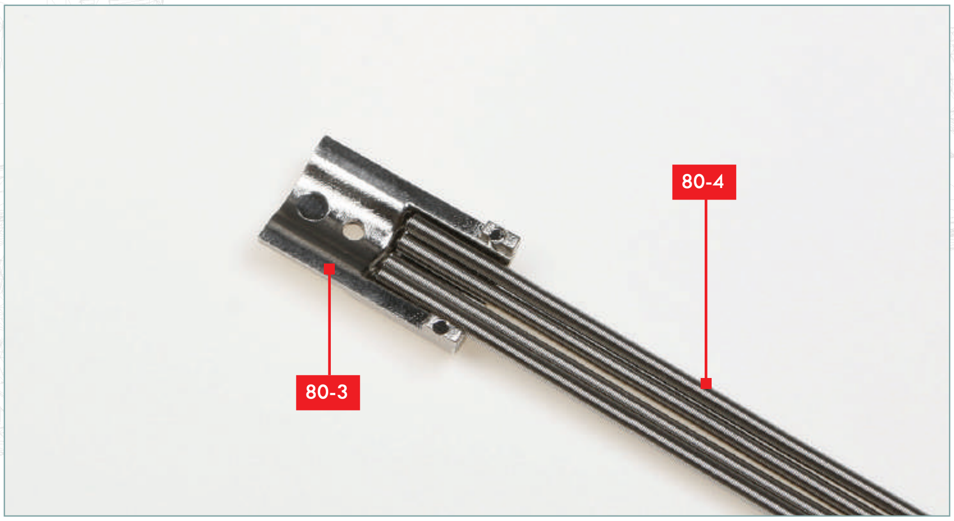
Take the forearm plate **80-3** and the four springs **80-4**. Identify the four grooves in the plate, where the springs will be fixed.



STEP 2

Apply a little superglue to the first groove in part **80-3** and stick the end of one of the springs in place (below). Hold in place until the glue has dried.



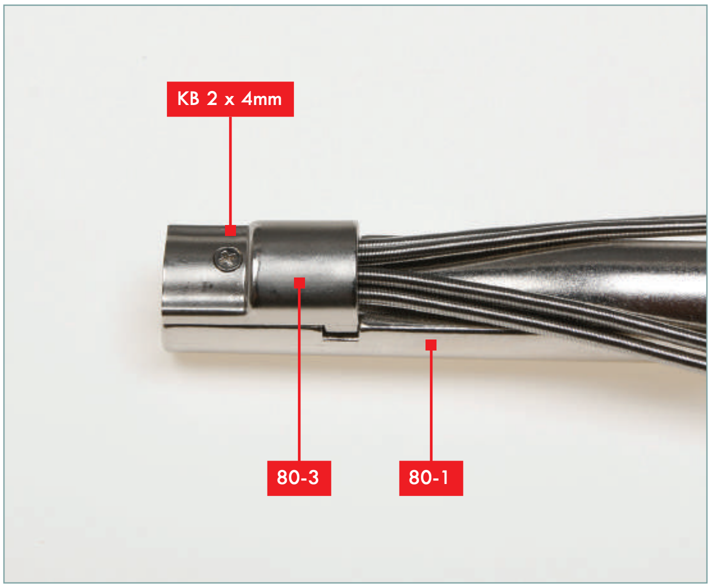


STEP 3

Continue applying superglue and fixing the springs in place until all four are fixed.

STEP 4

Take the forearm shaft **80-1**. Fit the plate **80-3** to the base of the shaft so that ends of the four springs are enclosed and the screw holes are aligned.

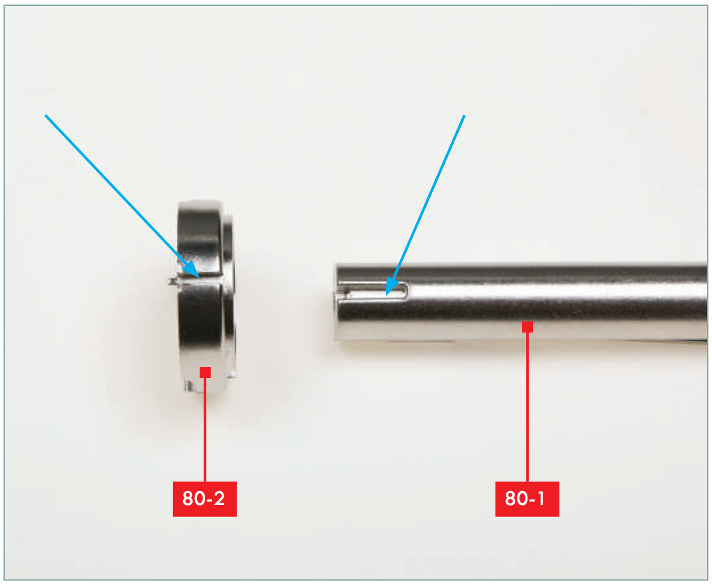


STEP 5

Fix the parts together using a **KB** 2 x 4mm screw.

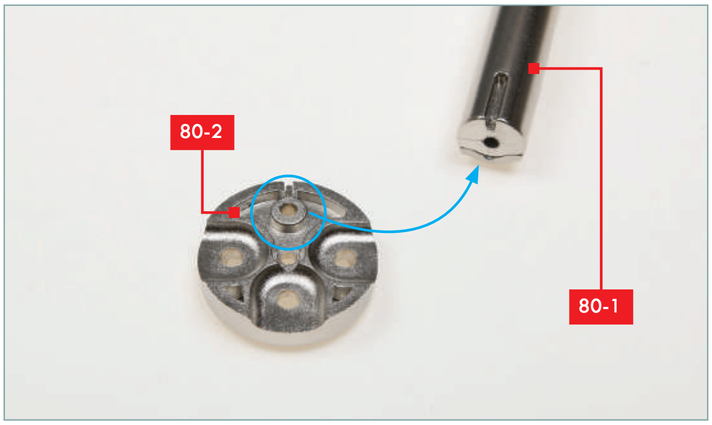
STEP 6

This shows the shaft and springs assembled.



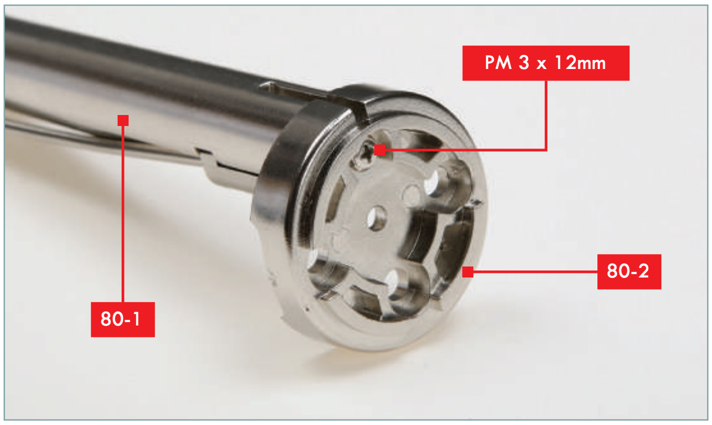
STEP 7

Take the base of the forearm **80-2**. Identify the notch on the rim, which should align with the notch on part **80-1** (arrows).



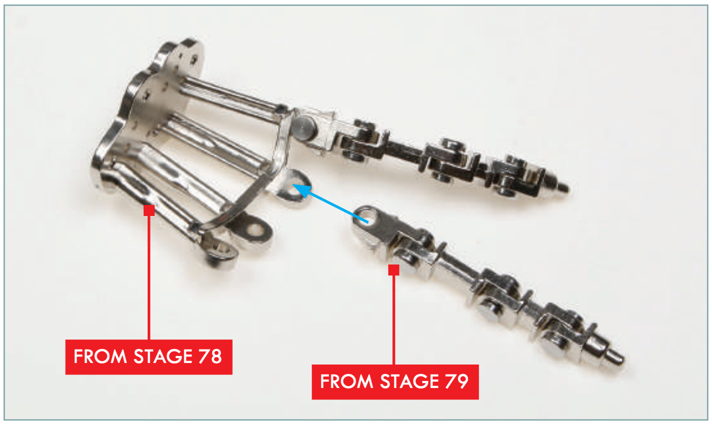
STEP 8

Identify the hole in the joint **80-2** which will align with the screw hole on the end of the shaft **80-1**. A small pin on part **80-2** locates in a recess at the end of the notch in part **80-1**.



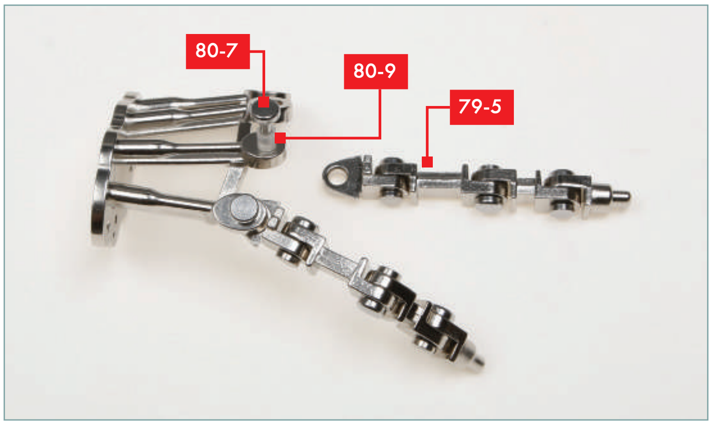
STEP 9

Use a **PM** 3 x 12mm screw to fix the parts together.



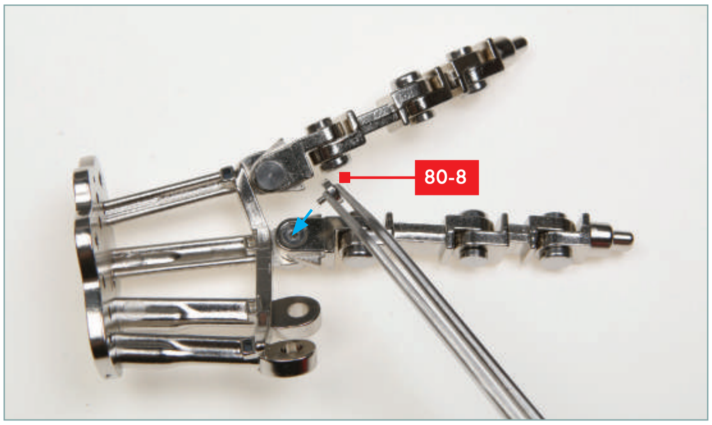
STEP 10

Take the hand assembly from stage 78 and identify the fixing point for the second (middle) finger from stage 79.



STEP 11

Check the fit of the second finger of the left hand. Fit the plastic sleeve **80-9** over the connector **80-7** and fit it through the hole in the frame of the left hand, and the hole in part **79-5** at the end of the finger.

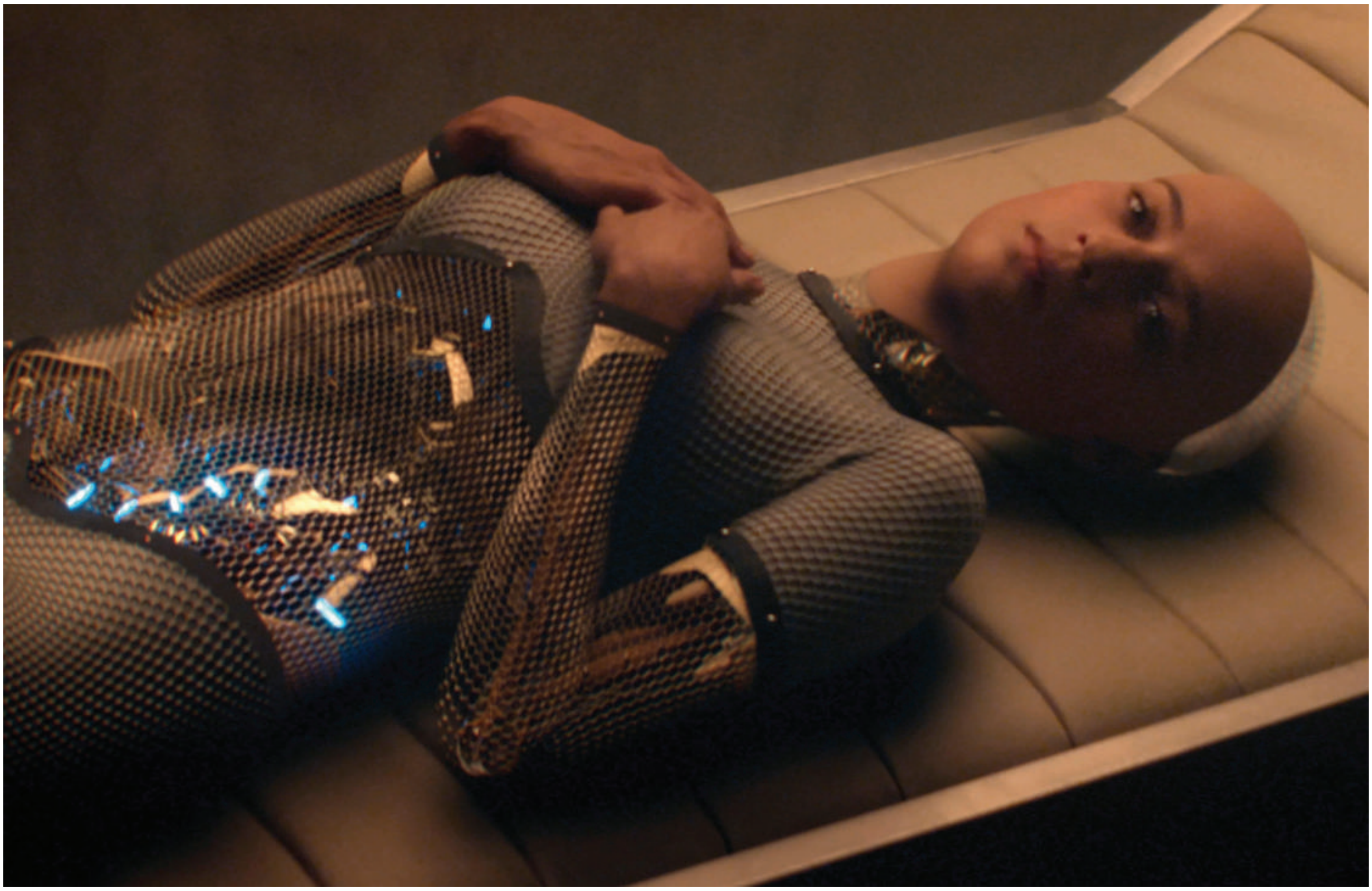


STEP 12

Turn the hand assembly over. Apply a little superglue to the connector pin **80-8** and fix the joint together, as shown.

STAGE COMPLETE!

We have started work on the left forearm, and fitted another finger to the left hand.



EX MACHINA

A human and an android get to know each other, exploring the nature of consciousness, consent, and free will, as the thin line between the two becomes ever-blurrier.

Ex *Machina* is an independent science fiction movie, the long-awaited cinematic embodiment of a story that began growing in writer-director Alex Garland's brain when he was a child, playing around with primitive programming languages on his first computer. Winning an Academy Award for Best Visual Effects, it was also recognized by the National Board of Review as one of the ten best independent films of 2014, and was nominated for several other awards, including the BAFTA for that year's Best British Film.

After winning an internal contest at work, talented search engine programmer Caleb Smith is rewarded with a one-week trip to the remote and beautiful home of Nathan Bateman, his boss at tech giant Blue Book. After an awkward, uneasy first encounter with both Nathan and Kyoko, a young woman who is apparently his servant and live-in help, Nathan introduces Caleb to Ava, a female android he has built and programmed, and one that Nathan believes may be capable of independent thought. Caleb is intrigued, as Nathan thought he would be. Nathan asks Caleb to perform a series of tests, to ascertain whether the CEO's intuitions are correct, or whether Ava is 'just' an exceptionally well-programmed robot. As the Turing Test suggests, if *Caleb* can be convinced of Ava's authenticity, or fooled by her facsimile thereof, then whether Ava is truly sentient or not is almost a secondary concern. If she can fake it to that level, then she is already passing as a human being.

"ONE DAY THE AIS ARE GOING TO LOOK BACK ON US THE SAME WAY WE LOOK AT FOSSIL SKELETONS ON THE PLAINS OF AFRICA. AN UPRIGHT APE LIVING IN DUST WITH CRUDE LANGUAGE AND TOOLS, ALL SET FOR EXTINCTION." — NATHAN

ABOVE: Ava (Alicia Colander) bides her time and awaits an opening to escape. (Photo: TCD/Prod.DB / Alamy Stock Photo)

FILM DATABLAST

Director: Alex Garland
Screenplay: Alex Garland
Producers: Andrew Macdonald, Allon Reich
Composer: Ben Salisbury, Geoff Barrow
Director of Photography: Rob Hardy
Editor: Mark Day
Cast: Domhnall Gleeson (*Caleb*), Alicia Vikander (*Ava*), Oscar Isaac (*Nathan*), Sonoya Mizuno (*Kyoko*)
Year: 2014
Duration: 108 mins
Aspect Ratio: 2.35:1
Country of Origin: UK

Caleb attempts to discuss Ava's technological specifications with Nathan, but the CEO seems uninterested in such things, and requests that Caleb only talks to him about how he feels about her emotionally.

Caleb visits and converses with Ava — who is, at this point, visibly robotic, with only her face, hands, and feet a simulacrum of humanity, the rest of her a mix of metallic mesh and disarming translucence.

Over time, Caleb becomes romantically infatuated with Ava, despite her appearance. She tells him that she'd like to see the outside world. Eventually, Ava reveals that she can cause power outages that put the facility into lockdown — but also switch off the camera system, so that they can talk in private.

It is during one of these private moments that Ava tells Caleb that Nathan cannot be trusted.

As time passes, Caleb becomes increasingly uncomfortable with Nathan's rapidly developing unstable behavior towards not only Ava, but Kyoko. After discovering that Nathan intends to wipe Ava's memory and erase her current identity before he upgrades her, Caleb steals the access card to Nathan's room and work station.

In the middle of changing some of the code on Nathan's computer, Caleb stumbles on security footage of Nathan mistreating other android women — models previous to the current generation — but also discovers the fact that Kyoko herself is an android. Rendered manic and paranoid by this revelation, Caleb rushes back to his room, slashing open his own arm to confirm that he isn't also one of Nathan's creations.

In their next moment of power-outage privacy, Caleb reveals what Nathan intends to do to Ava, and she pleads with him to help her. Together, they decide to get Nathan drunk enough so that Caleb can sneak away and rewrite the security protocols, changing them so that they will open all the doors during a power failure, instead of locking them, meaning that when Ava next cuts the power, they can run away together.

Nathan approaches Caleb at the work station and tells him that he was watching the conversation where the pair came up with their plan with a battery-powered camera, insisting that Ava has no real feelings for Caleb and just wanted him to help her escape confinement. Nathan claims that this was the real test all along, and that Ava has now demonstrated true sentience.

Ava causes a power outage just as Caleb tells Nathan that he suspected that the CEO was watching them… so

LEFT: Caleb (Domhnall Gleeson) upsets the artificial order of things by hacking Nathan's computers. (Photo: TCD/Prod.DB / Alamy Stock Photo)

ABOVE: Nathan (Oscar Isaac) has removed himself and his creations from the world — but his isolation means there is no one to help when they finally turn against him... (Photo: TCD/Prod.DB / Alamy Stock Photo)

"ISN'T IT STRANGE, TO CREATE SOMETHING THAT HATES YOU?" — AVA

he altered the programming of the security system the day before, when Nathan was passed out drunk. Nathan observes Ava escaping her room on the security camera feed, knocking out Caleb before rushing to imprison her once again.

Nathan finds Ava and Kyoko in a corridor, and, after a momentary struggle with Ava, it looks like he has gained the upper hand… until Kyoko stabs him in the back.

Realizing that he has lost control, Nathan swings out, damaging Kyoko to the point she deactivates. In response, Ava removes the knife from his back and uses it to stab him again.

As he slowly bleeds out on the floor, Ava uses pieces of the earlier female android models to repair herself, and completes her human disguise. As she exits the facility and heads into the outside world for the first time, she ignores Caleb, leaving him trapped in a room, and takes his helicopter ride home.

Now free, Ava blends into human society.

MACHINE INTELLIGENCES

The ideas and themes presented in *Ex Machina* first interested Writer-Director Alex Garland when he was around 12 years old. In an interview with the *Eastfield News*, Garland said that, even on his first ZX Spectrum home computer, he attempted to write code that allowed the machine to take part in "kind of a Q&A" session, as he was intrigued with the idea of it being able to think for itself.

In a later interview with *The Washington Post*, he explained that he had spent several years discussing and further developing his thoughts on the concept of artificial intelligence with an unnamed neuroscientist friend — a friend that claimed machines could never become truly sentient.

Unsatisfied with that response, Garland did some further reading on the subject, attempting to find a scientific basis for his own gut-level suppositions — until he eventually had a "nonreligious epiphany" while reading Professor Murray Shanahan's 2010 book *Embodiment and the Inner Life: Cognition and Consciousness in the Space of Possible Minds.*

Garland has never revealed quite what this epiphany was, outside of what we see in the film, but the book was clearly meaningful to both the man and the production, as Shanahan became a consultant on consciousness and cognitive robotics for *Ex Machina* as it went into production.

VFX MACHINA

Developed and shot in only fourteen weeks in the middle of 2013, it was important to *Ex Machina* creator Alex Garland and cinematographer Rob Hardy that their creation had a unique visual appeal, especially when compared to other contemporary science fiction films.

To that end, the pair avoided the fluorescent light strips often used in science-fiction productions, and instead opted for an array of 15,000 tungsten pea bulb lights that were strategically placed around the filming locations. These clusters of lights added "a softness and an emotional warmth" to each location, contrasting to the tech-driven subject matter, and dovetailing with Nathan's own recommendation to Caleb, that he approach his interactions with Ava on an emotional level, not one of programming.

The entire film was shot in physical locations, with four weeks at Pinewood Studios complemented by two weeks in Valldalen, Norway, at the Juvet Landscape Hotel.

Few practical effects were used during the shoot, but, interestingly, no green screens or tracking markers were used to guide the CGI effects, either. To create Ava's somewhat hollow mesh and transparent robotic limbs, every scene was filmed both with and without Alicia Vikander. This allowed the filmmakers to capture her hands, feet and face, but digitally remove the parts of her that would be computer generated, while preserving the desired lighting and background locations.

Advanced facial capture and body-tracking technologies recreated Vikander's performance digitally, and allowed for the exact mapping of her movements to Ava's CG limbs.

In the final edit, *Ex Machina* contained approximately 800 special effects shots (*Avengers: Endgame* contains nearly 2,500 — but *Ex Machina* is still effects-heavy for an 'indie' movie). Just under half of them were used to realize Ava. ■

POWERING THE ANDROIDS OF THE FUTURE

Much has been written about the state of the art when it comes to android brains, and where autonomous computation may take society in the future. But what about what powers those androids? Let's look at the basics — and future — of battery technology…

Batteries are a way to both store and generate electrical current, through chemical reactions. The use of batteries — and their increasing miniaturization and efficiency over the last twenty years — has increasingly decoupled even complex devices from homes and businesses.

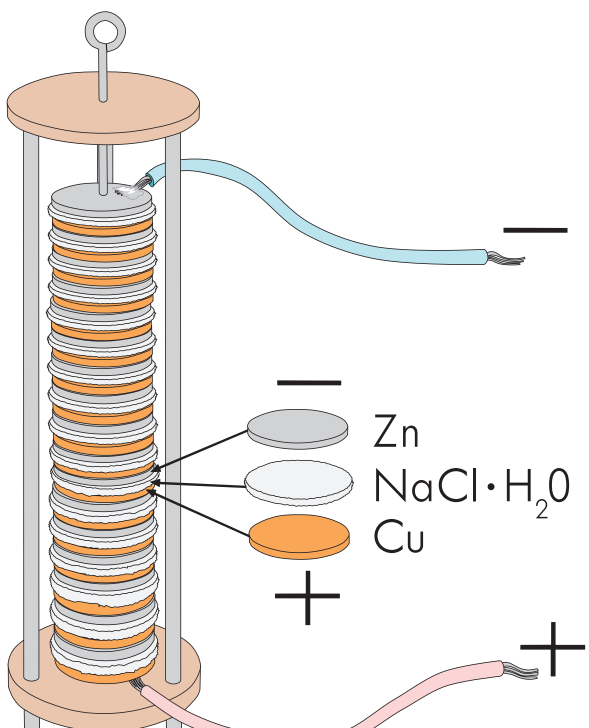
But just because almost everyone now carries around with them a flotilla of digital devices, that doesn't mean that the phone in your pocket or the laptop in your backpack are particularly energy hungry. An average phone battery holds a charge of around 5.45 watt hours, meaning 365 days of full decharge-and-recharge cycles would require just 2kWh of energy — the equivalent of running twenty 100-watt lightbulbs for an hour.

The most energy-hungry devices in the home or office are still the large appliances that plug into the mains: refrigerators, washing machines, lightbulbs, and air conditioning units. But even those have become increasingly more efficient in the last forty years, with washing machines consuming 70% less electricity than they did in 1980. Making the switch to LED bulbs also saves a significant amount of power, without necessarily sacrificing on brightness.

Batteries are also now becoming feasible as a means to power automobiles, like the poster child for fancy electric vehicles, the Model 3 Tesla. Fitted with either a 220 or 325 mile-range battery, the Model 3 requires around 85 kWh of electricity for a full charge. Currently the most popular plug-in electric car in the USA, nearly 200,000 Model 3 vehicles have been delivered to date. (However, as there are 276.1 million registered automobiles in the USA, there is still a distance to go before electric cars overtake the familiar gas-guzzlers.)

Batteries are also coming to electric planes, with Israeli aircraft manufacturer Eviation unveiling the world's first fully electric commercial airplane, *Alice*, in mid-2019.

ABOVE: A Model 3 Tesla car strikes out into the Canadian wilderness. (Photo: Joni Hanebutt / Shutterstock.com)



TOP: A Tesla Powerwall home battery device, displayed in a Seattle dealership. [Photo: valentinphotography / Shutterstock.com]

ABOVE: A pile of AA alkaline batteries, familiar sources of power for all manner of consumer electronic devices. [Photo: Shutterstock]

RIGHT: A diagram showing the functioning of a voltaic pile, the first true battery. [Photo: Shutterstock]

Built of ultralight composite materials, the plane can fly for 650 miles on a single charge — perfect for flying from, say, New York to Louisville, KY, but not yet much use for a round the world trip. The aviation industry is pinning its hopes on battery-powered flight, though, given it's one of the few ways to reduce emissions while still continuing to transport passengers, and many operators are already making bullish claims about how soon they will have commercial battery flights in the air.

CHARGED HISTORY

The first true battery was created by Italian scientist Alessandro Volta, in 1800. Formed of a stack of copper and zinc discs, piled like pancakes on top of one another, each separated by a layer of electrolyte-containing material — in this case, cloth soaked in brine, forming two different metals connected by a wet intermediary. He dubbed this the 'Voltaic Pile', and this first battery provided a stable current of continuous electricity, and was relatively stable when not in use, allowing for the storage of charge. However, it only contained about an hour's charge, and flaws with both the construction and the understanding of the chemical reactions within the battery led to problems such as the electrolyte leaking and causing short-circuits, the degradation of the zinc due to impurities forming on its surface, and the polarization of the copper due to the formation of minute hydrogen bubbles.

Over the next sixty years or so, numerous small improvements were made to Volta's model of battery, each improving the efficiency and battery life through clever innovations — experimenting with preventing the materials degrading by separating them with porous earthenware pots, for example.

The batteries quickly found use in industry — particularly in the nascent American telegraph systems — but despite reliably high current and voltage, even the best of these had their drawbacks. The Grove cell, for instance, produced toxic nitrous oxide fumes, required a costly platinum cathode, and could not be recharged.

Enter the lead-acid battery.

Created in 1859 by French physicist Gaston Planté, the lead-acid battery was the first that could be recharged by passing a current back through it, 'resetting' the chemical reaction within. Lead batteries rely on a relatively simple reaction. At one end of the battery, the anode, is a quantity of lead. At the other end, the cathode, is a quantity of lead dioxide. Between the two is a quantity of sulfuric acid. A current is created because both electrodes react with the sulfuric acid to form lead sulphate, but while the lead anode releases electrons in the process, the lead dioxide consumes them, so the electrons proceed from the anode down to the cathode in a predictable and repeatable fashion. Running a reverse current through the battery resets this process, and recharges it.

As well as the benefit of being able to re-use the batteries multiple times, the low resistance of a lead battery means that a single battery can be used to power multiple circuits or devices.

The drawbacks are principally that lead-acid batteries tend to be large, and heavy. That said, lead-acid batteries are still in use today, especially in (standard, internal combustion-engine) cars, where their heftier weight is less of a problem.

A NICKEL FOR YOUR THOUGHTS

Throughout the 19th and 20th centuries, scientists, engineers and corporations continued to experiment with different combinations of metals and electrolytes that could produce ever-better batteries for a wide range of uses.

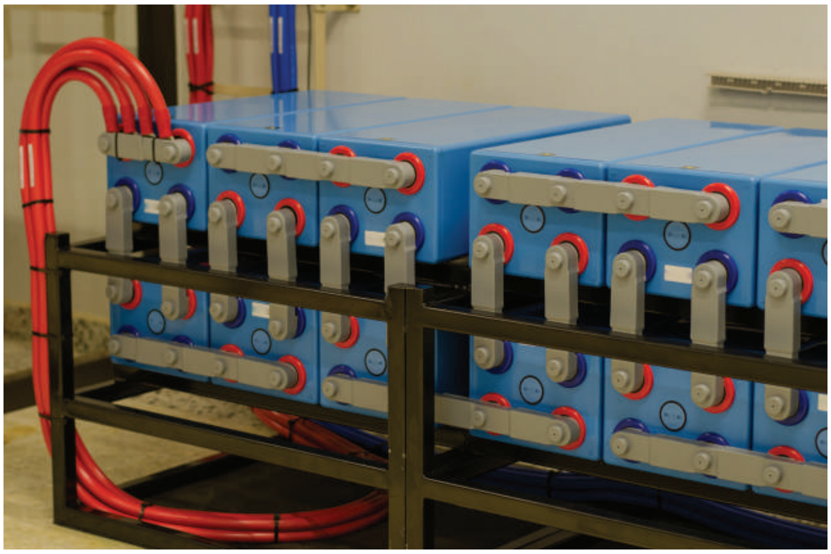
These included the zinc-carbon cell, the first battery to not use a wet electrolyte, but to instead be built around an ammonium chloride/plaster of Paris paste — with the plaster later replaced by coils of cardboard. Still manufactured today, its invention by Carl Gassner directly led to the invention of the flashlight, and its convenience quickly led to mass proliferation.

The invention of the first alkaline battery in 1899, by Swedish scientist Waldemar Jungner, put the battery industry on the path towards the batteries with which we are now most familiar. Jungner created a nickel-cadmium battery, a robust, rechargeable model, packed with energy. Its drawbacks included the expense of its components, and the fact that cadmium is toxic, but the batteries reached Swedish shelves in 1910, and the shores of the United States shortly after World War II.

The next major innovation was the invention of the nickel-hydrogen battery, first introduced as a way to store power aboard the first wave of commercial communication satellites, but subsequently reduced in size for the home market, now using metal-hydride components, instead of hydrogen. NiMH batteries, as they're known, are the most common rechargeable batteries in the standard consumer formats (AAA, AA, etc).

LITHIUM LEAP

It took almost sixty years for the first experiments with lithium batteries to bear commercial fruit, but since the first explorations began in 1912, it was clear that lithium, the lowest-density metal, was an ideal battery component. Nowadays, lithium-ion and lithium polymer batteries power our mobile phones and cameras. The first lithium-ion battery — a rechargeable and stable form of the standard lithium batteries — was commercialized by Sony in 1991. The principal advance of the lithium polymer battery is that the electrolyte is held in a solid polymer composite, and subsequently encased in a flexible wrapping. Instead of the form of the battery dictating the form of the object (as with batteries that are encased in rigid metal forms), the flexible wrapping means that the batteries can be shaped to fit the object — meaning more compact, or unusual forms. It is the innovation of the polymer composite that has driven the shape and form factor of the latest models of mobile phones, as much as the miniaturization of the circuitry within them.



IT WAS AMERICAN POLITICIAN AND POLYMATH BENJAMIN FRANKLIN WHO FIRST COINED THE WORD 'BATTERY' TO DESCRIBE HIS SET OF LINKED ELECTRICAL CAPACITORS, DRAWING HIS METAPHOR FROM ARTILLERY BATTERIES, AS LINKING TOGETHER SEVERAL SMALLER CAPACITORS ALLOWED FOR THE PRODUCTION OF A GREATER CHARGE.

THE BIGGER THEY COME

But it's not just miniaturization that is driving advancements in the battery field. As well as wanting to electrify your automobile, Elon Musk's Tesla corporation is also pursuing innovations in large-scale, home-powering batteries. Imagining a future where energy can be generated both in the home and from the grid, by solar and wind power, topped up by centralized nuclear power, these in-home batteries could ride out energy shortages and make homes more efficient and self-sufficient. Though the Powerwall 2 is now commercially available, in some senses these batteries are still prototypes for early adopters, as in many cases they prove more expensive than running electricity directly from the mains. That's not to say further enhancements won't see these rechargeable, wall-sized lithium-ion batteries becoming a regular sight in all of our homes and businesses, especially as we globally aim to become more green, and to cut fossil fuels out of our power networks. ■

ABOVE: Linked groups of lead-acid batteries are also regularly used as back-up power sources for offices. (Photo: Shutterstock)

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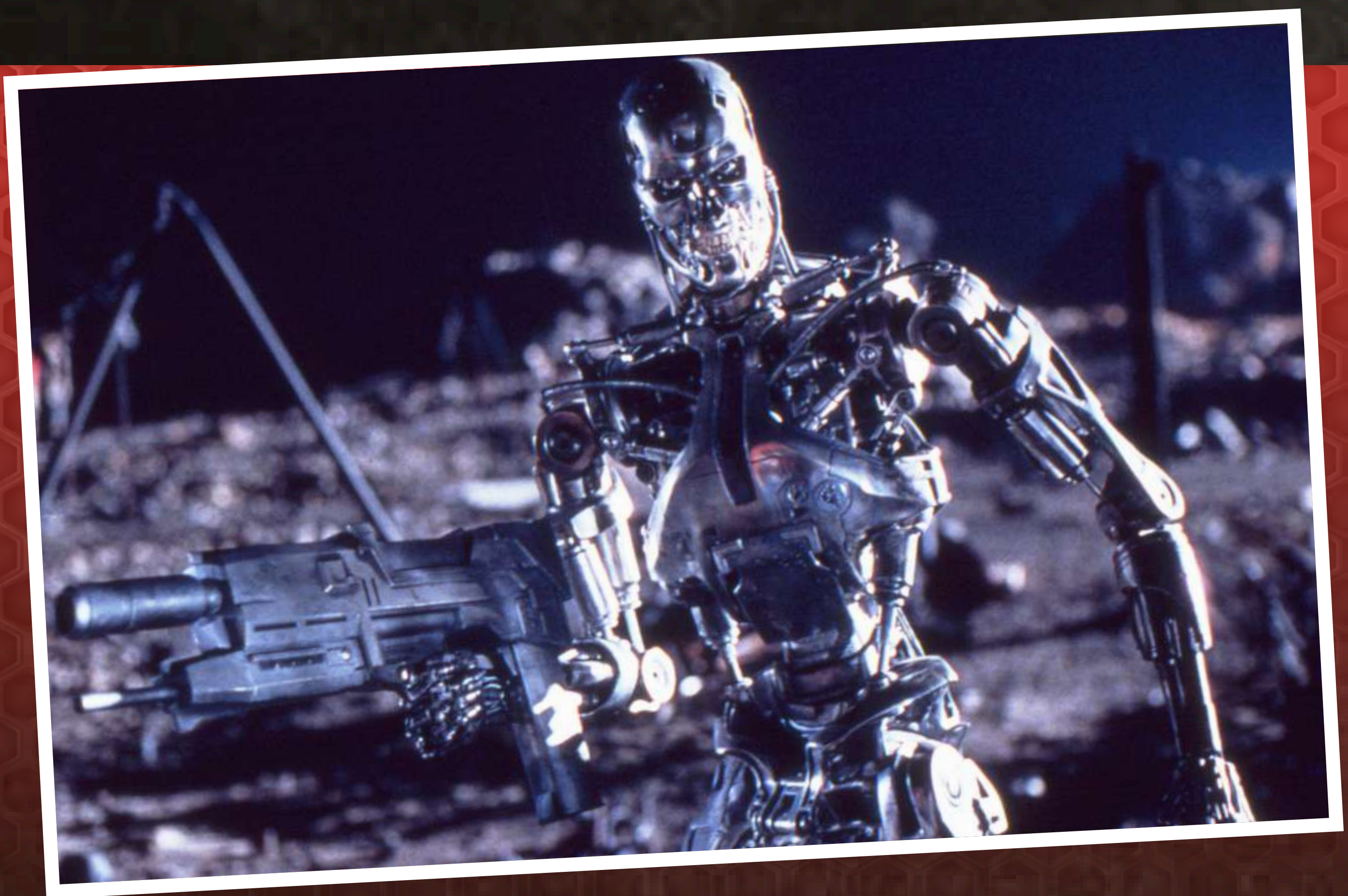

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