ALUMINUM CAR BODY REPAIR MANUAL

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INTRODUCTION

The goal of this report is to inform auto body technicians who already have knowledge of automotive body work how to successfully complete a repair on a damaged aluminum body sports car. This repair manual was created because very few informative texts exist for aluminum car body repairs. This report begins with untouched damaged on an aluminum body and systematically moves through a linear repair process leaving the repaired car in an original looking condition.

This report is important because it is one of the limited repair manuals produced which comprehensively describes the rare art of repairing hand formed aluminum body sports cars.

This report was created by skilled mechanics and technical writers who have firsthand knowledge and experience with the technical repair processes contained within this repair manual. The research done to complete this repair manual was done at Kirkham Motorsports in Provo, UT. Kirkham Motorsports has been in business for approximately 20 years and is the industry leader in high quality aluminum body sport car replicas.

This repair manual is broken up into three sections; each section covers a major step in the repair process. Each section is broken into chapters, the chapters focus on one individual repair process. The repair manual contains three sections and a total of ten chapters.

SECTION 1:
TOOLS AND ROUGH SHAPING

SECTION 1 SUMMARY

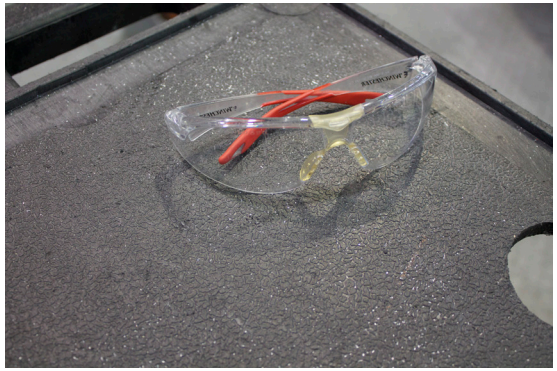
This section contains chapters one through four. The goal of this section is to help the technician begin repair work on an aluminum body sports car.

1: TOOLS NEEDED FOR THIS PROJECT

This chapter contains a list of the tools necessary for the repair. A short description of the job each tool performs is also given. Keep in mind, each repair job is unique and it may become necessary to improvise and use or make tools that are not on this list. Also, keep in mind that several of the tools in this chapter were handmade and are not available at any tool store; therefore, it may become necessary to make a tool to fit a specific repair.

SAFETY TOOLS

Safety glasses:
These should be worn during the entire repair to prevent foreign objects from meeting the eyes or surrounding area.



Latex gloves:
Gloves are a good way to protect the skin while working on the repair.

Ear muffs or ear plugs:
The noise from hammering aluminum can permanently damage hearing. Always wear hearing protection.

Respirator:
Use lung protection when sanding the aluminum.

Fire extinguisher:
When working with the torch, be sure to have a fire suppressor easily accessible in case a fire breaks out.

Oxygen/acetylene torch with rosebud flame head:

This tool is used to anneal the aluminum, making it softer and easier to work with during the repair.

Large aluminum backing plate:

This backing plate absorbs the blow from heavy tools used in the rough shaping stage of the repair. Think of it as an oversized dolly.

1-inch-thick rubber backing plate:

This rubber plate goes between the large aluminum backing plate and the car body to prevent the car skin from incurring more damage.

Sledge hammer:

The sledge hammer is used to push out very large dents where a lot of force is necessary.

Large channel locks:

The channel locks are for bending aluminum that has been tightly wrapped around on itself.

Scrap aluminum:

The scrap aluminum should be placed between the rough jaws of the channel locks to prevent the jaws from scarring the car body while pulling on the skin with the channel locks.

Body hammer:

The body hammer has a slightly rounded face on one side and a chisel end on the other.

Large two-faced dolly:

The two faced dolly has a round side and a flatter side, both sides are used to match the contours of the car body that is being worked on.

Polyurethane teardrop hammer:

The teardrop hammer is made of soft material that will not scar the car body while hammering; both ends are used to fit the contours of the car.

Ballpeen hammer:

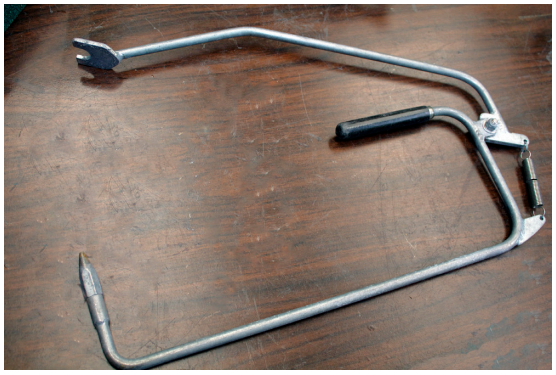
The ballpeen hammer is a hard-faced hammer, rounded on one end and flat on the other. Both ends are used to fit the contours of the car body.

Slap hammer:
The slap hammer is used to bring up or take down large areas of material all at once.

Flat-face file:
The flat-face file is used when filing a relatively flat surface with little curvature.

Dual-action air sander:
The dual action sander moves in an omnidirectional pattern as to avoid over-sanding one area of the car.

Bull's eye pick:
The bull's eye pick is used to raise or lower small areas of damaged aluminum.



Round-face file:
The round face files are used when a flat-face file would gouge the curves of a concave surface.

80-grit sand paper:
80-grit sand paper is the first level of abrasion after the car body has been adequately filed.

Sanding block:

A sanding block is a rigid block that takes out the highs and lows in the final finish. If a rigid sanding block is not used, the car body will appear wavy after the final finish is completed. A sanding block should be used for last 220-level of the final finish.

150-grit sandpaper:

150-grit sandpaper is the second level of abrasion.

220-grit sand paper:

220-grit sandpaper is the third and fifth (final) level of abrasion used for the final finish

320-grit sandpaper:

320-grit sandpaper is the fourth level of abrasion. 320-grit is the last level of abrasion before reverting to 220-grit for the final finish.

NOTES:

2: ASSESS THE DAMAGE AND ANNEAL THE ALUMINUM

TOOLS NEEDED FOR THIS CHAPTER:

- Oxygen/acetylene torch with rosebud tip
- Eye protection
- Fire extinguisher

Damage before repair work

The picture above shows that the rear fender has incurred substantial damage from the rear tire delaminating and whipping the rear fender. At the top of the indentation, a very tight fold was made in the aluminum. Fortunately, as the large indentation is worked out, the tight fold at the top of the damage will simultaneously be worked out.

This repair should begin with the large dent, then concentrate on the remainder of the fold.

When assessing damage, the technician must determine:

How much has the aluminum been stretched, or has the material been torn?

If the material has been torn, it can be repaired in the same manner as this repair manual illustrates how to repair untorn material.

ANNEALING THE ALUMINUM

While assessing the area, make sure any electrical wiring, fuel supply or return lines, brake lines, or any other car parts sensitive to heat are well away from the area being annealed. If this is not possible, make a heat shield with a scrap piece of aluminum. Be sure the material to be annealed is clean of solvents, cleaners, or any other substances that may catch fire during the annealing process.

Make sure a fire extinguisher is close at hand for any fire emergency that may occur.

To begin, ignite the torch with only acetylene gas flowing through the head. Dark black soot should flow off the red and yellow flame. Use the soot to coat the damaged aluminum black.

The picture below shows the technician using the red and yellow soot-emitting flame to cover the damaged area with soot. It is not the goal of this step to heat the aluminum; simply cover it with soot.

Coating with Soot

Neutral Flame

The picture above shows a neutral burning flame, (one consuming oxygen) emitting no soot and the fender completely covered in soot. The technician will move the neutral burning flame over the coated area to burn the soot off the aluminum.

BURN THE SOOT OFF THE ALUMINUM

Burning the soot off the panel will anneal the aluminum.

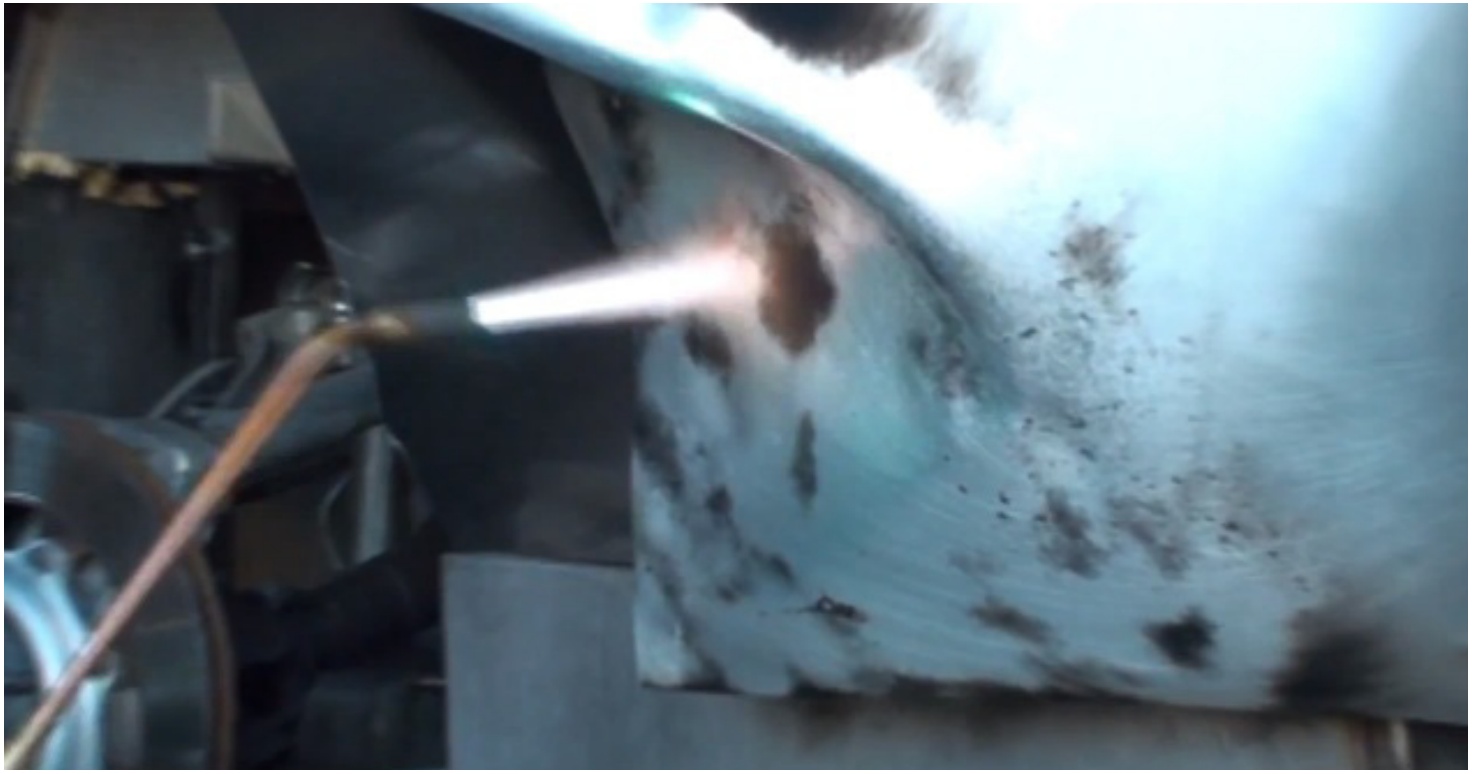
Aluminum anneals at approximately the same temperature as the soot will burn off the material.

Burning the soot off the aluminum is a very gradual and even process. Do not overheat one area; instead move the flame over an area about the size of an 8.5 x 11" sheet of paper at a time.

Occasionally, small quarter-size patches of soot will remain. It is not necessary to burn off all the soot to anneal the aluminum. If the aluminum begins to turn a gold or manila color, stop heating the aluminum immediately. Further heat will burn a hole in the material.

ATTENTION!

Allow the material to cool completely before touching or beginning the next chapter of this manual.



Soot patches may remain

NOTES:

3: WORKING BIG TO SMALL

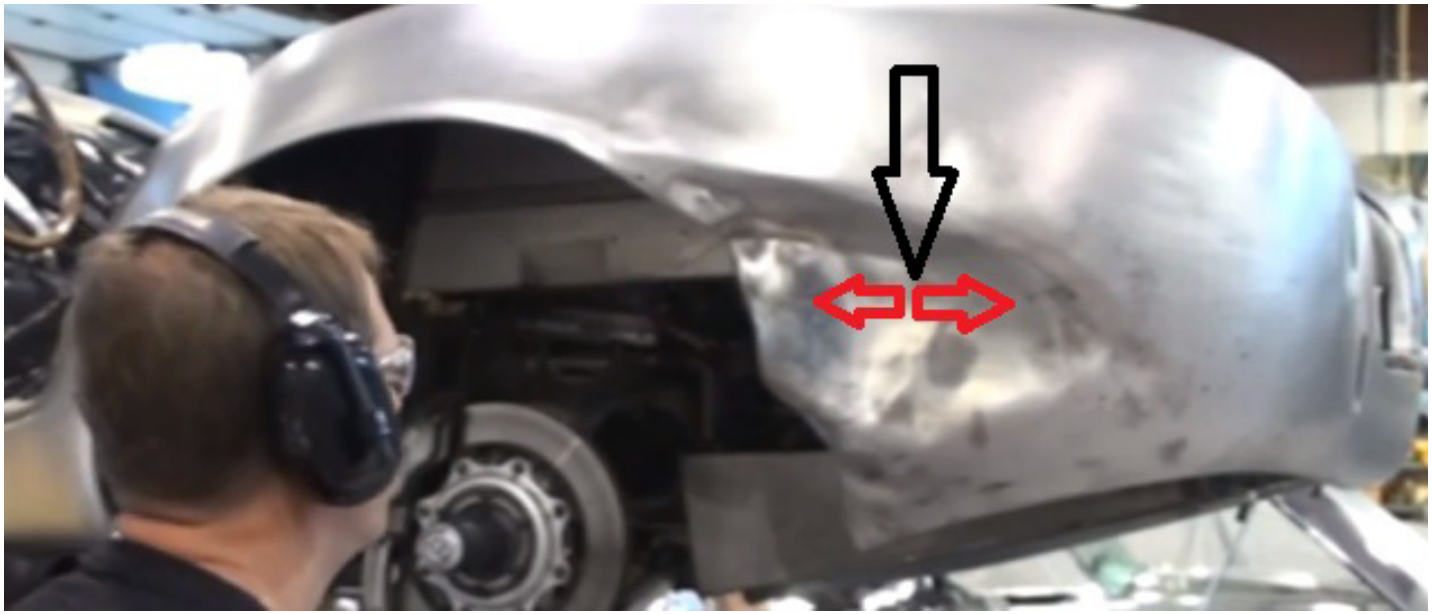
TOOLS NEEDED FOR THIS CHAPTER:

- Sledgehammer
- Rubber backing plate
- Aluminum backing plate
- Latex gloves
- Eye protection
- Hearing protection

BEGIN SHAPING THE ALUMINUM

Start by removing the large dent(s) first. A sledgehammer is used in this repair because a lot of foce is needed to remove the large dent. In this portion of the repair, the technician will need an assistant to help protect the aluminum, as a lot of force is necessary to remove large deformities. The assistant will need to place the large rubber plate between the car body and the large aluminum backing plate on the reverse side of the area that is being moved with the sledge hammer. The two backing plates (rubber and aluminum) are used to protect the back side (finished side) of the aluminum. The backing plates are used to ensure the damaged material moves evenly and prevent an indentation from the hammer's face in the material.

The picture below has a black arrow pointing to the deepest area in the dent; the red arrows show the progression of where impact was needed after the initial low area began to rise. Start in the deepest part of the dent and work out. Take care to avoid moving the material past the original body shape; this is done easiest by working evenly on an area about the size of an 8.5x11" sheet of paper.



Work outward from the deepest part

The picture below shows the work after a sledge hammer has been used to bring up the extremely low points in the material. A deep dent is still visible. The material is still substantially deformed and needs to move a little more.

Visible dent

In the picture below, the red arrow points to where the work begins and radiates outward. The heavy rubber dolly is still used to protect the aluminum from being damaged in the repair process.

Backing the material

Work finished in this chapter

When the large dents have been moved and the material needs to move less than one inch to be its original state, stop using the sledge hammer and move to the next chapter.

The picture above shows the rear fender with all the aluminum within the one inch margin. The material still has wrinkles and dents, however, the work for this chapter has been completed.

NOTES:

4: REMOVING TIGHT WRINKLES AND UNFOLDING ALUMINUM

TOOLS NEEDED FOR THIS CHAPTER:

- Scrap aluminum
- Large channel locks
- Ball peen hammer
- Two faced dolly
- Eye protection
- Latex gloves
- Hearing protection

UNFOLDING THE WRINKLES

Using the channel locks to unfold the damaged aluminum requires special care. The teeth on the channel locks will cut or tear the aluminum body; therefore, a small piece of scrap aluminum or other soft metal should be used to protect the car body from the channel lock's teeth. The scrap aluminum should be placed in between the teeth of the channel locks and the car body. Imagine a soft taco shell (scrap aluminum) wrapped around meat and beans (the car body) all being held in your hand (the channel locks).

In the picture below, the red arrow points to the channel locks. The black arrow points to the piece of scrap aluminum (being held by the technician's right hand) that was folded into a U-shape and hooked around the car body's folded aluminum. Once the scrap aluminum is in place, position the channel locks around the scrap aluminum and tighten the channel locks firmly.

Avoid unfolding one part of the aluminum all at once and work evenly from the most folded part to the least folded part. Work over the entire fold length, only moving the aluminum about 0.25 to 0.5 of an inch each bend.

Unfolding the aluminum

The picture below shows how to pull a wrinkle out using a hammer and a dolly. The two faced dolly is placed four to five inches away from the hammer's striking area on the same wrinkle line. As the hammer strikes the aluminum the technician pulls down on the hammer in the direction the aluminum needs to be unwrinkled. The direction of the pull is generally toward the direction of the deepest dent, where the deepest dent was at the beginning of the repair.

Once the aluminum has been unfolded and any wrinkles have been removed to 0.25 inch of a margin, move to the nex section

Straightening a wrinkle

NOTES:

SECTION 2:
MINOR SHAPING

SECTION 2 SUMMARY

This section contains chapters five through seven. The goal of this section is to describe the relief of minor dents and wrinkles. At the conclusion of this section, the basic shape of the rear quarter panel is regained and made ready for the last repair section (Final Finish).

5: RESHAPING THE FENDER FLARE

TOOLS NEEDED FOR THIS CHAPTER:

- Teardrop hammer
- Steel hammer
- Dolly (of appropriate shape and size)
- Safety glasses
- Latex gloves
- Hearing protection

REVERSE CURVE WORK

The fender flare follows the radius of the rear tire. At the edge of the reverse curve or flare, the panel forms around a wire, creating rigidity. The cord of the fender contains an aluminum wire wrapped up in the last 0.25 inch of the aluminum while the car was being manufactured.

Throughout this section, use tools that closely match the contours of the area being worked in each step; i.e. don't use a flat face dolly in the reverse curve area. Instead, use the round side of the dolly.

By following the undamaged portion of the body, the technician can re-establish or reference the original shape of the fender wire and fender flare. Although the damage is significant, the original material can be manipulated into the original fender shape.

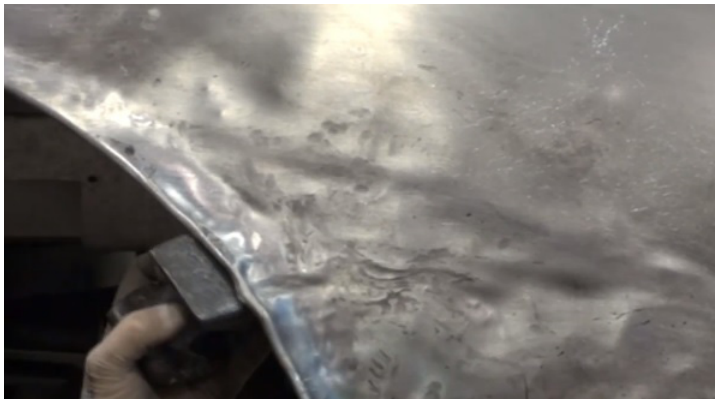
Using a teardrop hammer, appropriate dolly, and moderate force, the technician can reshape the flare. The technician uses the end of the tear drop hammer and the two-faced dolly that most accurately fits the shape of the area being worked. Place the dolly on the backside of the fender and establish the desired shape by hitting the area repeatedly. Remember to work on an area about

Teardrop Hammer & Dolly

Before work on wrinkle

the size of a dollar bill to maintain an even repair. Do not overwork one area all at once, the key is to gradually shape a large area and not force a small area into shape.

If necessary, use the chisel end of the body hammer to reshape deformities close to the cord. The small striking area of the chisel will allow the technician to remove deep dents in a small area where the tear-drop hammer or the reverse side of the body hammer are too large.



After working on wrinkles and reshaping the flare

This picture shows how the wire has been reshaped. To achieve the final depth needed for the reverse curve, the technician places the dolly under the wire and hits the large area of the body just above the crease of the reverse curve. Doing so lowers the body panel while raising the fender flare.

Straightening the wire and reverse curve

NOTES

6: ALLEVIATING MINOR DENTS AND WRINKLES

TOOLS NEEDED FOR THIS CHAPTER:

- Steel body hammer
- Dolly (of appropriate shape and size)
- Latex gloves
- Safety glasses
- Hearing protection

After regaining the rough shape of the flare, the technician can use a steel hammer and appropriate dolly to alleviate mild wrinkles. During the entire process, it is important to work gradually and avoid overshaping one area all at once.

Tight Wrinkle

Starting from larger wrinkles and working to smaller ones, use a body hammer and dolly to straighten and reshape the aluminum. Place the dolly inside the fender well, and tap with enough force to reform the metal.

For deep dents associated with wrinkles, work from the deepest portion of the wrinkle toward the least wrinkled area.

Round Dolly

Firmly hold the large flat dolly against the aluminum, and tap with the round dolly inside the fender. Use enough force to reshape the panel.

Work at this stage of the repair is slow and requires a lot of feel. A skilled technician can identify and work out deformities discovered by a hand's feel.

Large Dolly

When the material only contains minor high and low spots (0.125 inch margin), move on to the next section.

NOTES

7: LOCATING HIGH AND LOW SPOTS

TOOLS NEEDED FOR THIS CHAPTER:

- Tear-drop hammer
- Large dolly
- Latex gloves
- Hearing protection
- Safety glasses

Locating high and low spots

The technician can locate high and low spots by moving his or her hand over the aluminum and feeling for deformities. The technician's hand will move smooothly ove the car body if dust or bably powder is on the technician's hand.

Highs and lows on the wire

NOTES

SECTION 3:
FINE SHAPING

SECTION 3 SUMMARY

This section moves through the final steps of the repair process leaving the car in an original looking condition. This section contains three chapters that move through all the necessary steps to apply the final finish back on the car. This section begins with a pick and file to raise any remaining low spots and file all the material until it all resides on one smooth uniform plain. This section ends with the final process for putting the brushed finish on the car.

8: PICK AND FILE

TOOLS NEEDED FOR THIS CHAPTER:

- Bull's-eye pick
- Flat-face file
- Round-face file
- Safety glasses
- Rubber gloves
- Hearing portection

PICK AND FILE

Pick and File Tools

Begin with a bull's-eye pick and a flat-face file. The pick can severely damage the metal if certain precautions are not taken. The technician should first make sure the face of the pick strikes the metal flat and not on an angle. Second, avoid striking the aluminum body too hard. The technician will need to build up a "feel" of how much effort is needed when squeezing the handle of the pick to raise the aluminum body. With these precautions in mind, begin the work of this chapter.

The pick will raise low areas or dents in the panel. The file will smooth the panel, making it perfectly straight and returning it to original condition.

The technician must remember to file and pick slowly and evenly.

Filing Process

When filing, go over the surface gently to remove high spots. A technician can gouge the metal by pressing too hard or deep. To avoid gouging the metal, hold the file at roughly a 45-degree-angle from the direction of the cut. Everywhere that is filed is either a high spot or flat. Any remaining low spots will need to be picked up and filed off. Low spots will not be found until they are on the same plane as the rest of the filed material.

Using the pick, find the center of the low spot and place the U-shaped cut-out over the center of the low spot. Tap lightly in the center of the low spot to raise it. Work on an area about the size of a quarter at a time. Avoid hitting the same spot more than

Pick Process

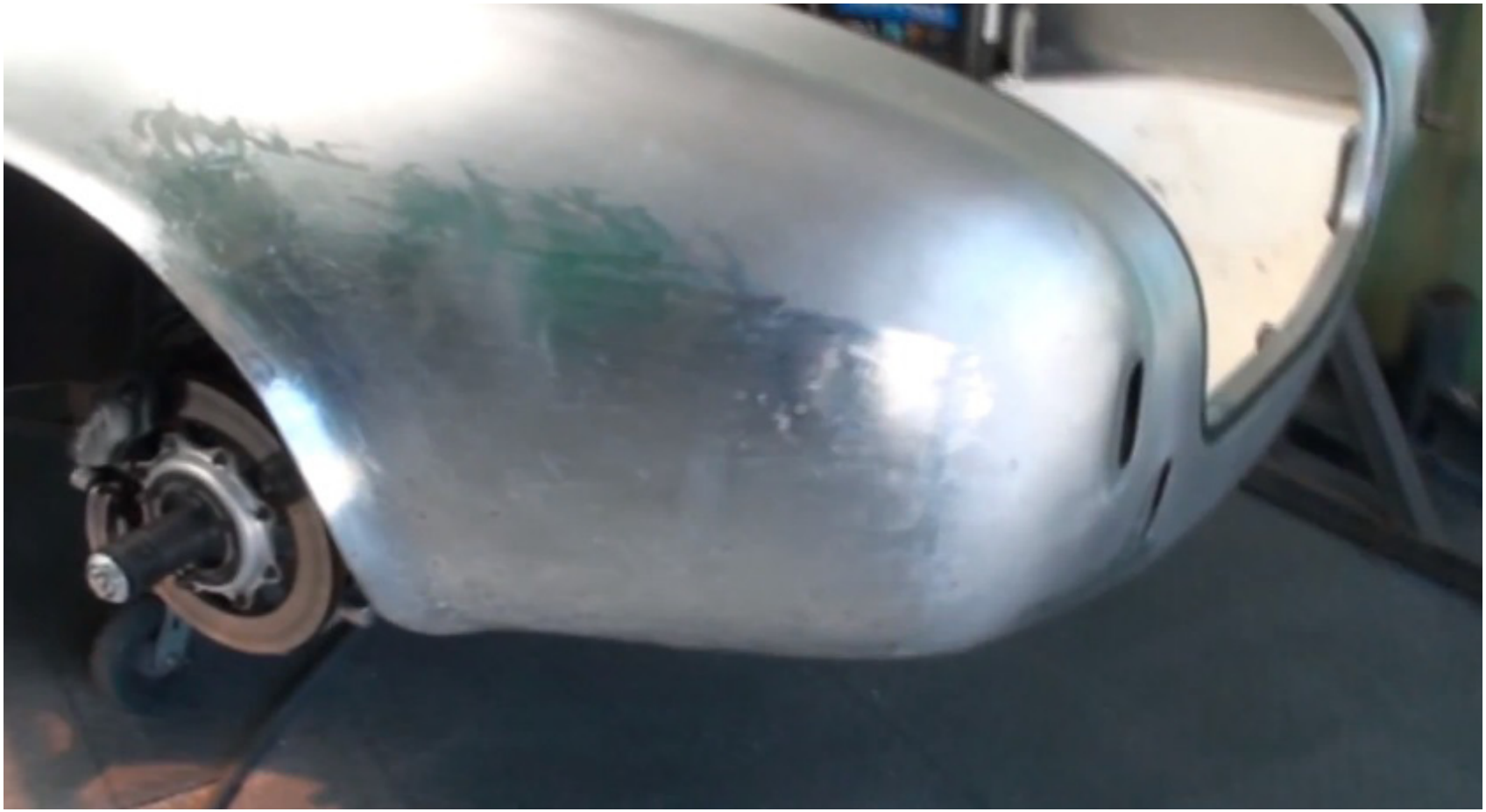
once in a row. Move the pick slightly in between strikes to lift the low spot evenly.

After a low spot has been raised, file the area. This may take several repetitions for each spot, depending on how large and deep the low area is. Do not press down hard on the file to cut a low area out because the surrounding material will be cut too thin and can be easily torn.

Use a round-face file on reverse curve areas, or areas that are not a good match for the flat-face file. The round-face file cuts a smaller surface at one time. The technician must avoid cutting too deep too fast with the round face file. Avoid using the flat-face file in curved areas because the sharp corners of the flat-face file will gouge the aluminum.

Use this process on all problem areas until the entire panel is filed off and smooth. Keep working down the panel. Repeat the pick-and-file process on all spots until the area is even and the entire surface is on a single plane.

The fender should now be back into shape—perfectly straight with no dents on the exterior. After the entire damaged area has been raised and filed onto the same plane, this chapter is complete.



Fender after filing

When the entire repair area has been filed, and all the surface resides on the same plane, move on to the next chapter

NOTES:

9: SANDING

TOOLS NEEDED FOR THIS CHAPTER:

- Dual-action air sander
- 80-grit sandpaper
- 150-grit sandpaper
- 220-grit sandpaper
- 320-grit sandpaper
- Safety glasses
- Respirator
- Hearing protection
- Latex gloves

USE A DUAL-ACTION AIR SANDER TO REMOVE FILE MARKS.

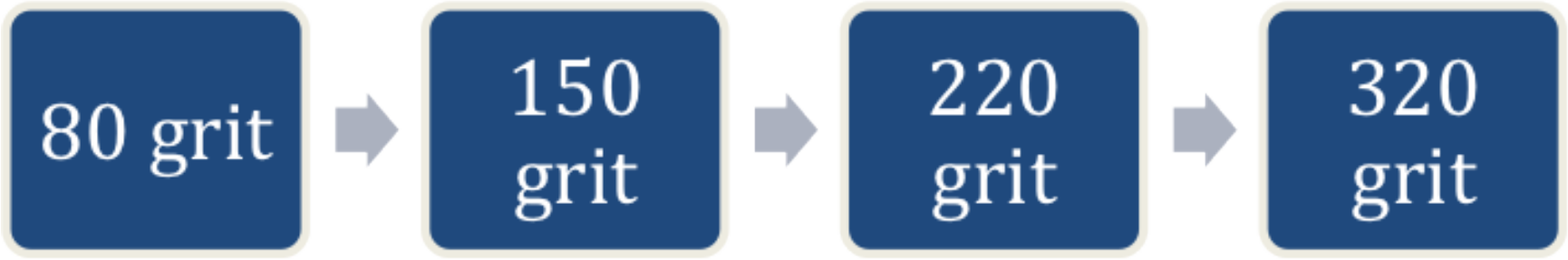
Dual-action sander

Work over a large area while sanding, about arms-reach each stroke.

Use the same motion while sanding the entire fender unless a reverse curve area is being worked; in which case, use smaller strokes, always remembering to keep the sander moving.

If the sander is not kept in motion while on the car body, it can create a wavy final finish or worse, cut through the body.

Sanding process



Sanding process

Sanding is a gradual process, and the sandpaper used should be finer with each step . Begin with 80-grit sandpaper, then move up to 150-grit, then 220-grit, then 320-grit.

All the repair areas should be sanded before moving on to the next level of abrasion. Do not skip an area and plan to make it up in the next level of abrasion.

Fender after sanding

NOTES:

10: FINAL FINISH

TOOLS NEEDED FOR THIS CHAPTER:

- Sanding block
- 220-grit sandpaper
- Latex gloves
- Respirator
- Safety glasses

APPLYING THE FINAL FINISH

After the entire repair area has been sanded with 320-grit sandpaper using the dual action sander,

Sanding block

the brushing process and final finish are ready to be applied.

To begin the brushing process, apply 220-grit sandpaper to a sanding block and brush the car in

Sanding with block

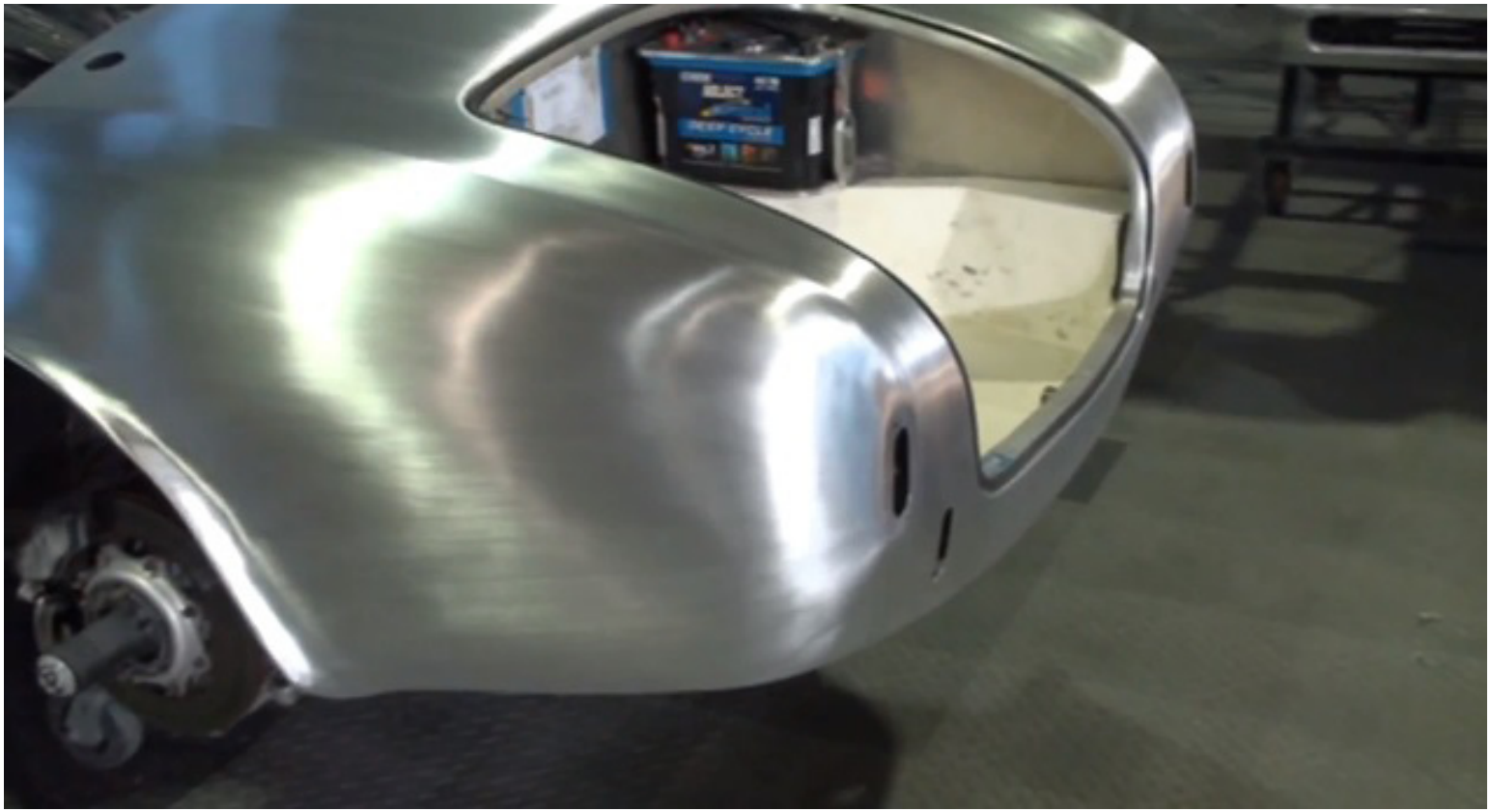
End point

a uniform direction, bringing all brush marks to an end point. In this case, repairing the rear fender, the end point for the brush marks is the rear tail light. Picture the way the wind moves over the car while the car is in motion, and try to move the sanding block over the fender in a similar way.

Blend the repaired area into the original, undamaged area.

Brush in straight lines to get the desired finish.

Continue until the repair is invisible.



Chapter completed/finished repair

NOTES:

APPENDIX A:

THE HISTORY

Some of the first cars built were aluminum. During the early stages of auto building, the methods were slow and expensive. As America moved into World War I, and later World War II, hand-forming and mechanized forming of aluminum became a huge part of wartime manufacturing because aircraft were built mostly of lightweight aluminum. The mechanized forming of aluminum was paired up with hand-forming aluminum to create such high performance aircraft as the P-51 mustang fighter plane, B-29 Super fortress bomber, and the P-38 heavy fighter and long range bomber escort.

After the wars, manufacturing techniques had improved substantially and hand forming aluminum on post World War II aircraft was virtually eliminated. During the Vietnam War, hand- forming aluminum was no longer a method of aircraft manufacturing and manufacturing was so advanced over previous eras it was cheaper to build a new aircraft than it was to repair a substantially damaged one.

The individuals who possessed the skills to hand form aluminum in World War I and World War II were no longer needed and much of the skill pool was lost. The last surviving thread of these craftsmen applied their skills to creating light weight race car bodies. As the hot rod era swept the nation in post-World-War-II-America and during the Vietnam War, race car builders facilitated many of the same techniques that helped the allied forces gain air dominance over Europe and the pacific. Lightweight building materials and big powerful engines proved to be the potent combination in the air and on the track.

THE HOT ROD ERA

A notable car designer of the late 50s and early 60s employed lightweight construction and high performance engines as a staple for a car he was developing. That innovative man was Carol Shelby. Shelby wanted to cover a car body with the lightest material available and put a high performance engine

in it. Shelby chose aluminum for the car body and interior panels. The first original Shelby cobras were lighter and faster than anything on the road. Shelby had rediscovered a venomous combination of lightweight materials and big horsepower motors.

As the gasoline rations began in the early 70s, gas-guzzling hot rods fell out of fashion for the practical driver and hand forming high performance hot rods was no longer profitable, yet again the pool of indivciduals who knew how to hand form aluminum was drastically reduced.

THE REVIVAL

In the early 1990's, David Kirkham was well on his way to medical school. He was completing the last semester of his four year education at Brigham Young University when he was poking around Provo airport with his brother Thomas. The two spotted an Iskra fighter trainer jet. The jet's skin was made by hand forming and machine forming aluminum into complex curves much like the hand formed aircraft of WWII and the hot rods of the '60s. David examined the data plate on the aircraft and found contact informant for the manufacturing company located on the other side of the world in Melitz Poland. The brothers sent a fax to the company with the following words "Can you build an aluminum body sports car?" the brothers received a faxed reply shortly after… "Yes". David quit showing up for his anatomy classes and boarded a plane to Poland.

The journey began; David learned how to form aluminum by hand using the same techniques used in WWII. David learned the perishing skill form a gentleman who worked for Rolls Royce in WWII. In the last days of the gentleman's life he taught David the art of shaping aluminum.

TODAY

In the early years of the company the entire car was manufactured in Poland however in the last 10 years nearly all the processes have been relocated to the factory in Provo, UT. Today the latest replicas are manufactured entirely in Provo.

WORKS CITED:

KirkhamMotorsports1. "Kirkham University Aluminum Fender Dent Repair." *Youtube.* 15 June 2011. Web. 28 January 2013.