## All Aluminum- C7 Corvette Chassis (w/added weld repair info)

The new C7 Stingray employs and all aluminum frame. In the Z06 the main hydroformed frame was a single section and had to employ a compromised uniform wall thickness front to rear. The C7 all aluminum frame is made from 10 castings, 38 extrusions, 76 stampings, and 3 hydroformed parts. The center section of the perimeter frame is still hydroformed but of a thickness selected just for that sections strength requirements. It is connected to a casting containing the properly located threads for suspension and front cradle cross member attachment. Extending from the casting, to the front, is a lighter weight extrusion and structural member that is designed to crush in a crash. The windshield frame and firewall support are made of a number of separate pieces joined together to make a ridged assembly. The frame is 57% stiffer and 100 pounds lighter than the previous C6 corvette steel frame.

## Joining The Pieces

GM invented and patented a new resistance spot welding process employing 439 of these welds to join frame members. Unlike some sheet metal joining where extra spot welds can be used to compensate for quality variations, the C7 frame welds must be of high, consistant quality. They mention Laser welds are used in the tunnel assembly consisting of 37 segments totally 71 feet of weld.

## Conventional MIG Welds Are Also Used:

Viewing a bare chassis, with running gear, at Laguna Seca in August 2013 showed numerous, more conventional MIG welds were used to join the various sections. Some were very uniform and most probably made with an arc welding robot. MIG welding requires the use of a wire, feed through a MIG gun, where an arc is formed between the tip of the wire and the workpiece. The arc melts the filler wire and base material so the weld appearance is much different than a Laser weld, which generally does not employ a filler metal.

In addition to the robotic MIG welds, it appears some weld joints were made with a manual MIG welder, similar to those commonly used by a body shop or home hobbyist. However from the weld size, the MIG welders employed were probably of 350 amps or higher capacity and may have been of the Pulsed MIG type.

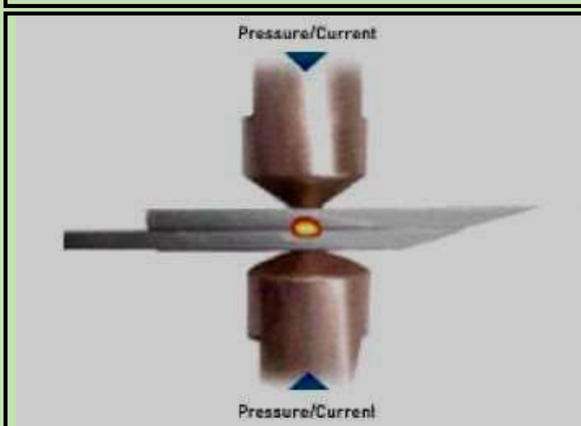
## Photo Sequence Shows Some of The C7 Frame Welds

**Photo right is the first page of a technical paper written by GM engineers and published in the June 2013 issue of the American Welding Societies monthly Welding Journal.**

**It describes the development of the procedures and patented spot welding electrodes required for the 439 structural resistance welds used to join the various parts of the C7 aluminum frame.**

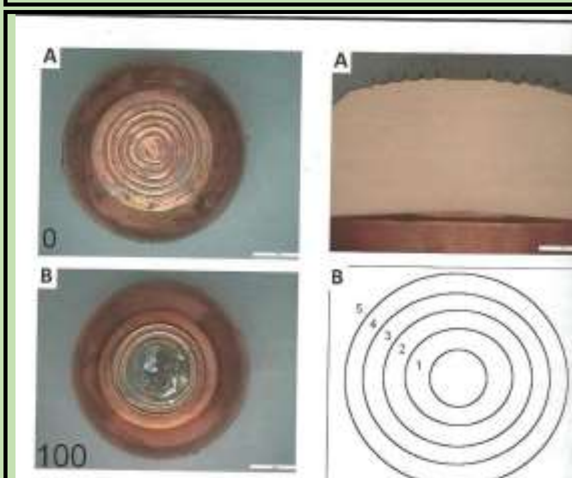
**They discuss the major problem encountered when spot welding aluminum. The oxide layer on an aluminum sheet prevents consistent current passage and causes aluminum to be mixed with the surface of the copper alloy electrode, degrading its performance as welds are made. This causes inconsistent weld quality**


Improving Aluminum Resistance Spot Welding in Automotive Structures




**Resistance spot welds are made between two sheets of material to be joined and copper alloy electrodes. The electrodes press the material being joined together with high force. A very high current is passed through the material for a short time that causes the small area in contact beneath the electrodes to melt and join together.**

**The GM solution to the aluminum spot welding problem was to put rounded raised concentric rings on the copper alloy electrode face. When these electrodes are pressed into the aluminum sheet, they distort the surface breaking up the brittle oxide surface film. This allows sufficient and consistent current passage to make repetitive, quality welds. They evaluated various tip materials to minimize wear of theses peak areas.**

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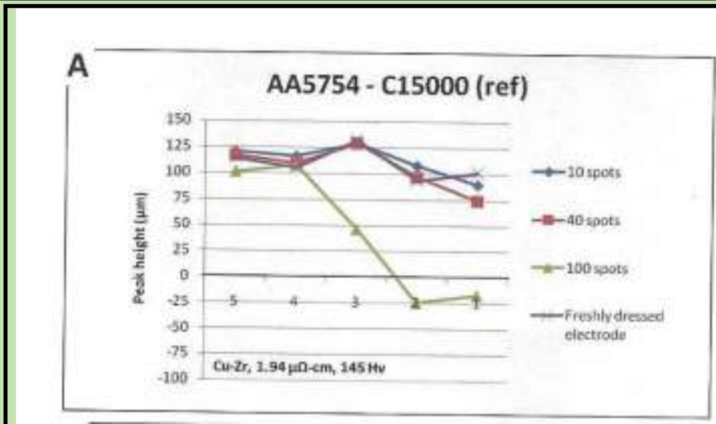



**Welds were made in common automotive aluminum alloy sheets, and various composition copper tip materials. They used about 1000 pounds pressure and 28,000 amps for 0.150 seconds. They measured the height of the electrode peaks with various alloy tips after a number of spot welds were made. This chart shows that two tip materials (#'s 4 & 5) kept their raised heights even after 100 spot welds. Two behaved poorly after exceeding 40 spot welds.**

**The researchers also analyzed the chemistry of the peak area tip surface utilizing a Scanning Electron Microscope. This defined the elements on the surface. This allowed them to define why some alloys caused more wear. They found that a layer of aluminum and an aluminum intermetallic compound formed on the electrode created a brittle layer that generated more heat. Eventually this brittle layer broke off causing pits in the tip surface. By selecting the proper electrode alloy this pitting phenomenon was minimized.**

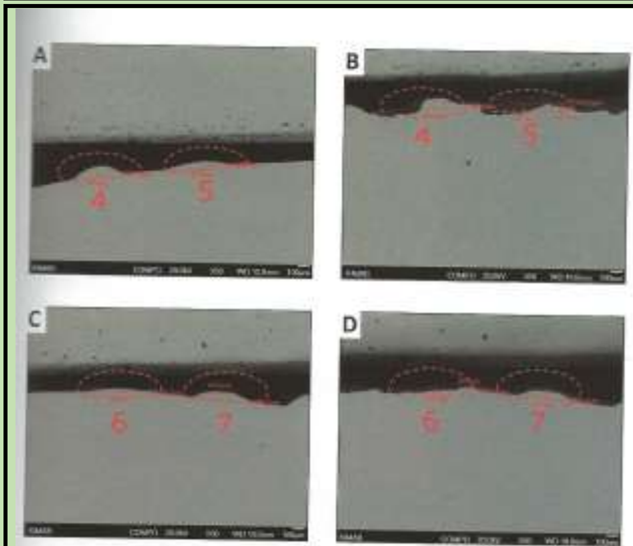
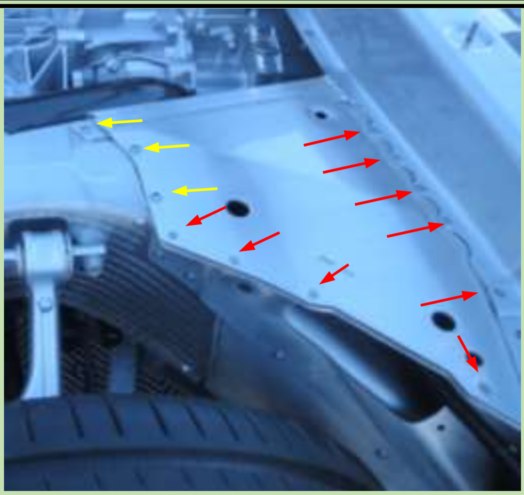
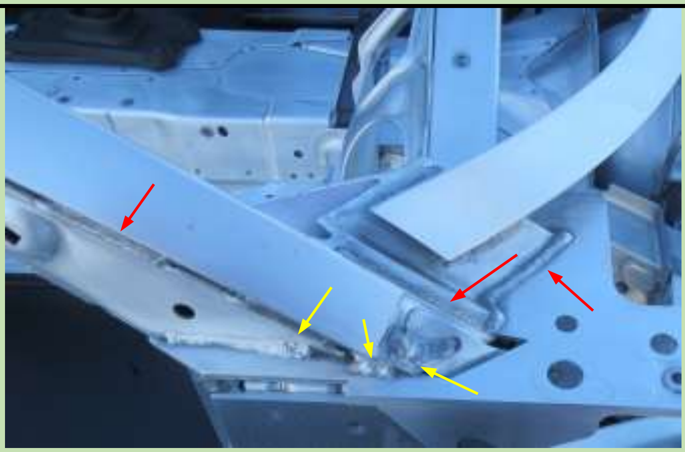



*Fig. 8 — SEM images after welding AA6111-T4 with electrode C15760. A — Peaks 4 and 5 after 40 welds; B — peaks 4 and 5 after 100 welds; C — peaks 6 and 7 after 40 welds; D — peaks 6 and 7 after 100 welds.*

**The concentric rings that form on the spot weld can be seen clearly in these two spot welds on the frame photographed at Laguna Seca.**

**Surprisingly there were few finished welds shown in the technical paper and none showed as clearly as in the photographs we took at Laguna Seca!**

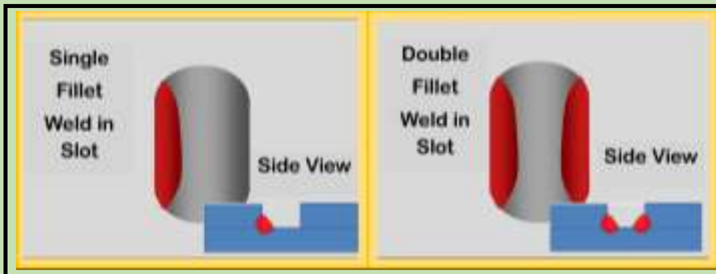
**As mentioned, GM reported that there are 439 such spot welds employed to join sections of the C7 frame.**

| | |
|---|---|
|  | **Resistance spot welders made in automotive production are often attached to robots and welds are programed by a process computer when the parts are held in place by a fixture.** |
|  | **There are a number of resistance spot welds joining this reinforcing plate to the rear C7 frame (shown with red arrows.)**<br><br>**There are many mechanical fasteners also employed for various joints (shown in yellow.) GM reports there are 188 Flowdrill-machined fasteners used with a structural adhesive. A high-speed drill extrudes the frame material to create a strong, integral collar that is tapped for screw-type fasteners.** |
|  | **There are many MIG welds used in the joining of the chassis parts. In fact, looking at the linear length of joints made with each joining processes, MIG welding is the largest. Most all welds appear to be made with a MIG welding robot since they are very uniform and welding speed was very consistence (red arrows.) Perhaps only for this prototype frame, some welds appear to be made with a semi-automatic process where a welder moved the MIG gun along the joint and maintained the gun to work gap (possibly those shown with yellow arrows.)** |
|  | **These MIG welds also appear to be made with a MIG welding robot. They are uniform and the crater in one was filled preventing a crack in the depressed end (red arrow.) This can be easily accomplished with a robot by stopping the travel and if needed by tapering the current down before stopping the arc for a short time.** |

Most MIG welds in the frame at Laguna Seca were of excellent visual quality. The lap fillet welds attaching the top bracket are an example (red arrows.)

However the fillet weld attaching the reinforcing bracket to the perimeter frame and cross member is too concave (a slightly convex to flat weld is desired) and it cracked in the throat (yellow arrow.)

Two interesting welds were found on the front frame. These are called fillet slot welds (red arrows.) They allow a larger weld to be made than a conventional MIG spot weld or MIG plug weld. Two slots were machined in the bracket and lap fillet welds made on one side. This assures penetration is made into the main member. Lap fillet welds were used to join the top of the bracket (yellow arrows.)

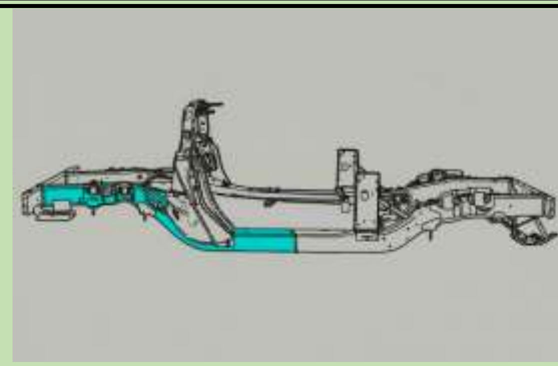


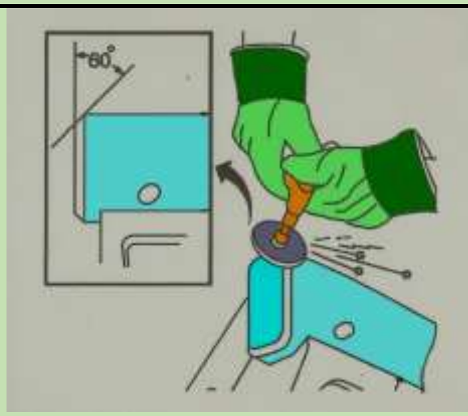

Of interest, this partical slot weld joint was defined in a book I wrote for CarTech last year, entitled Advanced Automotive Welding. The book mostly discusses welding Street Rods and Race Cars, as well as important weld quality and metalurgical issues.

I authered this CarTech 2012 published book that is 176 pages and has 450 high quality pictures with 50 to 80 word captions. It covers all arc welding processes used for joining carbon steel, Chrome Moly steel, aluminum, stainless steel, titanium and magnesium materials. Welding techniques employed for the material thicknesses used in automotive constrution are discussed. There is an example of a weld repair on an aluminum Z06 Corvette frame that applifies what is covered in a GM body repair manual. A few pics from the book are shown below:

## Repair of a C6 Z06 Aluminum Frame (Taken from above pictured book)

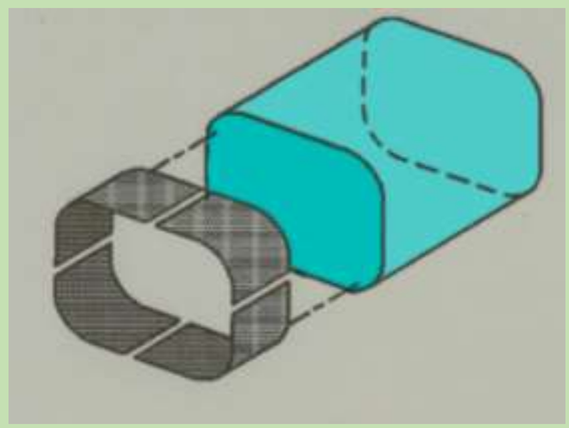
**Unlike the C7 frame rail, made of many pieces welded together, the C6 Aluminum frame rail is one piece hydroformed aluminum. The repair requires buying a complete frame rail and cutting out the bent frame section and a piece from the new frame to match.**

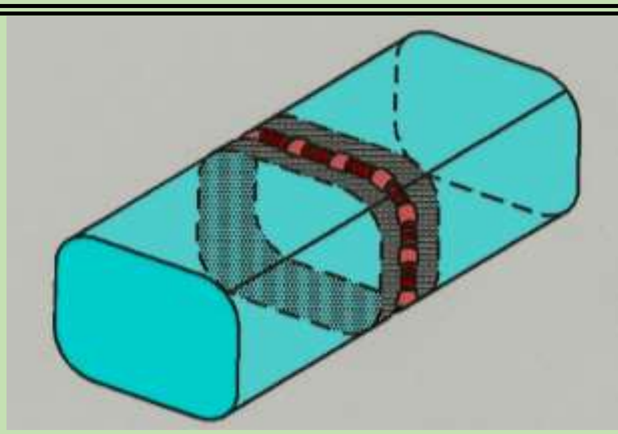





**Then the remaining old frame and the new frame section are beveled with a grinder to form a gapped single V joint. Note GM specifies grinding at a 60 degree angle that will make a 120 degree included angle, a lot of weld metal to fill, requiring several weld passes.**

**They suggest and interesting way to make a backing member to put behind the gapped, wide angle, single bevel joint. They suggest cutting a 2 inch long section from the new frame and cutting it in 4 pieces as shown. Each section is inserted into one end to be welded about 1 inch and tack weld in place. Then the replacement frame section inserted over the backing pieces leaving the thickness of the material as a gap. In the case of the C6 Z06 frame that in 3/16 inches.**





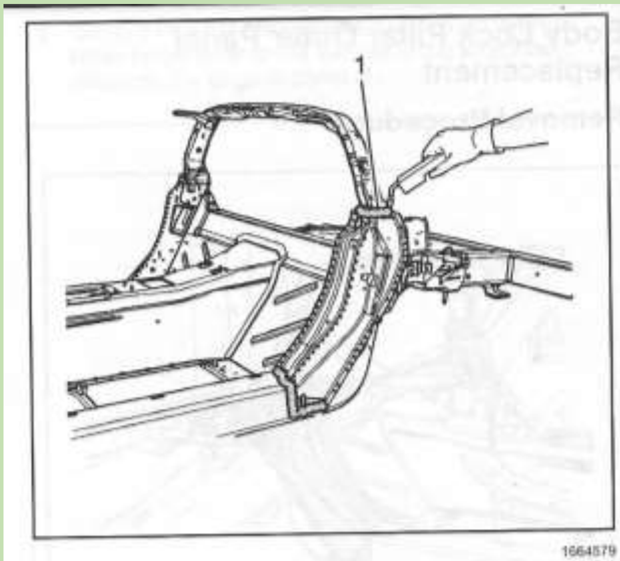
**GM specifies a root pass and a separate cover pass. They also specify welding for 2 minutes and letting the weld cool for 2 minutes no doubt to help preserve some of the strength of the base material.**

# Weld Repare Proccedures

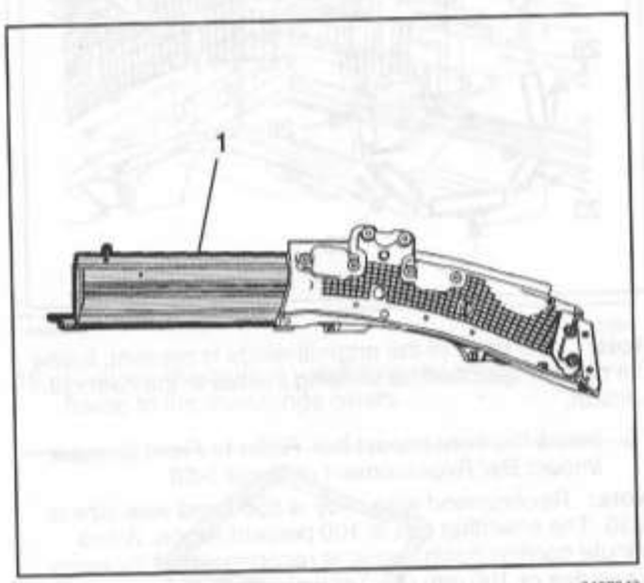
## From 2014 Service Manual

**Of Interest are some of the weld procedures suggested for repairing the 2014 Aluminum frame. They suggest removing the defective frame pieces by cutting or grinding out the welds and recommend welding the new parts back.**
**They specify using 5554 alloy welding wire versus the 5356 alloy recommended for the C6 Z06 aluminum frame. Alloy 5554 produces about the same strength but is less crack resist. However GM no doubt did the required tests and found it was most compatible with the alloys being welded. Follow their advice!**




**Note:** Recommended wire alloy is 5554 and wire size is 0.035. The shielding gas is 100 percent Argon.

6. Using a PULSED-MIG (P-MIG) or Resistance Welder, weld the lock pillar to the structure duplicating the factory welds (1).




9. Remove the damaged section of frame rail. Cut the welds around the perimeter using a cut off wheel or equivalent tool. Grind off the remaining weld from the casting.

**Note:** Recommend wire alloy is 5554 and wire size is .035. The shielding gas is 100 percent Argon. A two minute cooling down period is recommended for every 2 minutes or 100 mm (4 in) of welding.

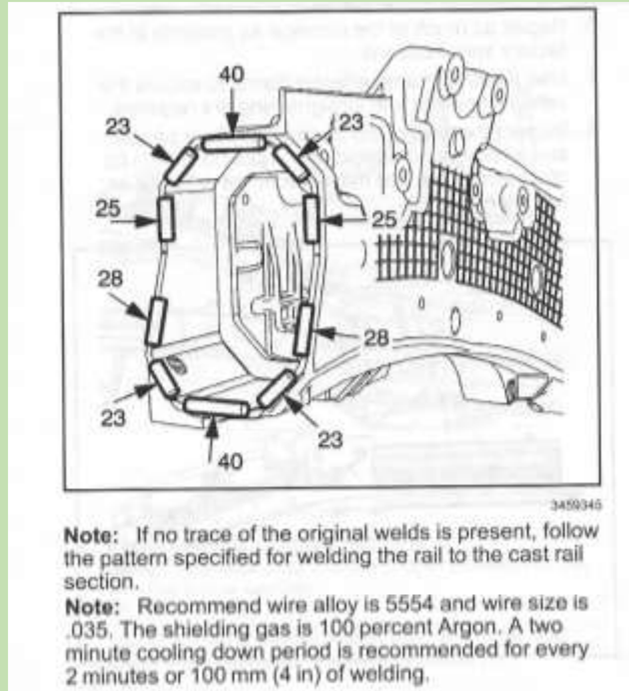
**Note:** Use a stainless steel brush to remove the oxide layer prior to welding.

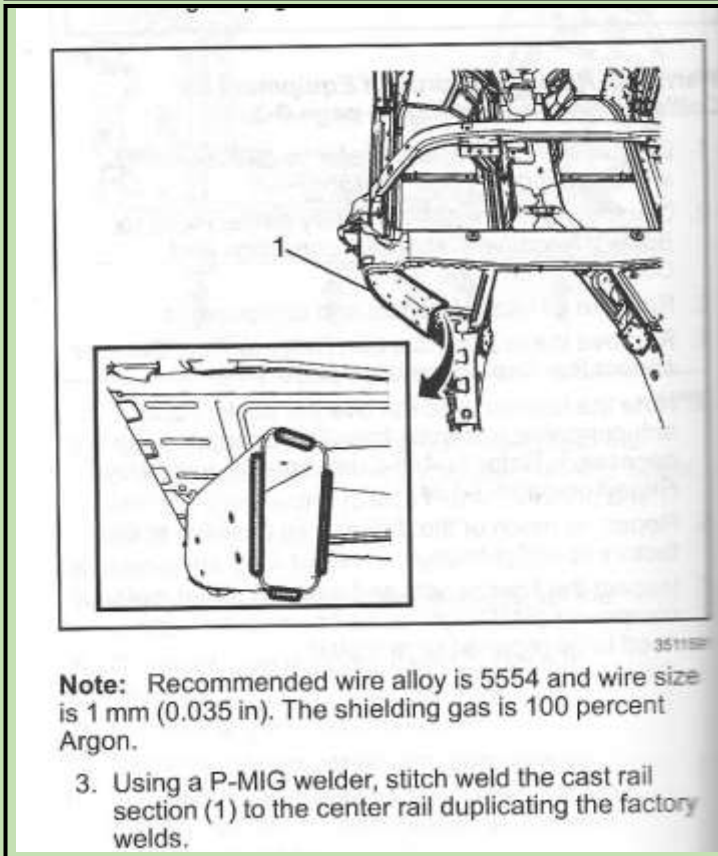
4. Using a PULSED-MIG (P-MIG) welder, weld the front frame rail to the cast rail section duplicating the factory welds.

**Another very interesting recommendation is specifying the use of a Pulsed MIG Welder. These are not inexpensive devices you can pick up at Harbor Freight! Today they are easier to use than in the past but they cost in the range of $5000 and up! Not the welder you would find in most shops, nor would the average welder (let alone a body shop technetium) know how to set it up or use it!**
**Note, in this pic it defines the need to use a stainless steel brush to clean the material prior to welding.**

**In the above pic and text it defines the need to use a stainless steel brush. It is critical that the bush be dedicated to welding aluminum! This goes for any aluminum welding. If the brush is used on any steel, small pieces of iron can get transferred to the aluminum causing weld defects. Aluminum also oxidized very rapidly. Aluminum oxide has a very high melting point and a molten aluminum weld cannot wet into the oxide. It must be removed, preferably just before welding.**

**In this pic they are welding a frame rail to the cast frame member. Note they are recommending using the original short spaced welds. Note they specify letting the weld cool for 2 minutes for every two minutes of welding to help retain the base material properties.**




**Note for all welds they recommend 100% Argon shielding. When welding aluminum you cannot use the common shielding gas used for MIG welding steel that contains from 8 to 25% $CO_2$ (which for steel welding is needed to have a more stable arc and increase weld penetration.)**

**Only two choices for welding aluminum, Argon or a mixture of Argon and Helium. It must be totally inert.**

**Note they have a metric conversion error! 1 mm diameter MIG wire is actually 0.040 in. and not 0.035 in.. Of interest in the US steel MIG welding wire is not sold in a 0.040 inch (1 mm) size but it is for Aluminum! Which one are they specifying? Suggest finding a Collision Repair Manual or check with GM!**

**WA Technology**

## Other 2017 Grand Sport & 2014 Stingray PDF's Available:


***Some 40 items discuss improvements or information about a 2017 Grand Sport and 2014 Stingray function and/or esthetics. Some are minor and others, like the installing ceramic brake pads, include detailed install information.***

***Below are the PDF's available. Click on picture (may need Ctrl pressed.) Or just copy and paste the PDF info (Blue type) into your browser. Or email me at*** GUttrachi@aol.com **and state the title desired, shown in Yellow:**

***Note:*** **GS indicates that info may only be in the process of being added to C7 PDFs.**

| | |
|---|---|
| **Rusty GS/C7 Muffler**<br>*Why the C7 muffler is rusted and a simply way to make rust turn matte black.*<br>*Bottom pic rusted, top pic treated*<br>http://netwelding.com/Muffler_Rust.pdf |  |
| **Change GS/C7 Oil**<br>*WHY change your own oil and HOW to do it*<br>*Revised, includes C7 Lifting Methods*<br>http://netwelding.com/Changing_Oil.pdf |  |
| **C7 Carbon Fiber Side Skirts**<br>*How to install side skirts with jacking information for DIY's without lifts*<br>http://netwelding.com/Side_Skirts.pdf |  |
| **C7 Carbon Fiber Splitter w/End Plates**<br>*How to install Splitter & Nylon bra fit*<br>http://netwelding.com/CF_Splitter.pdf |  |
| **C7 Removing GM Plastic Film**<br>*How To Remove The Rocker Panel Film*<br>http://netwelding.com/Rocker_Panel_Film.pdf |  |

## GS/C7 Mirror Proximity Alarm

***Limit switch alarm warns when passenger mirror is too close to door frame***

**http://netwelding.com/Mirror_Proximity_Alarm.pdf**

## Jacking Pads for GS/C7

***Jacking Pads must 2 1/2 inch max OD. Made four. Also Hockey Puck pad and 2 1/2 inch OD x 2 inch high pads bought after installing side skirts.***

**http://netwelding.com/Jacking_pads.pdf**

## GS/C7 Radar Power

***The C7 cannot tap the mirror or sun visor for power !***

**http://netwelding.com/Radar_Detector_Power.pdf**

## GS/C7 Belt Rattle

***Passenger seat belt rattles against the seat back. The solution, add a shoulder belt pad.***

**http://netwelding.com/Eliminate_Rattle.pdf**

## Aluminum C7 Chassis and Weld Repair

***The C7 has an all aluminum chassis, made from 117 welded pieces***

**http://netwelding.com/Aluminum_Chassis.pdf**

## GS/C7Ceramic Brake Pads

***The Z51 has very dusty brakes. These pads help!***

**http://netwelding.com/Ceramic_Pads.pdf**

## GS/C7 License Plate Frame;

**Must Meet South Carolina Law**

**http://netwelding.com/License_Plate_Frame.pdf**


## Manage GS/C7 Spilled Gas

***Protect the side of the C7 when filling up with gas***

**http://netwelding.com/Manage_Spilled_Gas.pdf**

## GS/C7 License Plate & Cargo Lights

***LED license plate light & cargo area bulbs are brighter and whiter***

**http://netwelding.com/License_Plate_Light.pdf**

## GS/C7 Rear Cargo Area

***Rear cargo area needs storage device and rear protector***

**http://netwelding.com/Rear_Cargo_Area.pdf**

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**C7 Door Panel Protector**

*protector plate added to prevent scuffing of door when exiting*

http://netwelding.com/Door_Panel_Protector.pdf

**GS/C7 Improved Cup Holder**

*A solution to the cup holder spilling under hard braking or shape turns.*

http://netwelding.com/Improved_cup_Holder.pdf

**GS/C7 Wheel Chatter/Hop**

*Why sharp, low speed turns with cold tires causes the front tires to chatter/hop.*

*http://netwelding.com/Wheel_Chatter.pdf*

**C7 Carbon Fiber Grille Bar**

*Install genuine carbon fiber grille bar overlay*

*http://netwelding.com/CF_Grille_Bar.pdf*

**Jacking a GS/C7 Vette**

*Safely jacking either front only or back and front*

*http://netwelding.com/Jacking_A_C7.pdf*

**Deer Whistle Installed on GS/C7**

*Do they work? Plus Install Info*

*http://netwelding.com/Deer_Whistle.pdf*

**Replacing C7 Battery**

*After using a GM type charger and showing fully charged, voltage low, replaced battery with AGM!*

http://netwelding.com/Battery_Issues.pdf


**GS/C7 Window Valet**

*Lower Windows with FOB*

*Window Valet Helps 2014/2015 Latch Hatch*

http://netwelding.com/Hatch_Latch.pdf

**GS/C7 Splash Guards**

*GM offers splash guards for the C7 Corvette. An easy DIY installation.*

*http://netwelding.com/Splash_Guard.pdf*

## GS/C7 Blind Spot Mirror

***Smaller rear and side windows cause C7 blind spots. Small "blind spot mirrors" help***

**http://netwelding.com/Blind_Spot.pdf**

## GS/C7 Skid Pad Protector

***After the air dam, the aluminum "skid pad" hits driveway ramps etc. Plastic protector helps.***

**http://netwelding.com/Skid_Pad_Protector.pdf**

## GS/C7 Wheel Locks

***Wheel locks, torqued to required 100 ft-lbs, help protect your expensive wheels from theft.***

**http://netwelding.com/Wheel_Locks.pdf**

## GS/C7 OnStar Lights

***The OnStar LED's in the rear view mirror, at a quick glance, look like a police car flashing light! This is a fix.***

**http://netwelding.com/OnStar_Lights.pdf**


## GS/C7 Skip Shift Eliminator

***Skip Shift Eliminator install with suggestions on jacking a C7.***

**http://netwelding.com/Skip_shift_Eliminator.pdf**

## C7 Catch Can & Clean Oil Separator

***Direct inject engines like the LT1, are particularly subject to "coking." What is Coking and how to reduce the potential?***

**http://netwelding.com/Catch_Can.pdf**


## GS/C7 Round Shift Knob

***A round shift knob shortens throw.***

**http://netwelding.com/Shift_Knob.pdf**

## GS/C7 Stingray Sill Plate

***Stingray sill plate replaces original.***

**http://netwelding.com/Sill_Plate.pdf**


 *GUttrachi@aol.com*

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| **GS/C7 Nylon Bra**<br>***Nylon Bra Stops Bugs on Front and Grill.***<br>**http://netwelding.com/Nylon_Bra.pdf** |  |
| **GS/C7 Clutch Fluid Change**<br>***Clutch fluid after 3000 miles gets dirty***<br>**http://netwelding.com/Clutch_Fluid.pdf** |  |
| **C7 Carbon Fiber Hood Vent**<br>***Replaces Plastic Hood Vent***<br>**http://netwelding.com/Hood_Vent.pdf** |  |
| **GS/C7 Cold Air Intake**<br>***Low Restriction Air Filter & Duct***<br>**http://netwelding.com/Cold_Air_Intake.pdf** |  |
| **Garmin GPS for GS Cubby**<br>***Garmin Mounts in GS Cubby***<br>**http://netwelding.com/GPS_In_Cubby.pdf** |  |
| **GS Splitter Stage 3 Winglet**<br>***Stage 3 Winglets Intergrate with Spats***<br>**http://netwelding.com/Stage_3_Winglets.pdf** |  |
| **GS 2LT to 2.5 LT**<br>***Red Upper Dash Pad Like 3LT***<br>**http://netwelding.com/Red_Dash_Pad.pdf** |  |
| **Jake Emblem/Decals for GS**<br>***Jake Symbols Support GS Racing Image***<br>**http://netwelding.com/Jake_Emblems.pdf** |  |
| **GS Splitter Protectors**<br>***Cone Washers Protect Splitter Bottom***<br>**http://netwelding.com/Splitter_Protectors.pdf** |  |
| ***May Be Of Interest:***<br>**Engineering a ProStreet Rod**<br>***How Our '34 ProStreet Rod Was Designed and Built***<br>***8.2 Liter Engine, 4 Wheel Disk Brakes & Coilover***<br>**http://netwelding.com/Engineering%20Street%20Rod%203-08.pdf** |  |