Adding Gas Springs to an A-Frame Trailer

Section I: The Problem of Lifting Roof Panels of Older A-Frame Trailers

A-Frame trailers are manufactured with four huge internal springs *(one in each corner)* that assist in lifting the heavy folding roof panels. These springs slowly and continuously deform/weaken when they are compressed *(i.e., when the panels are folded down).* The consequences of this natural phenomenon have been an ever-increasing problem for owners who find that they are also aging and deteriorating.

Replacing these internal springs is not an easy task for the average A-Frame owner. In one known instance the replacement springs on an older Chalet trailer destroyed the roof panels because they are reportedly being manufactured different than were the original springs.

Many owners of older A-Frame trailers have subsequently tried a variety of methods to aid them in lifting the roof panels of their aging A-Frame trailers. For some owners, the chosen option has been to sell their trailers. The problem was then transferred to the follow-on owner(s).

Necessity Is the Mother of Invention!

Section II: A Solution Arrives from the Australian Aliner Club

A retired mechanical engineer in Australia named David Hall devised a simple solution for dealing with this natural phenomenon. His solution is that of providing a boost to the lifting force of the original factory springs by adding high-pressure nitrogen-filled gas springs *(i.e., at either two or four of the corners).* David published his article on how to add gas springs to an older A-Frame trailer in the Australian Avan *(i.e., Aliner)* Owners' Club website. One must be a member of that club to access his published article at:

http://avanclubaust.org.au/members/modifications/gas-struts-installation/

David says that the Aussie Avan Club *(the supporting founders of the American Aliner Owners' Club)* has been around a while and many of their members were feeling the effects of age. The roof springs on their aging A-Frame trailers were reportedly beginning to lose their spring too. In 2015 David utilized his engineering talents to design and install these on his aging 2005 *(Cruiseliner model)* A-Frame trailer. The article he wrote on how he successfully accomplished this retrofit is attached to this article for your perusal. In it he indicates that he used 26" gas springs. The front gas springs *(with solar panels added to that panel)* were rated at 33 pounds and the rear gas springs were rated at 22 pounds.

Since David Hall published his article on the Aussie Avan Owners' Club website, several of the American A-Frame manufacturers began installing these in new A-Frame trailers with variations. Their installation techniques vary significantly from the concept that David Hall presented.

I was very happy to learn that a solution had been found to compensate for the aging A-Frame trailer roof panel lifting spring issue. I evaluated the various installation methods being used by American A-Frame trailer manufacturers on new units *(in early 2016).* I opted to use a slightly modified version to that being used for Forest River A-Frame trailers *(i.e., Flagstaff and Rockwood).* I deemed it to be the safest and most effective means to add maximum lifting torque with the lowest possible force gas springs. At that timeframe I could not find any technical information on the internet for accomplishing this modification on older A-Frame trailers.

2005 Aliner Retrofitted with High-Pressure Nitrogen Gas Springs

Section III: Why Consider Using Gas Springs vs. Replacing the Factory Springs

It is my wish that other A-Frame owners will be similarly excited about this new breakthrough concept. This article has been written to help those who are considering following the lead of David Hall *(the concept founder)* and others in making a similar conversion to an older A-Frame trailer should their roof panels become rather difficult to lift.

Please note that some *(older)* A-Frame trailers have aluminum exterior walls and some *(newer)* units have exterior fiberglass walls. It is presumed that gas springs will eventually lose gas and weaken. However, they can be easily and economically replaced *(or recharged)*! It takes only seconds to remove or re-install them! Some have a "C" clip that must be released and some just snap on and off.

Section IV: General Information about Nitrogen-Filled High-Pressure Gas Springs

The use of nitrogen-filled high-pressure gas springs is a well-established technology that has been used elsewhere for many years to provide extra lifting force for such things as the hatch of an SUV or a boat, vehicle hoods, tool boxes, truck bed Tonneau covers, A-Frame trailer beds, etc. Unfortunately nobody thought about using these to aid in lifting the roof panels of aging A-Frame trailers until very recently—thank you David Hall! A great solution is now here!

Section V: Design Considerations for Installing Gas Springs

Gas springs are readily available in standard metal and also in stainless steel *(for smaller sizes)*. They come in a variety of lengths and applied lifting forces. You will need to determine the optimum length and lifting force with your retrofit solution. Placement restrictions/limitations are the initial consideration for determining the desired gas spring length.

The gas springs that are initially installed may eventually need to be replaced with higher force springs as the factory-original springs continue to deform under stress and subsequently weaken. Fortunately gas springs can be replaced in seconds and they are very affordable. Also, if you purchase the wrong force of springs you may be able to exchange them for higher or lower force springs from the vendor. Please note that if you select 36" long gas springs I believe that the lowest force rating normally available is 40 pounds. Therefore, I would recommend that you only consider using this length for rare situations where very large roof panels are exceptionally difficult to lift. My initial three stainless steel 20" long gas springs needed to be exchanged for some with a lower force rating to reach the optimum compromise force. One vendor said that most people fail to accurately determine the required force and need to replace the initial springs with higher or lower force springs—so don't feel ashamed if this happens to you.

If you are scientifically-minded you may choose to use engineering principles to determine the required gas spring force. However, the unknown variable in this dynamic situation is the state of deterioration of the factory-original internal springs which will likely continue to deform.

David Hall used engineering principles to determine the required force of his gas springs *(see his attached article).* The reader can follow his procedures to determination the needed length and force rating of his/her gas springs. My only added suggestion is that you try to select a gas spring length in the 20, 30 or 40 pound force range to minimize the potential for undesirable side effects. With a 20 or 30 pound force rating spring most people should be able to easily attach or remove these while they are compressed *(i.e., while the roof panels are in the down position).*

It appears that one manufacturer of A-Frame trailers is using up to 120 pound *(fully extended)* force gas springs on new trailers. The gas spring force will increase by normally 20 to 50 percent when compressed based upon the characteristics of the particular gas spring *(i.e., the K-Factor or gas spring rate).* The K-factor is inversely proportional to the ratio of the diameter of the spring rod to the diameter of the inner gas chamber. This increased force is continually applied to the components of the trailer when it is in the storage position. You may desire to research the long-term affect of using these powerful gas springs for any reported adverse side effects to the components of an A-Frame trailer.

It appears that new Chalet A-Frame trailers avoid the concept of adding gas springs to assist in lifting their roof panels. New units are using a power assist lift system for all but the smallest models. On the smallest models they are adding a mechanical leverage device to manually aid in lifting the roof panels. If you are buying a new A-frame trailer this option is worth considering. However, for an older A-Frame trailer, gas springs appear to be an ideal retrofit solution.

Now let us discuss the force for the gas springs. I would say that it is optimum to use the lowest possible force gas springs for a variety of reasons. To do so means that you need to increase the distance of the spring from the hinged pivot point to compensate for a lower uplift force. The torque applied is that of **FORCE** x **DISTANCE**. Thus with a lower force you will need to increase the distance to obtain the same torque *(just like using a cheater pipe extension on a wrench).* Also, to obtain maximum torque you would need to use a straight up force when the roof panel is collapsed *(a basic engineering concept).*

I would recommend considering marine grade gas springs in the approximately 26" *(to 28")* extended length range for most trailers. The installer will need to determine where it is feasible to place the upper and lower connection hardware to avoid conflicts. I had a serious conflict with my exterior refrigerator vent panels, etc. It was rather challenging to install a gas spring at that locale but I did find a means to do it *(see attached photos).*

The gas springs under consideration will have compressed and extended lengths that may result in a conflict at some locations with the upper and lower connection points. Unfortunately I failed to consider one benefit of longer springs in my design. By using them I could have possibly hidden two of the inside *(load-transferring)* plates that support the lower connection points. This is merely a cosmetic issue in my case.

If you live by or frequent coastal locations you will need to consider the affect of salty air when choosing your gas springs, etc. The use of exposed aluminum attached to stainless steel hardware may cause some galvanic corrosion issues in salty areas. I live in a dry climate area where this is of no concern to me. I will leave this issue for others to investigate as necessary.

Section VI: My Sources for the Component Parts

The world-wide marine equipment supplier I used to purchase my initial three 20" stainless steel gas springs and pivot balls was www.go2marine.com. I recommend them highly.

I needed to do a lot more research and consulting before devising a method of installing the fourth gas spring. I ordered it *(a 26" non-stainless steel gas spring at 30 pounds force)* for the problematic refrigerator area from another good supplier at: www.boatersland.com. Their prices and return policy are also excellent but the product write-ups are very limited and sketchy. The compressed length of that fourth gas spring did not match the information published by another major boat part supplier that provided a lot of technical information but had the very highest of prices. So I would therefore definitely personally confirm the extended and compressed lengths of the springs before doing any drilling.

Section VII: Design Considerations

I preferred the orientation that Flagstaff has devised to install their gas springs *(see below photo)* that provides optimum lifting torque *(i.e., force multiplied by distance)*. I varied from their installation procedure slightly because I felt it was imperative that I spread the outside wall force around using mounting plates on my thin aluminum-skinned Aliner trailer wall rather than just 5 small screws through the external wall. I have been informed that Flagstaff A-Frame trailers have thicker exterior fiberglass walls than do newer Aliner trailers. Apparently Flagstaff walls can accommodate the constant force of gas springs. This could explain why they have attached their lower pivot ball mounts to the exterior wall in the selected manner on the trailer shown below *(i.e., with no load-spreading mounting plate and just five small screws).*

Lower Stainless Steel Pivot Ball Installation on a 2005 Aliner

Please note that I have developed a method of insuring that the walls are not compressed *(while installing the pivot ball assemblies)* using a technique described later in this article. This method also transfers much of the downward force to the inside walls.

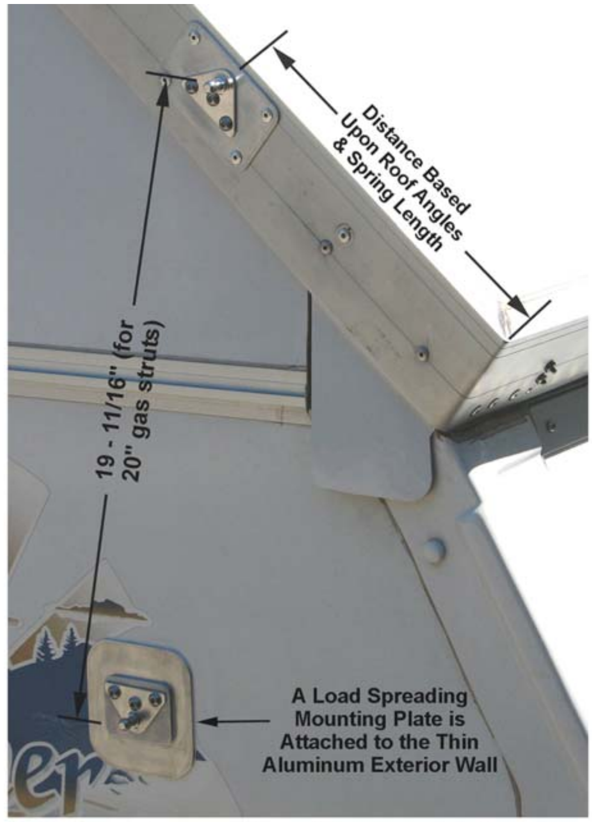
Factory Installation on a New Aliner Trailer

Factory Installation on New Flagstaff A-Frame

Section VIII: My Personal Selection and Design

Today I would use all 26" *(or slightly longer)* gas springs of 30-pounds force *(or less)* should I do it over again with my 2005 Aliner Expedition trailer with aluminum-skinned walls. I initially added two *(40-pound force)* stainless steel gas springs to the rear/lower roof panel of my trailer but only one to the front roof panel due to the conflict with the exterior refrigerator vent panels. The maximum compressed length of my three 20" stainless steel gas springs is 12". They cost less than $30.00 each—a very affordable retrofit component for my test case. The link for my selected spring type/size is:

http://www.go2marine.com/product/195273F/black-nitride-stainless-steel-gas-springs.html1059299420



Placement of the Pivot Balls on a 2005 Aliner

I designed the placement of my initial three gas springs based upon the angles of my roof panels *(i.e., 42° and 43° above level)* and their compressed/extended lengths. I prefer to not tell you what length I arrived at for my installation distance from the hinge side of my roof panels to the location of the upper 10 mm stainless steel pivot balls. The installer should determine this based upon the angles of the roof panels and the parameters of the selected gas springs.

At the ideal placement location you can capture the majority of the travel of the gas springs and also obtain maximum torque with low-force gas springs. I designed around compressing my three 20" springs to only 12½" *(see the reason for this in a later section)* and extending them to just under 19¾". That way they can be further extended to the full 20" *(only)* when the springs are being installed. Also, there is about 3" of play at the end of the roof panel travel to allow for raising them until they come back in when latched in the fully open position. Without this extra space I wouldn't be able to raise my roof panels. Also, my add-on solution for raising or lowering the roof panels during a wind storm requires this extra length *(see my wind kit design elsewhere).*

The 10 mm stainless steel pivot ball mounts I personally selected can be found at:

http://www.go2marine.com/product/92323F/nautalift-lift-support-

I slightly enlarged the holes in my mounting brackets to accommodate my preferred stainless steel 6mm mounting bolt sizes. The following sections delineate a suggested short-cut method to determine the required placement distance for the pivot ball mounts.

Section IX: Placement of an Upper Pivot Ball

The most effective location of the upper pivot balls is where the gas springs are in the vertical position when the trailer is level and the roof is in the closed position. This provides for maximum torque in rotating the roof panels to their raised position. Here is my suggested simplified procedure for determining the placement locations of the upper roof panel pivot balls using a ratio method *(instead of complex trigonometric equations).* Please note that this varies from one trailer to another because: *1) the roof panel angles above horizontal are not the same for all panels/trailers, 2) the desired/available travel of the gas springs may vary, and 3) obstructions may be encountered that limit the placement distance and subsequently reduce the effective travel of the gas springs.*

Step one - measure the length of the roof panels. As an example lets say the roof panels are 8' long.

Step two - affix small round colored dots *(or other identifying marks)* on the very bottom corner of both sides of each roof panel opposite the hinge *(when the panels are down)* and two other dots exactly behind them on the fixed-position sides of the trailer.

Step three - raise and lock the roof panels into their raised position. Next measure the distance between the upper and lower dots for each panel. This gives the needed ration of run to rise. Let us say for example that it is now 5 feet between the two dots when the 8' roof panels are raised.

Step four - determine the optimum travel of the selected gas springs from the open to the closed position. In this example my 20" gas springs have a closed length of 12". For my springs I only planned to open them to 19.7" when the roof panels are in their raised and locked position to allow a space for other issues *(like raising and lowering the roof panels).* I chose to only compress my springs to 12.5" to allow for manufacturing changes in the future, etc. In this example the travel would be therefore 7.2" between the desired extended and compressed positions of my gas springs.

Step five – to determine the desired placement distance of the upper pivot balls from the hinged edges merely multiply the gas spring travel desired *(i.e., 7.2")* by the ration of the run to rise. So in this fictitious example one finds the distance to be 7.2" x 8' *(the length of roof panels)* divided by 5'. This would work out to 11.5" for the placement of the upper pivot balls from the hinged edges of the roof panels *(note this is merely a fictitious numerical example).*

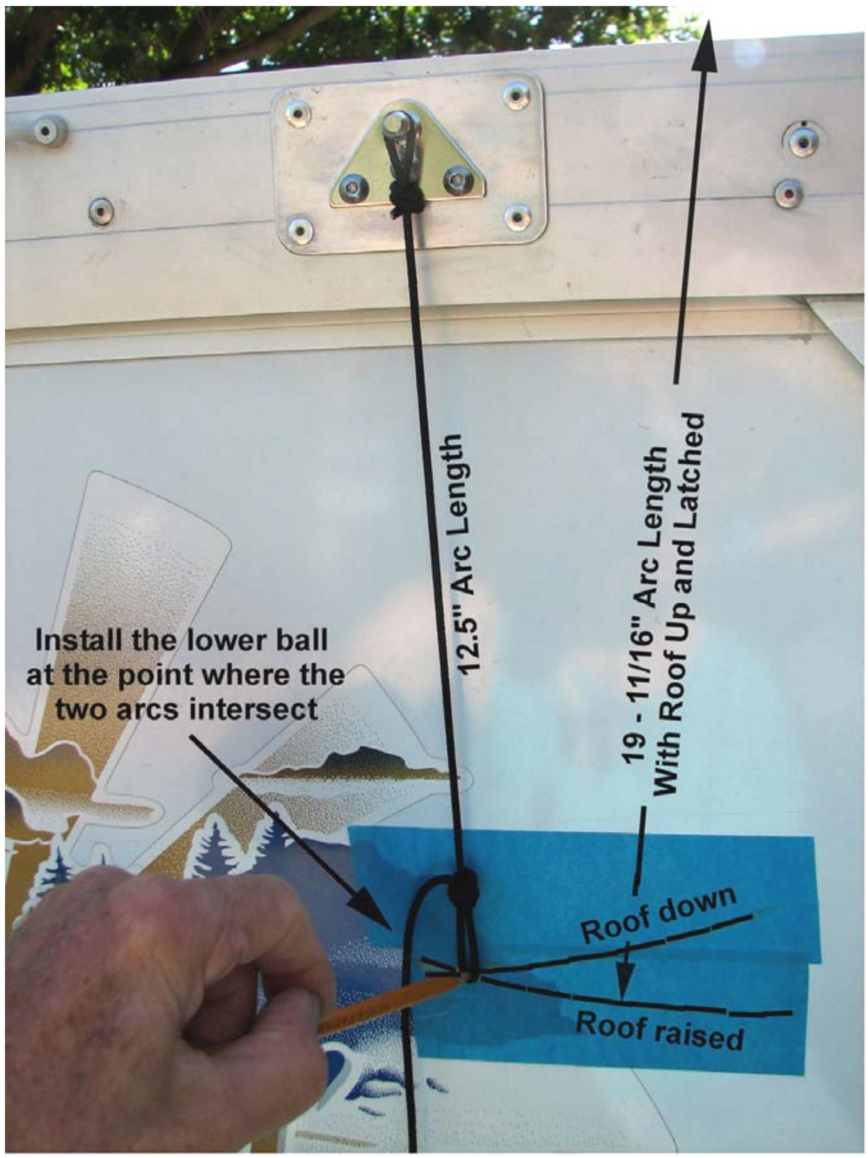
Step six – I would strongly recommend only marking the proposed locations of the upper pivot balls on the upper panels at this stage. You could use a colored dot at the proposed locations of the pivot balls *(hold off on drilling for now).* Then I would place some tape or paper over the rough locations estimated for the lower pivot balls. Arcs can next be drawn to confirm the placement locations of the lower pivot balls and that everything is correct. I would suggest that you check everything carefully and repeatedly <u>before</u> drilling any holes!

Section X: Placement of a Lower Pivot Ball

Step one – I placed a large square of blue masking tape *(see photo)* centered 12½" *(my desired compressed gas spring length)* directly below the upper pivot point *(the roof panels are down for this phase).*

Step two – next I used a length of string to draw an arc *(using a pencil)* with a radius of 12½" *(the selected compressed length)* on the temporary blue tape *(see photo).* Again, I would continue to wait to install an upper pivot ball until all these measurements check out. Please don't be misled by my photo that was taken long after this process had been accomplished and everything checked out. The photo is only intended to show the procedure I used.

Step three – next I raised and locked the roof panels in place and drew another arc in the same manner on the blue tape with a radius of just under 19¾" *(i.e., 19.7")* because that was my selected extended length. The points where these two arcs cross was the exact location where the lower 10 mm pivot balls needed to be mounted. With everything perfect, the lower pivot balls should be located directly beneath the location of the upper pivot balls when the roof panels are latched down in the closed position. If you use too short or too long of a distance for placing the upper pivot balls from the hinge on the panel edge the arcs may not cross. If you are just a bit short the springs will be at an angle *(with the bottom farther away from a vertical line through the hinged edge)* when the roof panels are collapsed. If you prefer a slight angle you can make adjustments accordingly.



Placement of the Lower Pivot Ball

Section XI: Additional Design Considerations

Upper Stainless Steel Gas Spring Mounting Plate on a 2005 Aliner

The factory A-Frame trailers I observed merely had the upper pivot ball mounts attached upside down to the top of the upper panels with small screws. I wanted to provide a very secure installation. Therefore, I added plates of aluminum *(riveted to the sides of the roof panels to spread the load)* and installed ¼" stainless steel bolts and Nylock nuts *(a.k.a. nylon insert locknuts)* as high as feasible *(as shown)* with the Nylock nuts that are installed on the inside of the trailer. Maybe this is overkill, but I have had many of the factory screws used in my trailer vibrate loose over the years. I prefer a bolt and Nylock nut *(or rivnut)* connection to that of a screw, especially for a critical connection that is under continual load and subjected to vibrations while being towed on the road. The reader may opt to use the more simplified installation method used by others.

> **VERY IMPORTANT:** I want to strongly encourage the installer to use a small wire brush to clean the threads of the bolts after they are inserted through the wall because they can easily acquire bits of aluminum that will interfere with the installation/removal of the interior Nylock nuts. This is easier than finding that he/she needs to grind the head off a stainless steel bolt to be able to remove it *(i.e., if it can't be fully tightened down).*

I recognize that the optimum lower pivot ball mounting locations on exterior A-Frame trailer walls are weak locations for this purpose. This fact likely explains the significantly different location being used by the manufacturer of Aliner trailers and also by David Hall who developed the concept originally. New Aliner trailers have the gas spring pivot ball mounting brackets attached to a stronger area with an underlying plywood backing along the wall edges. However, the effective torque is greatly reduced thereby requiring significantly greater force gas springs to achieve the desired torque. I have been informed that Flagstaff trailers have thicker fiberglass walls than Aliner trailers. This likely explains the observed variations at that timeframe.

Section XII: Mounting the 10 mm Stainless Steel Pivot Balls

For my lower installation points I fabricated 4" square aluminum plates and attached them to the exterior walls with button-head 6mm stainless steel bolts. I used interior 3" wide aluminum backing plates *(see photos).* These plates were sized vertically to transfer the load to*: 1) the inside panel using ¼" Rivnuts (i.e., rivet nuts) and button-head stainless screws and 2) the underlying wood support members.* To preclude wall crushing/deformation as well as provide for transferring the downward force through the wall to the inside plate, I installed three each stainless steel M6x25x10mm round rod stud *(fully-)* threaded insert rose joint adapter connectors nuts *(see later photos)* between the exterior and interior wall plates. These are 25 millimeters long and are the perfect length for a 1" thick composite wall. Their 6mm diameter is just a hair under that of a ¼" bolt. These can be purchased on Amazon for less than a dollar per stud in packs of 5 or 10. I also used one of these *(and part of a metric bolt)* to slightly extend the length of my commonly available 26" long gas spring *(at the refrigerator vent area)* because these are the same thread size as that used for the ends of many gas springs.

I selected weak exterior wall locations for mounting my initial three lower brackets *(to obtain maximum torque with low-force gas springs)*. I therefore chose to spread the exterior load utilizing strong aluminum plates anchored to the thin aluminum-skinned exterior walls backed by Styrofoam. I applied a *(3M fast cure 5200)* marine adhesive sealant *(white in color)* to anchor the plates to the exterior walls, protect against water leakage, etc. I store my 10 oz. *(calking gun)* tube in my freezer *(well-taped and wrapped)* between uses because it cures fast *(i.e., in 24 hours)* at room temperature. They are currently available at Lowe's for $23.98. My tubes last for years between uses because I store them in the freezer. A link for the specifications of my chosen adhesive/sealant is:

http://solutions.3m.com/wps/portal/3M/en_US/Adhesives/Tapes/Products/~/3M-Marine-Adhesive-Sealant-5200?N=5510818+3293241623&rt=rud

The shear strength of the marine adhesive I selected is roughly 200 PSI when bonded to aluminum.

The three 25mm length connector nuts inside the walls prevent compression of the underlying Styrofoam when the lower ball units are mounted using 6mm diameter Nylock nuts on the visible interior load-transferring plates. This combination provides rigidity to the bolts to allow for transferring part of the force to the inside of the walls where it is further transferred up/down as appropriate. This procedure is an easy, economical, safe and secure way to make the assembly work as a unit and transfer forces through the walls to stronger interior structural areas.

M6x25x10mm Round Rod Stud Threaded Insert Rose Joint Adapter Connectors Nuts

Metric 1mm x 6mm x 60 mm Button-headed Hex Socket 304 Stainless Steel Cap Bolts

M6 x 1mm 304 Stainless Steel Nylock Nylon Insert Hex Lock Nuts

For the first three gas springs, I used 3" wide inside backing/load transferring plates *(see photos below)* attached slightly above the mattress area and in the shower *(behind the shower curtain).* From a side perspective *(looking sideways along the exterior trailer walls)* the lower pivot balls are not aligned vertically below the upper pivot balls on A-Frame trailers.

The installer will likely find that he needs to add some appropriate exterior spacers *(see later photos)* to preclude a gas spring clearance problem when the roof panels are lowered. Otherwise the gas springs would contact the lower edges of the upper roof panels when they are down. Also, the front spacers needed to be thicker than the rear spacers.

Load-transferring/Backing Plate in Bathroom/Shower Area

Load Transferring/Backing Plate by Couch/Bed Area

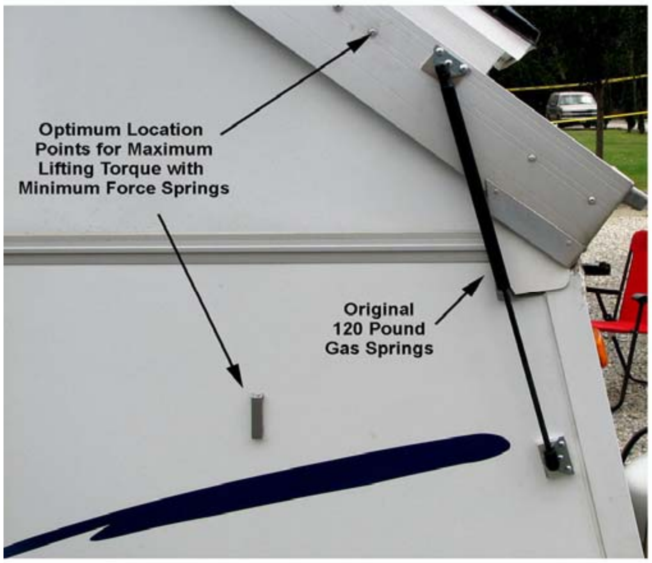
Section XIII: An Alternative Solution for a Fiberglass-Skinned Aliner Trailer

Newer Aliner and other A-Frame trailers have exterior walls made of fiberglass instead of aluminum. This change of material reportedly occurred around 2007.

Butch Penrose found that his roof panels had become exceedingly difficult to lift on his 2011 Aliner trailer *(with fiberglass walls)*. He therefore had slanted gas springs added to his trailer using 23” long 120 pound force gas springs on each of the four corners *(see below photos)*. Although this provided some assistance with lifting his roof panels, he opted to abandon this method and instead utilize a modified Flagstaff procedure which has proven to work more effectively.

In order to utilize the installation location being presented in this article *(for the lower pivot balls)* he developed a very ingenious alternative load-transferring process to that described above. He developed an <u>exterior</u> solution to transfer the force across the panel to the stronger corner areas of the walls that are backed by 1” thick underlying plywood.

Butch has been able to transfer the torque *(using his American boomerang)* to underlying wood support members in the corners *(that support the internal factory springs).* He was able to reduce the required force to 40 pounds by utilizing optimum gas spring placement. He also used an adhesive sealant to secure the structural aluminum boomerangs to the exterior fiberglass walls of his trailer. He then secured them with six screws and bolts as shown below. Now he can once again easily raise the roof panels on his 2011 Aliner with four each 40 pound force 23" gas springs. He is very enthusiastic and happy with his new procedure that follows those being used for Flagstaff trailers. His procedure is an alternative to the above described method of transferring the forces applied *(to the lower pivot balls)* into the interior areas of an A-Frame trailer.



Factory Installation Method on the Penrose 2011 Aliner

The Penrose Solution for a Fiberglass-walled Aliner

Section XIV: Attaching the Gas Springs – The Last Step

After my lower plates and mounting ball brackets were installed the adhesive was allowed time to cure for 24 hours. I then attached the ends of the springs to the lower mounting balls effortlessly while the upper roof panels were beyond their normal fully-extended position *(about 2¾").* You may find it easier to attach the gas springs to the lower/rear panel first before attaching them to the remaining upper/front panel unless you want to compress and then connect the gas springs *(i.e., before they reach the end of their travel).* At the end of their travel no compression is required to connect the gas springs.

To attach the ends of my 20" stainless steel gas springs I used a small flat screwdriver to lift the securing 'C' clips about 1/8", insert the ends over the balls, and then remove the screwdriver so the clips popped back into position. Adding and removing gas springs is fast and easy *(it takes but seconds).* My fourth 26" gas spring was of a different style and merely popped on an off without the need to raise a "C" clip. You will need to think about which style you would prefer.

The style of the gas spring over my refrigerator vents allows for very easy access since it pops off easily without the need to deal with a “C” clip.

Section XV: Dealing with a Difficult Installation Area

My refrigerator’s upper exterior vent panel is located exactly where I desired to install the fourth gas spring. I therefore was required to use a longer 26” gas spring *(with a force of 30 pounds)* for this location. I utilized a very wide/large aluminum plate affixed to the inner *(refrigerator area)* wall to transfer the load to a stronger interior area. I also used the same metric 1mm x 6mm x 25mm by 10mm diameter round rod stud *(fully-)* threaded insert rose joint adapter connectors *(see above photos)* combined with metric threaded 1mm x 6mm x 60mm button-head hex socket stainless steel cap bolts. The connectors are just a hair shorter than the thickness of the wall and preclude wall compression. They also transfer the exterior downward vertical load applied to the pivot ball to the interior aluminum plate when the hardware is securely connected. Then the aluminum plate transfers the load to a stronger interior area. I am including a series of full-sized photos at the end of this article to clearly depict this process for my very problematic area. If you need to make a similar installation to a refrigerator area I would add that I used a double *(i.e., two each)* angle device combination connected to my cordless drill to create the interior holes. There would have been inadequate clearance to insert a drill without removing the refrigerator *(too much work!).* Using a combination of two of these angle devices made the task simple and rotated the direction of the drill bit by 180 degrees.

Section XVI: Final Comments

It is my desire that others will contribute their creative genius to further refine the installation techniques should they similarly attempt to retrofit their A-Frame trailers with gas springs. I tried to use the carpenter’s rule *(i.e., measure twice—cut once!)* twice before I drilled any holes in the sides of my A-Frame trailer. I measured <u>four</u> times first *(from every conceivable perspective)* before I commenced drilling or cutting once. I chose to check and recheck before drilling my needed holes! I am quite mechanically and technically-inclined but I was still extremely cautious because I felt it to be so easy to make a mistake while accomplishing this innovative and complex retrofit.

The required lifting force for each application will vary. Also, higher force gas springs may be necessary in the future as the internal factory springs continue to deform and weaken over time. My gas springs provide an amazing effect and eliminate the difficulty associated with lifting the roof panels. It only requires very low force gas springs to make raising the roof panels less cumbersome when using the optimum installation location to achieve maximum lifting torque.

Using low force gas springs should prevent potentially undesirable side effects that could be associated with using higher force gas springs. The gas spring force will normally rise by 20% to 50% when compressed depending on their design *(i.e., their K factor).* So four gas springs rated at 120 pounds *(their fully extended force rating)* could be applying a significant static force *(i.e., up to 180 pounds each)* while they are compressed for prolonged periods of time.

I am aware of one case where the roof panels of an older Chalet trailer were damaged when the original springs were replaced. The new replacement roof was heavier leading to the installation of slanted 120 pound force gas springs to compensate for the increased roof panel weight. The new gas springs reportedly: *1) stretched the hinges and 2) damaged the ends of the trailer.* The owner is now considering installing lower force gas springs using the procedures delineated in this article.

In summary, please note that the concept of attaching gas springs, as described in this article, is still a developing technology. I was willing to take this risk because of the difficulty I have experienced raising my roof panels. I am very pleased with the results to date. I can once again very easily raise my roof panels. Today I would personally use four 26" long gas springs *(a common length)* with a force rating of only 30 pounds. Their longer compressed length would reduce the visibility of two of the inner plates *(a cosmetic issue).*

The cost in materials to accomplish this conversion using mostly stainless steel components has been very affordable. The initial three 20" stainless steel gas springs were less than $30.00 each. The three pairs of stainless steel pivot ball mount brackets were less than $10.00 per pair. Shipping is free on orders over $99.00. The cost of the aluminum, rivets, rivnuts, stainless steel bolts and Nylock nuts was minimal. The total cost for adding the fourth longer gas spring was $57.00. In summary, the cost for the whole job would have been about $200.00 if I bought all the components at one time.

One part of this effort that can prove difficult is that of fabricating the aluminum backing plates and spacers. A band saw that can cut aluminum may prove beneficial. Also, a Rockwell BladeRunner X2 *(on Amazon for around $90.00)* is reportedly worth considering for this task.

Another part of this process that is obviously difficult is that of determining the required lifting force of the gas springs. Engineering principles can aid in determining their required force but unfortunately the uplift forces of the internal springs changes as the panels rise. The location at which they no longer provide lifting assistance also changes as they age and deform. The gas springs also provide a greater force when they are compressed *(see discussion below).* David Hall *(see his attached article)* feels that a compromise solution is optimum whereby the effort to raise the roof panels is similar to the effort to close them. For the Butch Penrose solution, he is able to effortlessly raise and lower his panels with one arm standing as the rear of the trailer. Before these gas springs were installed it took the combined effort of both of us to raise his roof panels.

The reader can find out more about the design, operation, installation and maintenance of gas springs on the web. The difference between the compressed force and the extended force of the gas springs varies depending on the characteristics of the selected springs *(i.e., the K-Factor or gas spring rate*). Normally the rods of the springs should be in the downward position to allow for the internal oil to lubricate and protect them. Information on the functioning of gas springs is available on the internet. Basically the high pressure is applied to the end of the rod. Their force is that of the internal gas pressure multiplied by the cross-sectional area of the rod. As the rod is pressed into the gas spring the internal pressure increases and so does the force applied by the gas spring. A larger chamber for the gas can be used to reduce the K-factor addressed earlier.

I hope this article helps you learn how some of us have resolved the problem of our roof panels becoming exceedingly difficult to raise as the internal springs age and deform over time *(while in the normally-compressed mode).* Thanks again to David Hall and the *(very progressive)* Australian Avan *(i.e., Aliner)* Club who presented his ingenious solution *(see attached)* for resolving the problem he was experiencing associated with raising the roof panels of his aging Australian A-Frame trailer. As previously mentioned, he used four 26" gas springs of 22 and 33 pounds force each.

The issue of continually weakening A-Frame springs is a very serious matter that was causing ever-increasing problems for me. The grueling effort required to raise my roof panels was becoming overwhelming. I felt that somebody needed to find and document a solution for this problem. Unfortunately, I could not find a functional solution anywhere on the web as addressed earlier. Therefore, I spearheaded an effort to research this issue and document my findings for the benefit of others facing this same problem. If others can come up with a better solution or refine the contents of this article it would be greatly appreciated. Perhaps someone will next develop and share a table correlating spring length, compressed length, common A-Frame roof angles *(or run to rise)*, roof panel pivot ball placement distance, lower pivot ball placement distance, etc. For now this is as far as I feel is necessary to help carry the technology forward.

I am also hoping that the A-Frame trailer manufacturers will venture into the area of helping owners of older trailers retrofit them with gas springs. A growing number of older A-Frames could likely benefit from these to compensate for their ever-weakening internal springs. I would hope that with time installing new gas springs could become easier and more economical *(i.e., perhaps in the range of $750.00 to $1,000.00)* than replacing the original springs as repair shops gain experience and expertise with this task. This retrofit would increase the value of the trailer.

Brian Hovander

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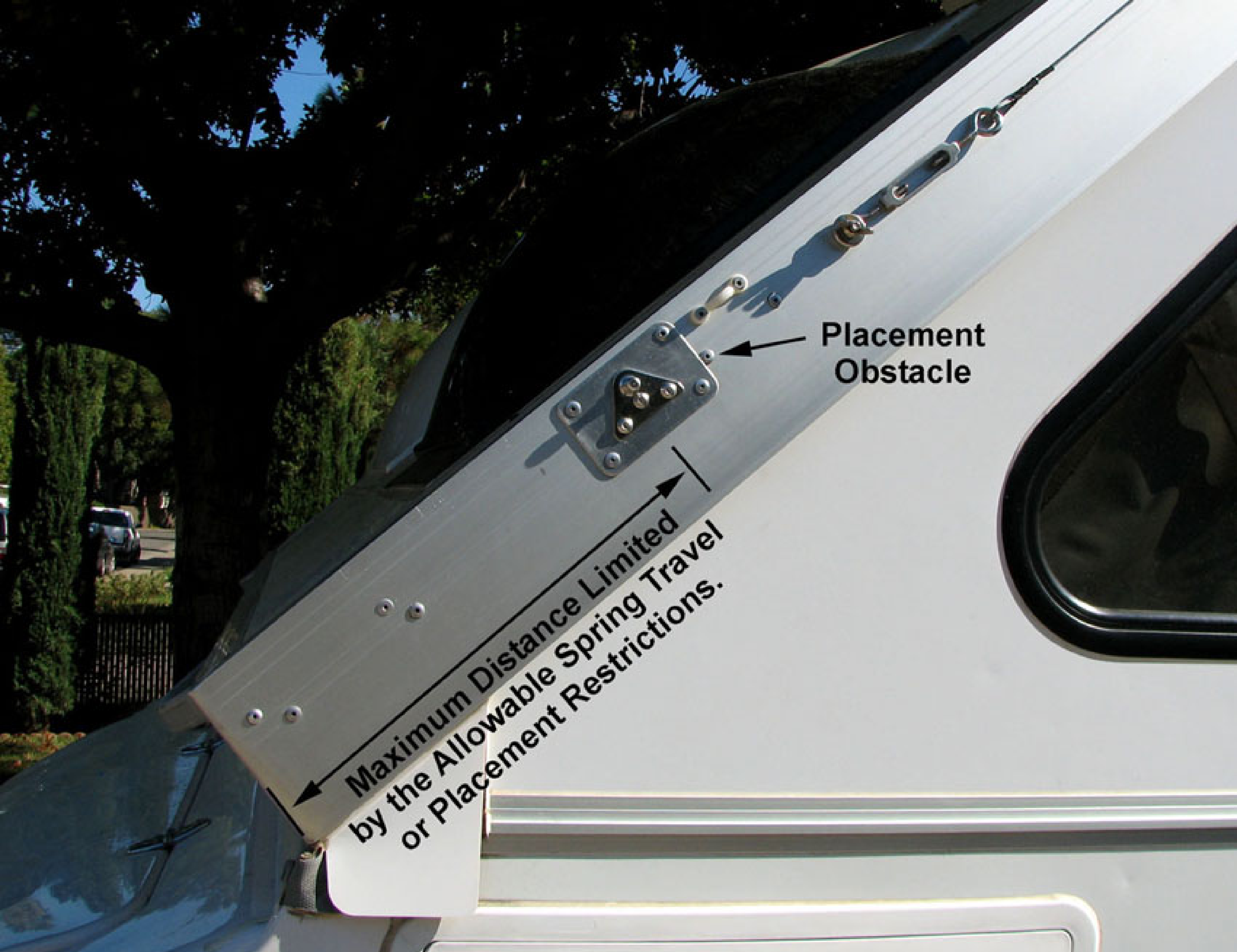
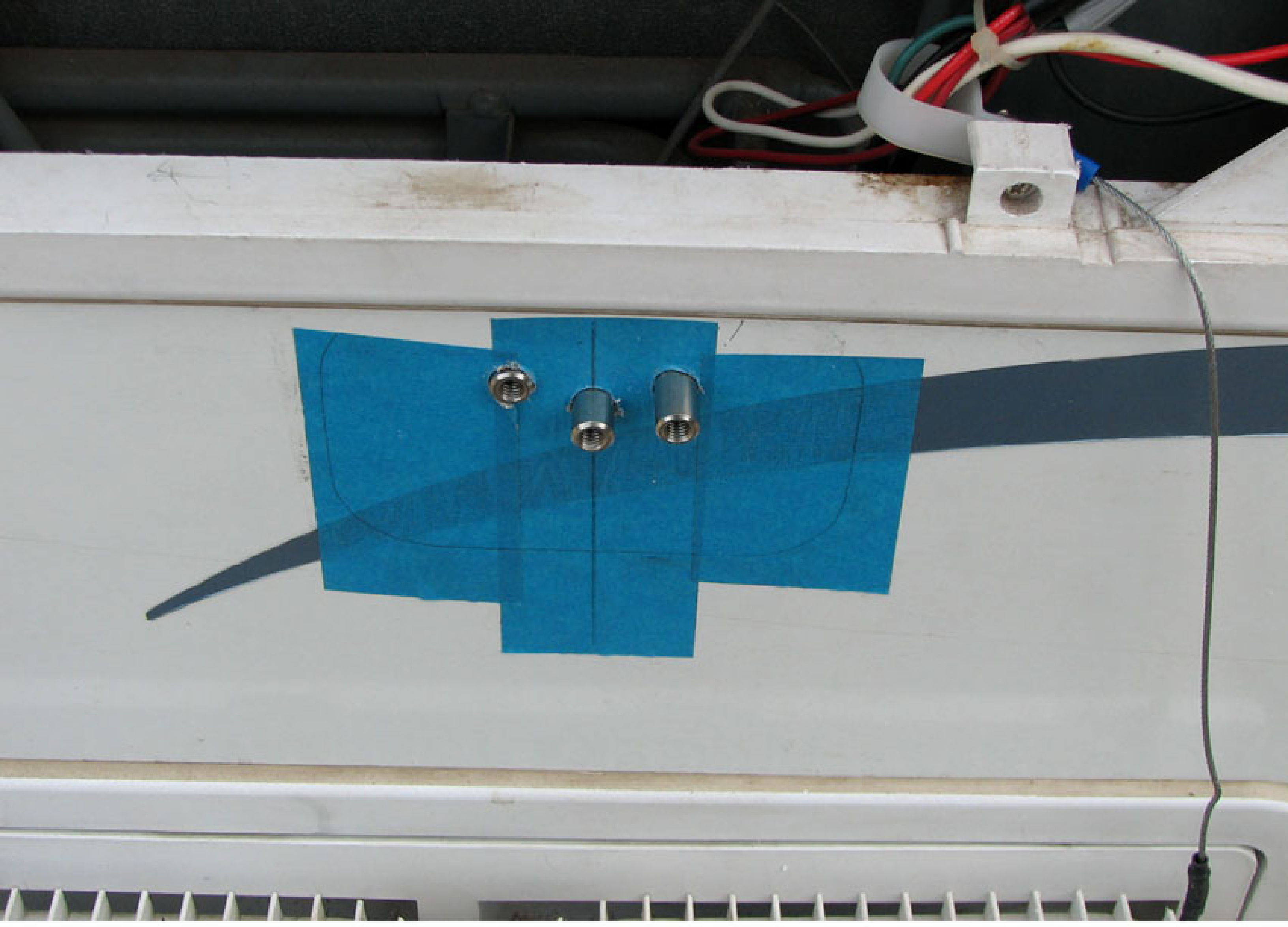
A short note about the Author:

The author is a licensed professional Civil Engineer in the State of California. During his career, he has worked with/for a wide variety of technology development organizations including *(but not limited to)* working with/for the Air Force Flight Test Center, NASA *(on the initial Space Shuttle Program)*, the Air Force Rocket Propulsion Lab and the Jet Propulsion Lab. He has been greatly associated with scientific individuals who were not afraid to try new inventions despite the risk of venturing into the unknown.

To develop the above delineated procedures he consulted with many other *(active and retired)* design engineers and technically-experienced individuals. He is providing the experiences he and others have gleaned thus far in their venture into the area of installing gas springs. Hopefully readers can benefit from this article and resolve their particular issues more quickly and effectively. He suggests using 26" *(to 28")* gas springs wherever possible to allow for much lower force rating requirements. Also, note that the concept founder uses 26" gas springs.

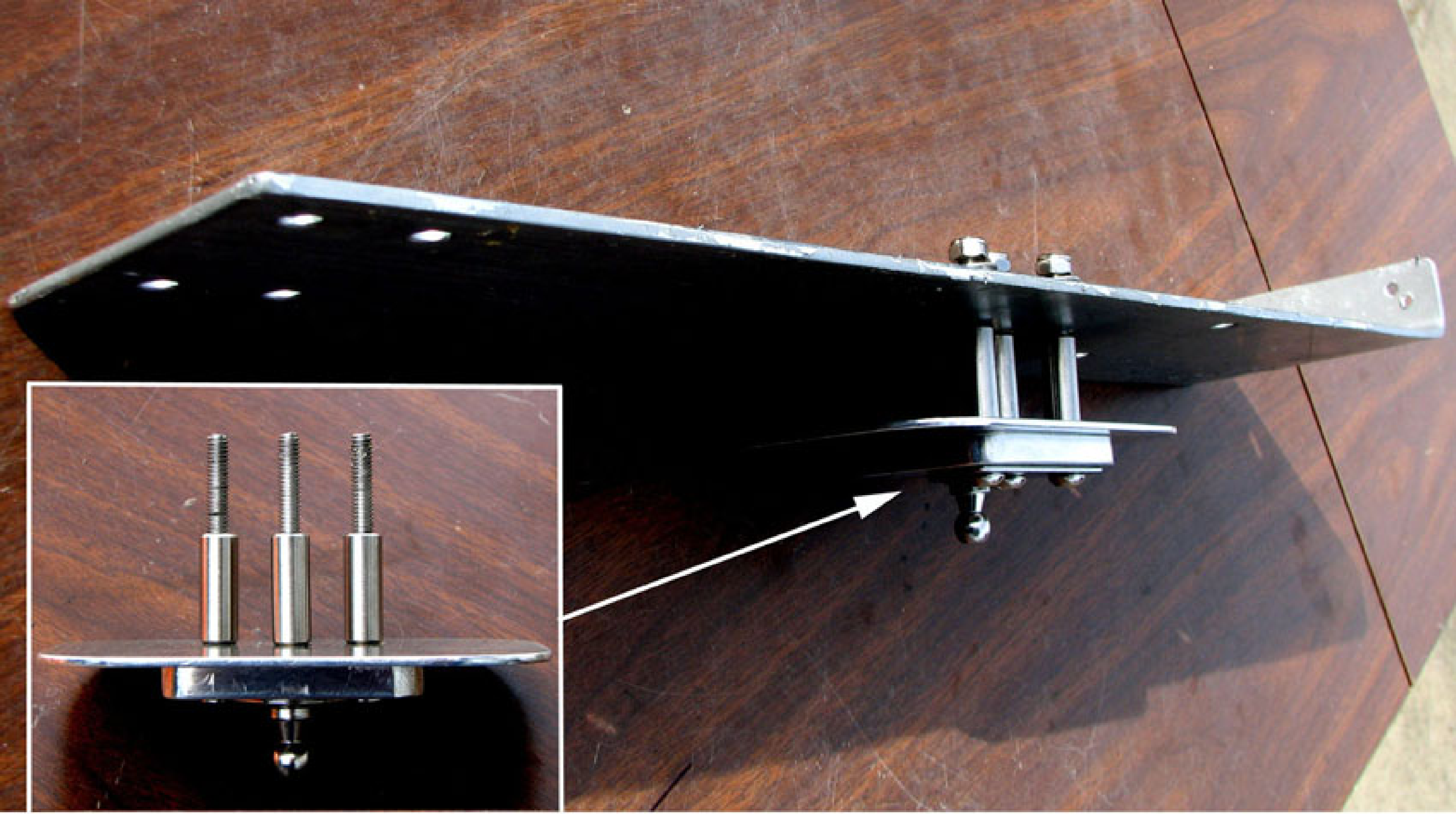


Installation of the Upper Pivot Ball Mounting System



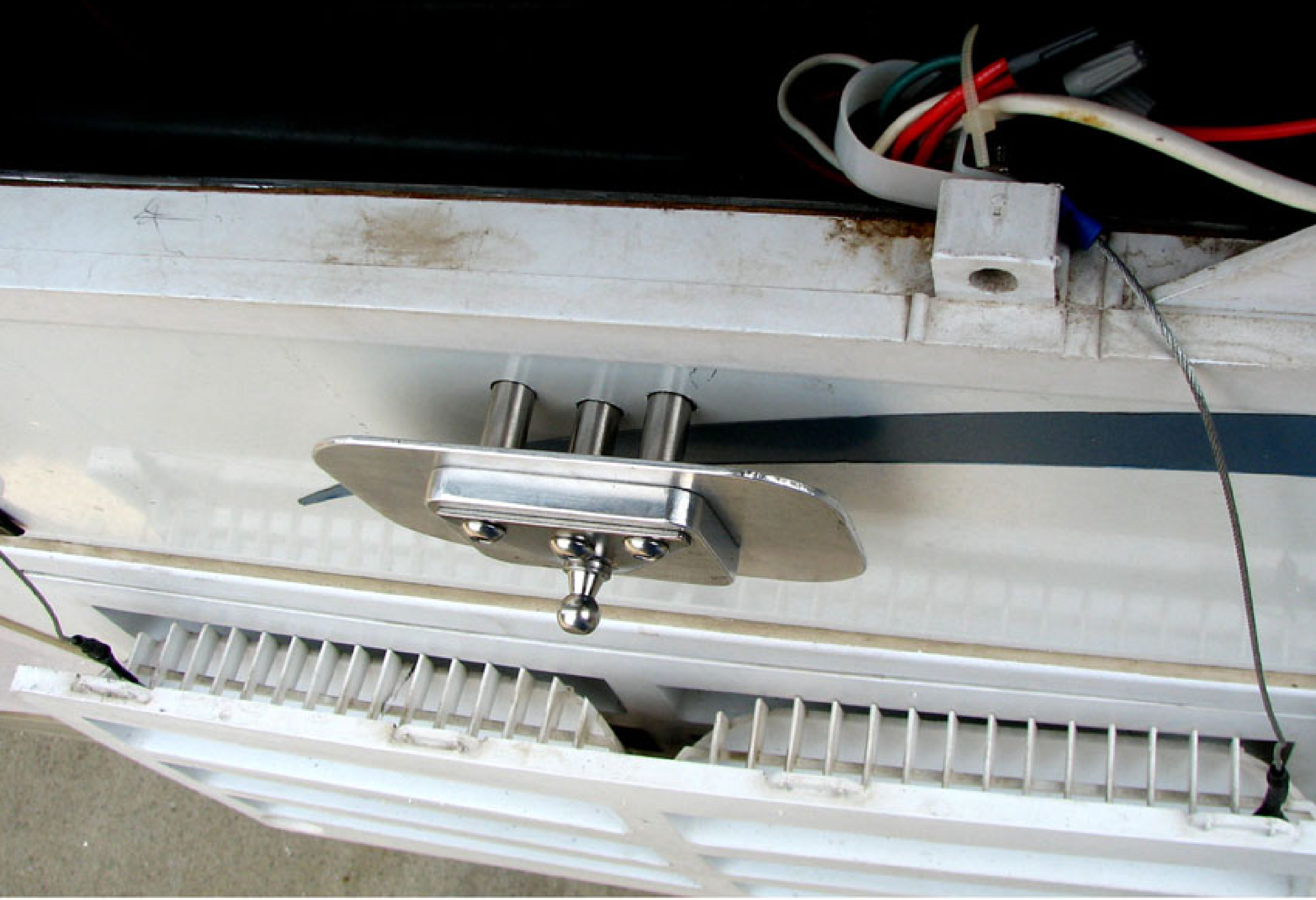
Holes Drilled for Gas Spring Lower Pivot Ball Mounting System

Holes Drilled for Gas Spring Lower Pivot Ball Mounting System



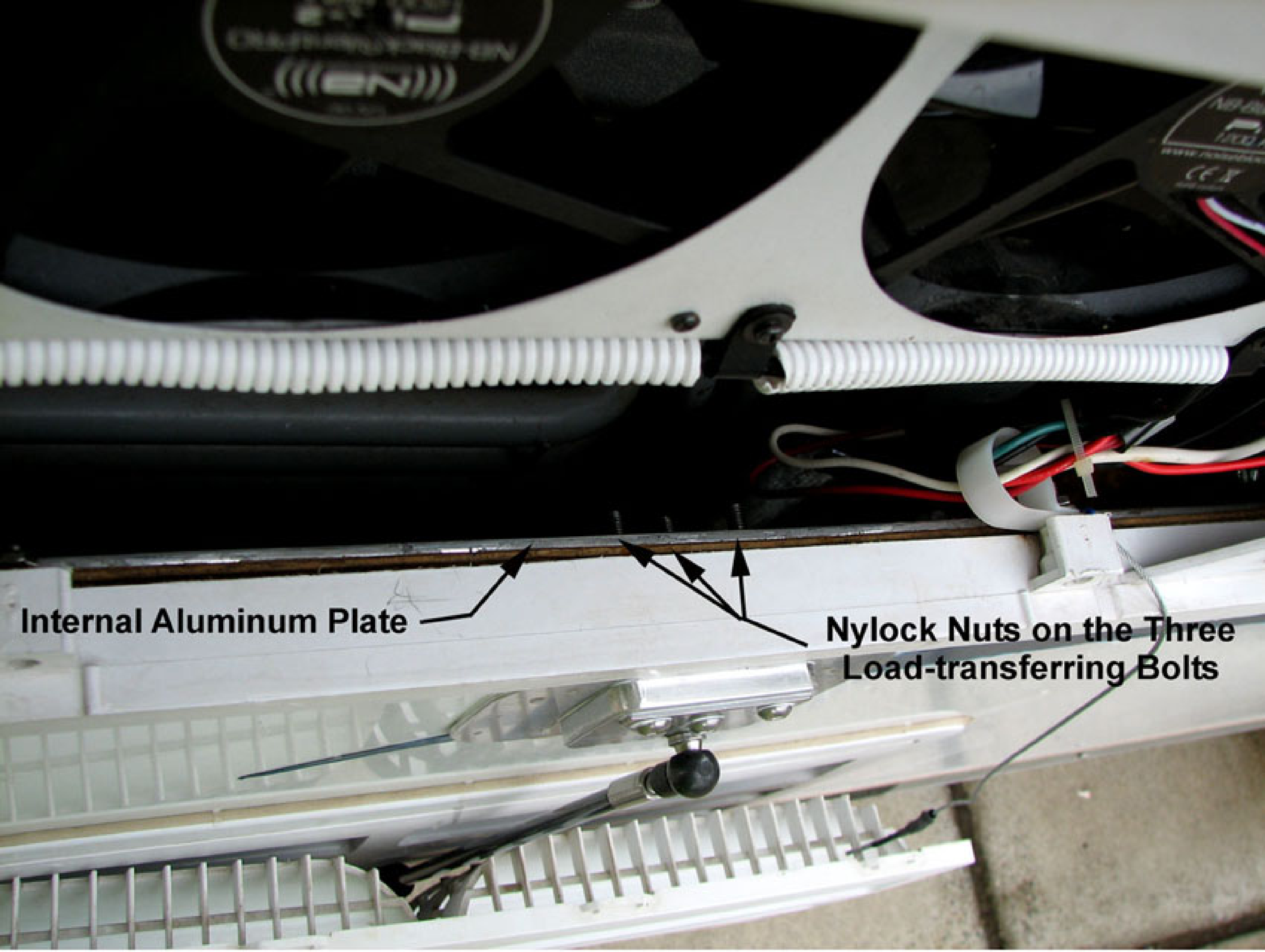
Heavy-Gauge Aluminum Load-Spreading Plate & Bracket System

Gas Spring Load Transferring System Being Installed



Gas Spring Load Transferring System Being Installed

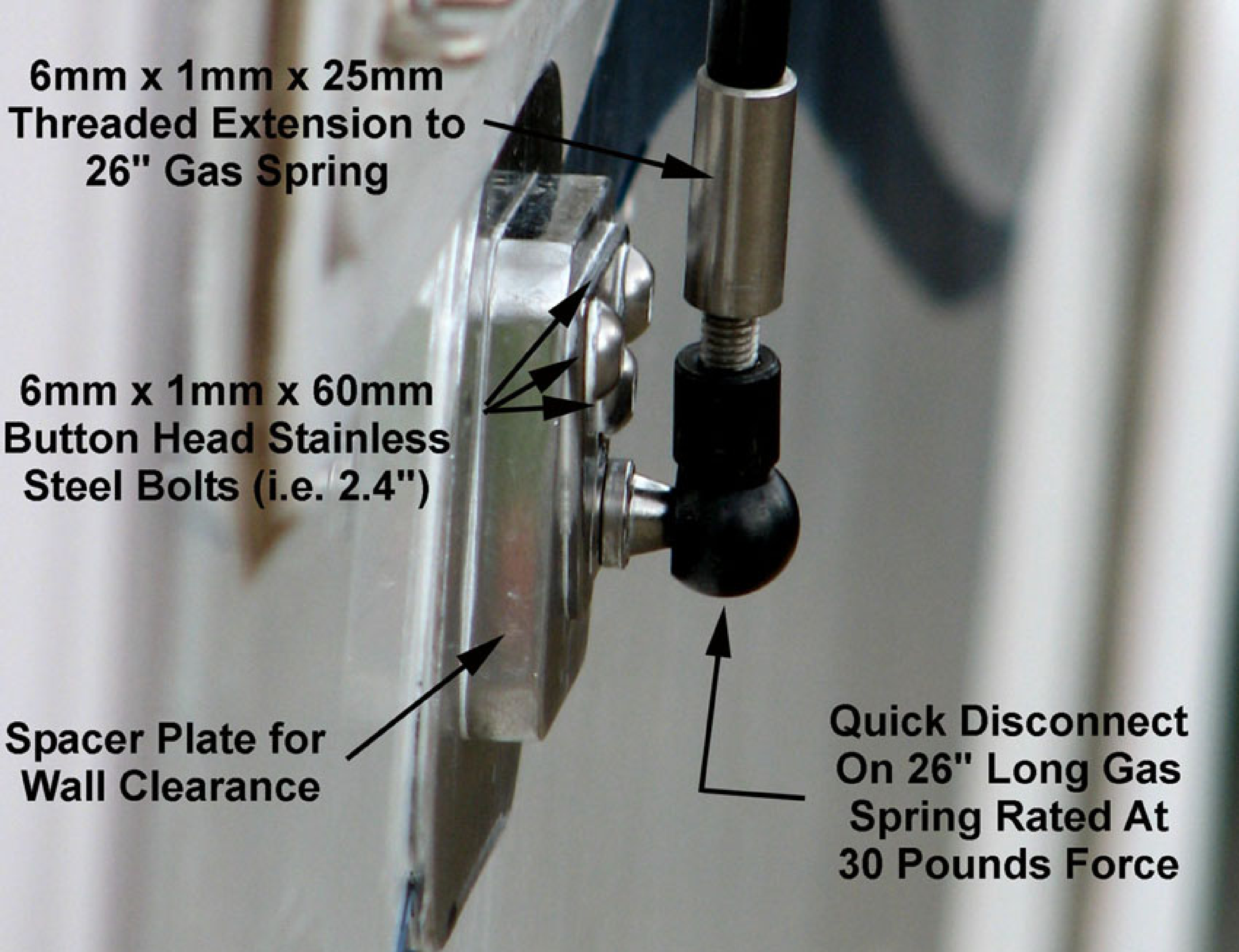
Pivot Ball Mounts Installed on a 2005 Aliner



View of Internal Load-Adsorbing/Transferring Aluminum Plate

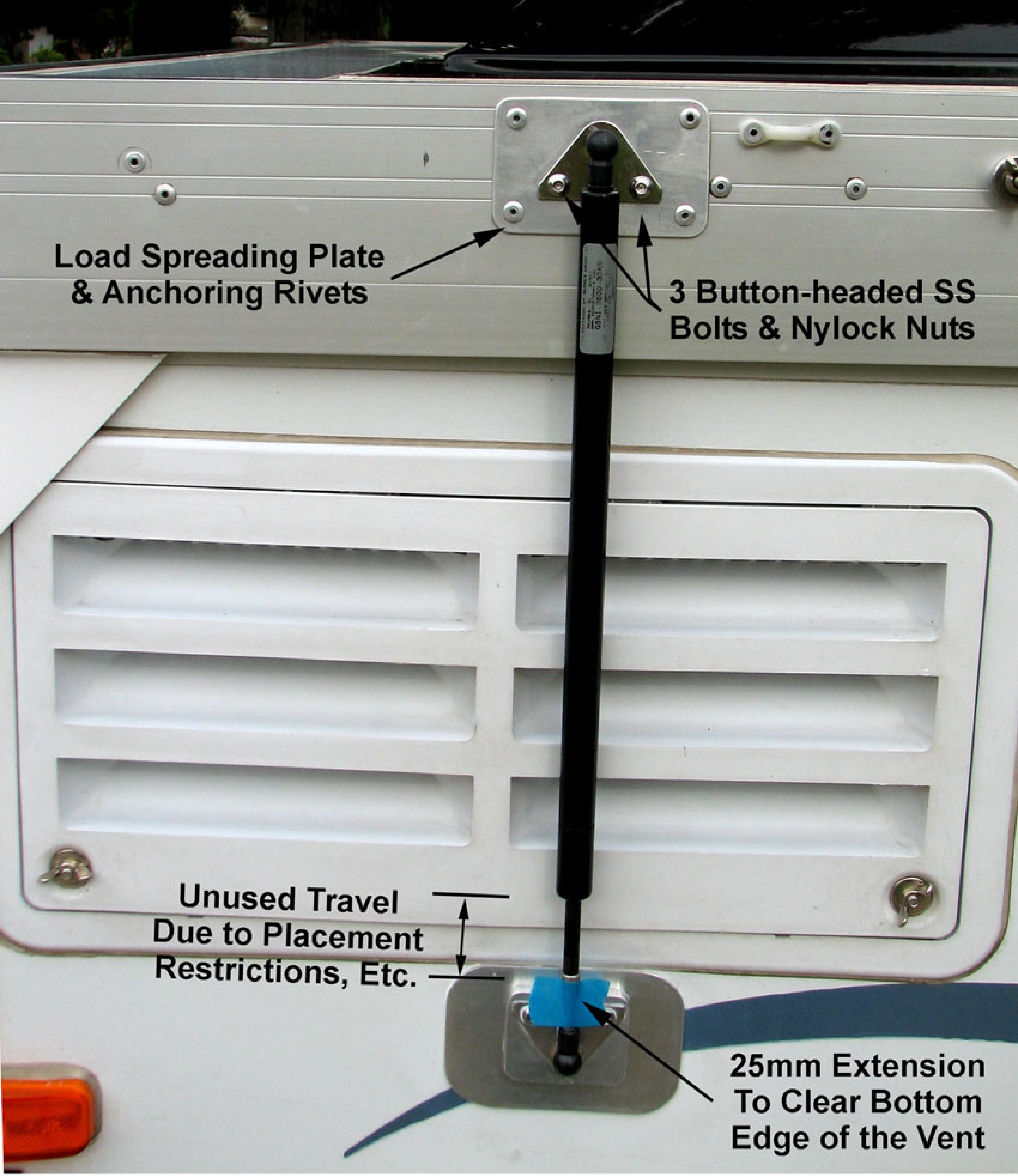
26" Gas Spring Added to the Refrigerator Area

26" Gas Spring Added Between Refrigerator Vents

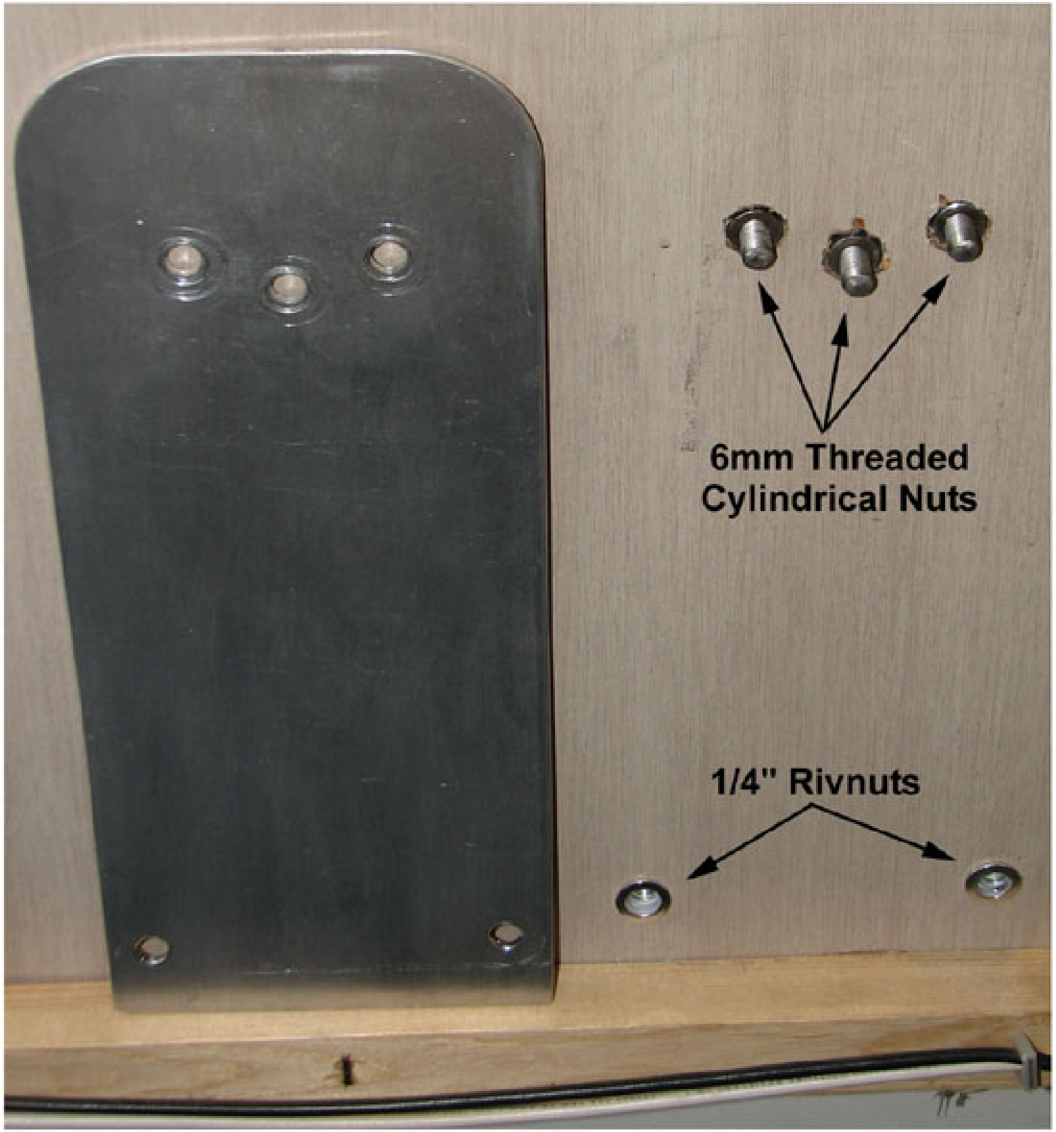


Lower 10mm Pivot Ball Assembly & Mounting Plate

External Gas Springs Added to 2005 Aliner Expedition



Gas Spring Installation Procedures



Interior Load Transferring Plate Installation

Gas Struts for Lifting Avan Roofs

By David Hall 3130
Retired Mechanical Engineer
Avan Club of Australia Inc.

Introduction

When our Cruiseliner was new the roof sprang up about 30cm (12") if the catches were released, but later the springs sagged and it only lifted a little, so we had to do most of the lifting ourselves. On the trip to the Longreach AGM we will make camp about 40 times, and raise the roof for as many daytime stops. Wow, about 80 in all! We enquired about replacing the springs or having them re-tempered, but Avan recommended against it, as it is quite a job.

Gas struts are reliable and are fitted to the tailgates of most cars. How are the tailgate struts of your SUV lasting?

The best feature of gas struts is that once installed, they just happen. They do not need to be set up each time they are used, like a winch, and they need no regular maintenance. They do however lose gas very slowly, and need recharging after many years of service.

I have just designed and installed 4 gas struts to help the sagging springs on the Avan. They work very well.

Now, when the catches are released the roof springs up about halfway, and stays there, and either of us can easily open or close the Cruiseliner unaided. Our latest camping routine is for Joyce to erect the Avan while I disconnect it from the car and level it up.

The struts and end fittings cost $A175, and fitting them is an easy job that a handy person can do with a measuring tape, 3/16 inch and 8mm drills, spanners and a pop-riveter. See below.

You will notice that I have also installed handles on the sides of the roof panels about 700mm (28") from the hinges to make it easier to erect the roof.

Gas Struts

Suppliers charge struts with nitrogen gas to deliver a particular force when extended. As they have one-way seals, they can be charged up with nitrogen, but not discharged, so their force can be increased later, but not lowered. The clue is to begin with a low pressure and if this is not enough to return them and get the supplier to raise the pressure, probably at no charge.

When struts are compressed the force they deliver rises about a third as the shaft is pushed in.

Design and Installation

There are two elements to the design, the lifting force needed, and the selection and location of the struts.

Lifting Force

A compromise must be found between the force needed to lift the roof and that needed to close it, the aim being to make the effort of lifting the roof about equal to the effort of closing it. If the struts are too strong then it is harder to pull the roof down and hook it down.

I weighed each panel in turn by supporting it with a pole at the peak and resting it on bathroom scales on the floor. The hinges were lubricated, the shock cords were loose and there was no friction between the panels at the top.

Strut Selection

I chose one from Struts Australia's standard 8/18 range, model K670-18-295, which has 670mm extended length, 295mm stroke, and is 375mm long fully compressed. It has an 8mm Ø shaft and 10mm Ø ball connections.

http://www.strutsaustralia.com.au/

Struts Australia
1/16 Fitzgerald Rd.
Laverton North. Victoria 3026.

Even though we keep the Cruiseliner outside, I selected a standard strut because stainless struts are very much more expensive.

The front pair were set to deliver 150 Newton (about 15 kg or 33 lbs) each, and the rear pair 100 Newton (about 10 kg or 22 lbs) each. The front pair is stronger to push the panels apart a little to reduce the friction between the panels, and as we have the weight of a small solar panel on the front roof.

The upper pivot is an 8mm stud at right angles to the shaft, KBSH1030M8 stud hex 30mm L M8x1.25 with 10mm ball

The lower pivot is a KB105 bracket offset black with 10mm ball.

The front roof is wider than the rear roof, so a 3mm (1/8 ") thick spacer is needed under each lower pivot at the front. I made them from aluminium bar, but they could be thick washers.

Differing Models of Avan

There are numerous models of Australian Avans. Recent models include Sportliners, Aliners, Cruisers, Cruiseliners, and Adventure Packs to mention a few. Later models have fibreglass ends and pre-2005 models have sandwich end panels. There are quite a variety of early models with a variety of wall heights etc.

Aliner bodies are 30cm (1 foot) shorter than Cruiser and Cruiseliner bodies, which are similar. This affects the roof angle.

Ours is one of the first Cruiseliners built in 2005 with fibreglass ends, and the dimensions given in this article are for that model.

It is likely that the gas struts specified here will suit all but Sportliners, which are too small to need roof lifters anyway.

The variations in body dimensions should be able to be accommodated by repositioning the lower pivot point horizontally, by swinging arcs as described under *Locating the Lower Pivot.* It is best to check and recheck these dimensions before drilling any holes.

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Strut Position

The wall panels of the Avan are of lightweight foam sandwich construction that is unable to support heavy point loads, so I have kept away from anchoring the struts to the wall panels.

Instead the ball joints are supported on the extruded aluminium framing of the roof and wall panels.

The original roof springs are adequate for lifting the roof partway, but then run out of steam, so the trick is to have the roof springs do the first part of the lift, and then have the gas struts cut in for the rest of the lift.

The characteristic of a gas strut is that it delivers its maximum force when it is fully compressed and its least when it is extended, which is exactly opposite to what we want. But we can overcome this by design of the mechanism and by carefully positioning the pivots.

The lower pivot is mounted on a bracket fixed to the aluminium extrusion running along the top of the side wall panel, arranged so that the roof will close without contacting it.

The upper pivot is a stud in the vertical side of the extruded angle along the edge of the roof.

The pivots are arranged so that when the roof is closed they are roughly in line with the roof hinge pin, which means that when the roof is closed the gas strut is delivering its maximum force, but in this position the strut is horizontal so the force is horizontal and there is no lifting component. The strut is nullified so the springs do all the work at the beginning of the lift.

The upper pivot is mounted on the side of the roof so that when the roof is up the strut is about at right angles to a line from the upper pivot to the centre pin of the hinge. This achieves the maximum lifting force, even though the strut is delivering its minimum output at the end of its stroke.

Upper Pivot

The strut should not obstruct the small side window, and to minimise forces on the pivot support it should be away from the hinge point. A suitable spot is 500mm (19 11/16”) from the end of the roof at each end of the Avan, and 40 mm (1 9/16”) above the lower edge of the roof frame. I drilled 8mm (5/16”) holes in the frame at these 4 points.

Lower Pivot

The following factors have been allowed for in locating the Lower Pivot

- The working stroke has been reduced 5mm to 290mm to allow space for its hydraulic damping as the strut approaches full compression. Matching this, the working compressed length increases to 380mm
- As the front roof panel nears full height it needs to open 30mm too far, before dropping back when the rear panel engages the groove at the ridge of the front panel. This requires the front struts to extend 8mm too far before falling back. This reduces the available extended length of the strut by 8mm to 662mm

Locating the Lower Pivot

- Raise the roof. With the upper pivot as its centre, mark an arc of 662mm radius on the lower wall just below the aluminium extrusion running along the top of the wall
- Lower and lock down the roof. Now with the upper pivot as its centre, mark another arc of 380mm radius to cross the first arc
- These arcs form a triangular shape below the top of the wall within which the lower pivot must be located. The final position of our lower ball was 890mm (35 1/32”) from the end of the roof and 37mm (1 15/32”) below the top of the sidewall
- The brackets are mounted on the lower half of the aluminium section running along the top of the wall, so that they clear the flashing overhang of the upper wall when it is erected.
- I mounted each bracket with 2 pop rivets, 4.8mm (3/16”) dia and grips of 4.8mm (3/16”) rear and 9.6mm (3/8”) front roofs.

Installing the Struts

- Raise the roof and with the tube end upwards connect the upper pivot by punching it onto the ball
- Compress the strut so that the lower pivot can also be punched on
- A strut can be removed with the roof up by prising back the lower circlip with a narrow screwdriver in the slot while compressing the strut a little to get it off the ball