NEW Carbon BUSTER

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Farewell to Mohammad Samii

Some people in our industry have an amazing passion for the Industry and show it with their volunteerism and support of the industry throughout their careers and life. One of those people is Mohammad Samii of Sammy’s Auto Electric of Champaign, IL.

Mohammad has produced over 275 electrical articles and supported APRA since 1992. His first APRA Electrical Clinic in 1992 was in Jacksonville, FL.

After 25 years of writing the “Auto Electric Corner” and producing Electrical Clinics on behalf of APRA, Mohammad has decided to, what I refer to as, “Semi-Retire” from the APRA. Mohammad has indicated he is happy to support special projects for APRA in the future but is taking a step back to enjoy some personal time. I would like to personally and professionally thank Mohammad for his many years of support and passion for the industry.

I know we will be well supported on electrical articles from our very talented Technical Director Wes Grueninger, but I would like to reach out to our members in seeking passionate people who are proud of the Remanufacturing Industry and who would like to occasionally produce an article or suggest topics for our Reman Connection magazine. Your support would be greatly appreciated and I am sure your experiences would help many members across the USA and across the world.

Please feel free to contact us at 703-968-2772 or write us at info@apra.org.

I always welcome response or rebuttal to my comments at kripli@apra.org

Respectfully,
Joe Kripli
On May 30, 2017, the United States Supreme Court decided in a unanimous decision that patent holders cannot use patents to restrict remanufacturing companies. According Chief Justice Roberts, “We conclude that a patentee’s decision to sell a product exhausts all of its patent rights in that item, regardless of any restrictions the patentee purports to impose or the location of the sale.”

“Take a shop that restores and sells used cars,” Chief Justice Roberts wrote. “The business works because the shop can rest assured that, so long as those bringing in the cars own them, the shop is free to repair and resell those vehicles. That smooth flow of commerce would sputter if companies that make the thousands of parts that go into a vehicle could keep their patent rights after the first sale.”

APRA has been actively involved in supporting this case and applauds the decision by the Supreme Court. APRA will continue to fight for the rights of members to remanufacture automotive, heavy duty and industrial parts.

The case was called IMPRESSION PRODUCTS, INC. v. LEXMARK INTERNATIONAL, INC. and legal scholars are calling it a precedent-setting ruling. Impression Products is an ink cartridge remanufacturer. The case questioned how much control a company an original equipment manufacturer maintains over their products after they sell them, both domestically and internationally.

During oral testimony, Lexmark stated that it should be allowed to stop remanufacturers from remanufacturing and reselling their cartridges because of patent rights. The court rejected that argument.

“The purchaser and all subsequent owners are free to use or resell the product just like any other item of personal property, without fear of an infringement lawsuit,” Chief Justice John Roberts wrote for the majority opinion.

“This is a major victory for the members of APRA,” stated Scott Parker, APRA Association Manager. “APRA will continue to aggressively fight to protect and defend the right of APRA members to remanufacture automotive, heavy duty and industrial parts. APRA is committed to protect the rights of its members in the independent remanufacturing aftermarket.”

A Letter from Eric Smith, Impression Products to APRA

Scott Parker, I just wanted to send you a quick note to thank you and your organization for your continued support throughout my patent infringement battle with Lexmark International! As you know, this was a seven year fight with a lot of twists and turns that ultimately found its way to the highest court in the land!

I believe last weeks ruling is not only a victory for Remanufactures but for every consumer in the world! At the end of the day, it was as simple as “you buy it, you own it” imagine that?

If you or your team have any questions or would like to know more about the case, please feel free to call me direct at 304-421-2018 and I will be happy to discuss it with you.

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ARMEX™ Launches Social Media Networks

APRA Member ARMEX™ a global leading brand of Sodium Bicarbonate (baking soda) used for non-destructive abrasive blasting has launched social media networks on Facebook, Instagram, Twitter and LinkedIn.

Brian Waple the ARMEX™ Business Manager stated “Social Media is the best tool we have today to connect and communicate with our customers and potential customers on platforms that are convenient for them to learn about and engage with ARMEX™.”

APRA Welcomes New European Chairman Dr. Daniel C. F. Köhler

APRA is pleased to announce the appointment of Dr. Daniel C. F. Köhler of Knorr-Bremse Systeme für Nutzfahrzeuge GmbH as the new Chairman, APRA European Board.

Dr. Daniel C. F. Köhler holds a PhD from the University of Bayreuth where he worked closely with Professor Rolf Steinhilper. In his PhD thesis “Regenerative Supply Chains”, meaning Remanufacturing Supply Chains, Dr. Köhler cooperated with BMW and Bosch, where he resolved the riddle of reman CO2-savings.

Currently, Dr. Daniel C. F. Köhler has held the position of Director Remanufacturing and Reverse Engineering at Knorr-Bremse Systeme für Nutzfahrzeuge GmbH in Munich (Germany) for the past four years. In that time Knorr-Bremse made substantial progress in developing their Reman business.

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The Power of WAI
I read with great interest your 2016-2021 Transportation Systems Forecast in the Issue 4, 2017 of Reman Connection magazine. It is quite evident that as long as consumers demand greater gas mileage, as well as cleaner emissions from their cars and trucks, that there is a great opportunity for Remanufacturers to provide the Aftermarket with reman OEM turbochargers, injectors, and pumps. Large, Medium, and Small remanufacturers throughout the World are now looking to expand their product lines and see a great opportunity in this area.

As Robbie Sullivan says, “good cores are the lifeblood of any remanufacturing operation” This is where the dedicated men and women of Goldfarb & Associates in Rockville, MD can help you. We have specialized in supplying turbocharger, diesel fuel injector, and diesel injection pump cores since 1998…almost as long as Turbo Supply! We source cores from around the world and handle truck, automotive, construction, agricultural, and marine applications which are bar coded for easy identification.

With over 5000 turbocharger cores in stock, we try to have the cores that you need with the quality that you can be assured of. All of our turbocharger cores are thoroughly inspected using a scope to look for any internal damage. If you are not completely satisfied with any core that we sell you, we will replace it or credit your account immediately…No questions asked.

In his article, Robbie Sullivan goes on to enumerate the many difficulties that a Remanufacturer will face, especially the lack of knowledge about turbochargers. Our staff has a combined 50 years of turbocharger knowledge and we are open to your visiting our facility in Rockville, MD where we will openly share our knowledge and experience with those looking to enter this industry.

Remanufacturing turbochargers can be an exciting and profitable business, but you will need to be teamed up with professional suppliers like Turbo Supply and Goldfarb & Associates to be successful.

Saul Goldfarb
President Goldfarb & Associates
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While growing up in southeastern Ohio during the late 1940s and early 1950s Jerry Norris learned a lot about old cars from his father. “My dad and his friends were driving Super and Modified Stock cars,” Norris remembers. The favored cars they would soup-up for racing were coupes from the 1930s, a fact not lost on young Norris.

“I always had it in the back of my mind to own my own 1930s Coupe someday,” Norris says. He was not shy about wanting such a car with others. In the spring of 1978 the long search ended when he was tipped off about a 1939 Plymouth coupe near his home in California.

After purchasing the car he nursed it home and began taking inventory. Norris found the very large trunk was full of spare parts including an engine and transmission. “My goal was to rebuild the car in my garage to the point that I could use it as my everyday car,” Norris says.

Having all those spare parts helped ease the task of rebuilding.

After purchasing a shop manual for a 1939 Plymouth and some critical tools Norris commenced removing the 201.3-cubic-inch, in-line six cylinder engine and the three-speed transmission.

Over time the diligent Norris rebuilt the engine, drive train, brake system, wiring harness, hoses and countless small parts.

With the mechanical parts in working order Norris bought “How To” books for body work, painting, instrument rebuilding, wood graining for the dashboard and garnish molding.

He became a self-taught restorer and within a couple of years the 3,044-pound car was reassembled and rolled out of the garage on new 6.00x16-inch tires on a 114-inch wheelbase.

For almost five years the presentable Plymouth became a daily driver for Norris. Both of his daughters learned to drive the stick shift manual transmission in the Plymouth.
The shift lever is located on the steering column. In the mid 1980s Norris was transferred to the east coast and the Plymouth came with him. It was his only car for some time and proved to be trustworthy.

Upon retirement in 1992 Norris moved to northern Virginia leaving his Plymouth behind with a couple of amateur mechanics that did some engine work and a body guy the fiddled with the car for several years before putting the car in storage.

After several years my family got after me to get the car out of storage and have it professionally restored, Norris recalls.

Finding a reliable restoration shop wasn’t easy but finally Norris settled on Fantom Works to bring his Plymouth back to like new condition.

The coupe now wears a coat of Shadow Green paint with the seats covered in tan upholstery. The wood grain dashboard houses the 100 mile per hour speedometer and the AM radio. Keeping the occupants comfortable is the optional heater as well as the cowl ventilator.

Suspended from above the two piece windshield are the vacuum powered wipers.

Minute details enhance the Plymouth such as the front fender-top lights and the Plymouth emblem in the lens of the taillights. The three-spoke banjo-style steering wheel is shoulder wide to provide leverage in steering.

The 1939 Plymoths are easily identified by the distinctive RITEWAY square headlights. The optional amber fog lights are MOPAR products.

An oil bath air cleaner sits above the engine. An 18-gallon fuel tank feeds the L-head engine.

Only 5,978 such Plymouth models were produced, each with a base price of $895. The number of survivors is a mystery.

Now that the professional restoration is complete Norris announces his Plymouth is finally a “true car” done correctly.
One of our regular customers brought in a 2006 Dodge Ram 1500 4WD with a 5.7L engine mated to a 545RFE transmission. The owner’s concern was a very bad shake when accelerating while having the 4WD engaged.

I proceeded with an evaluation of the issue. We have detailed procedures for this process, including but not limited to a battery/charging system analysis, complete module scan for DTCs, road test, visual inspection, and TSB search. During the road test I was able to duplicate the customer’s concern. On acceleration in 4WD, the truck had a pronounced wobble, or shake. When the truck was driven in 2WD the concern was not there, eliminating some of the possible causes for this issue. The undercar inspection did not reveal anything that I would consider abnormal for the age and mileage of the truck.

The fluids in the transmission, transfer case and both differentials were in good condition, but the front differential was a bit low due to a small axle seal leak. However, no clues as to what could be causing the issue.

There was some evidence that someone had worked on the front differential, or at least had removed an axle. The customer has had several other vehicles into our shop before and we had a good relationship with him so I had the manager call him and see if there had been any other work done, especially to find out if anyone had tried to repair the truck for the shaking problem before it came to us. From that phone call we learned that the truck was purchased at auction about 30 days prior to the shop visit, and therefore had no known previous repair history.

After the customer consented to some diagnostic time, I decided to start with the easiest thing I could do and removed the front driveshaft. Both the single front U-joint and the double cardan joint felt fine with no binding or play in either of them, so I left the shaft out and went for another road test. With the front driveshaft removed the wobble was gone, even in 4WD. I fully expected this because there was no load on the 4WD components.

Once back in the shop, the truck was placed onto a two-post lift so the front-end components could be examined with the suspension unloaded. I will start with saying that this truck was not in perfect condition, and while inspecting the front-end components, there was a little bit of play in the tie rods and the pitman arm. While not very bad, it was still something that I could not rule out 100% at this point. I checked the tire circumference with a stagger gauge and it checked OK. Prior to removal of the front driveshaft, I had also driven the vehicle in a straight line while in 4WD with no evidence of
any type of binding concern, so I knew that I wasn’t dealing with a gear ratio difference between front and rear differentials.

Getting back to the wobble, I can best describe what I felt as similar to a shake or vibration caused by loose front inner CV axles in a front-wheel-drive vehicle; when the inner CV joints get loose they can cause side-to-side type of sensation that we usually refer to as a “wobble.” This truck felt very similar to that, but since this is a 4WD vehicle and power is supplied to both front and rear, there is just enough difference in the feel that I was hesitant to condemn the CV axles as the culprit. While there was a bit of play in both of the inner CV joints, it didn’t seem to be enough to be the cause.

I sent an email to some other diagnosticians within our company to see if someone had dealt with a similar situation. The responses I received targeted either front-end steering components or a bad axle. While I was waiting for response from my fellow associates, I rotated the tires front to back to see if I could “move” the sensation but yet again was unsuccessful in pinpointing the cause.

Since I could feel some play in the inner CV joints, I decided to replace both of them with reman axles from one of our parts suppliers. Yes, you guessed it: the wobble was still there. I don’t think it changed even a little bit.

Disappointed but undaunted, we reinstalled the customer’s original axles back into the truck and continued the diagnosis.

Fortunately around this time we had another 2006 Dodge come into the shop, but this one drove fine in 4WD with no signs of a wobble or vibration like the problem truck had. At least now I had something to compare our subject vehicle to. We only have one drive-on lift available in the shop, so it was hard to do a side by side comparison of the two vehicles.

Nonetheless, I still could not really see a difference in the CV axle angles or driveshaft angles between the two trucks, but I was still convinced there had to be something I was missing. Since there was some play in the pitman arm and tie rods, we replaced those parts and had the truck aligned at a nearby general repair facility, but yet again did not fix the problem.

When I returned to the shop I parked the truck in the back lot alongside the other 2006 Ram and went in to speak with the manager to tell him the news. I am really frustrated at this point because I am having difficulty fixing this truck. When I go to the back lot to test drive another vehicle I looked at my nemesis sitting there and I noticed something: the front end of the problem truck is sitting a couple inches higher in the front as compared to the truck that does not have the issue. Neither of these trucks has a lift kit installed, but both have stock-sized tires; so why is the ride height different?

I took a closer look at the front springs and noticed that there was more space between the spring and the upper spring perch on the subject truck than on the comparison truck.

I did a little research and found that there are companies selling a “leveling” kit for these trucks that is just simply a block to increase the installed spring height intended to raise the front-end ride height, but without addressing the increased front CV shaft angle (Figure 1).

Now, to answer the question: why does this have such a big effect on the way the truck drives when it only adds a couple of inches to the ride height? The differential is attached directly to the motor mounts and moves with the engine. Because of this, the differential rotates upward on the passenger side when the engine’s torsional forces are active upon acceleration. This, combined with the increased CV angle from the spacers (without a differential drop), causes the CV joints to bind under a load.

We removed the “leveling” kit, which should be renamed to “Change Your Driveline Angle Kit.” Predictably, the wobble was gone and the truck drove like new again; well maybe not new, but you know what I mean. It’s worth mentioning that there are other brands of leveling kits available that will raise the front end of the truck the correct way to get rid of the factory rake these trucks are built with, yet do not change the driveline angle. These kits cost more than the $50-$100 kits, but the results would be well worth it. This is just another example of how aftermarket parts can deal us fits!

Larry (LJ) Porter has worked for Certified Transmission for over 20 years and is an ASE certified technician in transmissions, transaxles, manual transmission, steering, suspension and brakes. He was a remove and replace (R&R) technician for six years and has been a diagnostician since 1996.

For information about Certified Transmission contact jslimp@certifiedtransmission.com.
Lift-gate Motor and Engine Operation

A recent experience with a local welding supply company’s 2001 Chevy truck became interesting when we replaced its tailgate motor. The complaint was lack of power for lifting even a moderate amount of weight.

After inspecting the system, we decided to replace the worn-out motor of the lift (#1787AC made by Fenner Stone) and the power relay. Crossing the numbers, we came up with J&N’s 430-01005 motor and a 240-22008 relay. They were ordered and received the next day.

After cleaning off the heavy rust buildup on all the mounting surfaces and installing the new motor and relay, the work was done, and the liftgate was able to lift a considerable amount of weight. (Figure-1)

A day or so after the truck was sent out, we heard back from the owner. Now, the issue was that anytime they lifted a heavy weight, the engine died. They commented that this problem was not happening before!

This was partly our fault for not checking the system with the truck’s engine running before the truck was delivered. But since the new motor was lifting enough weight (two of us standing on the gate) we did not see any reason to check it with the engine running.

After some measurements were taken, it was determined that there was excessive voltage drop between the engine and the frame of the truck, and between the truck frame and the liftgate’s ground. Some accessories (most importantly the in-tank electric fuel pump) ground to the rear part of the truck’s cargo bed. So, any heavy current pulled by the liftgate motor (which uses the same ground path) was affecting the ground connection of the fuel pump—slowing it down and lowering the fuel pressure so much that the engine would stop running. Perhaps the reason they did not have this problem before was because the old liftgate motor was worn out—so, it was not pulling much (or any) current to affect the fuel pump, and consequently, the engine operation.

Adding a couple heavy grounds from the engine to the frame and from the frame to the body of the liftgate motor...
(Figure-2) took care of the problem. The result was good lifting capability without killing the motor.

**Problem with CS-130**

Obviously, there is not much activity around CS-130 alternators these days, but certain wiring issues can disable a fresh reman alternator. We have seen a few such cases, even with newer CS alternators, which caused a no-charge condition. A recent case was a good example of this.

The 1991 Cutlass Supreme was dragged in with a dead battery and a fresh reman alternator. They had replaced the alternator on this vehicle more than once and had installed a new battery—all to no avail. Checking the output wire showed it to be fine. Checking the CS-regulator connector (Figure-3) of this 7939-3 alternator showed near-battery voltage when the ignition switch was turned on and no voltage at the “L” terminal.

We know that a CS alternator of that vintage (with a 1116411 regulator) should work with power to the “I” terminal alone.

Suspecting other issues, we removed the connector from the alternator, installed our own home-made test lead, powered it up, and found that the alternator started charging just fine. So, the issue was with the “L” terminal affecting the operation of the alternator—even if it showed no measurable voltage at that pin.

The battery was disconnected, and the resistance from the “L” pin of the regulator connector (the car side) to the ground was measured. We found that it had very low resistance (less than 20 Ohms) to the ground. This was enough to shut the regulator down, causing a no-charge condition. So, a quick and easy fix was to disconnect the “L” wire from the regulator plug, and allow the “I” pin to do the activation and get the system going.

We have seen a few similar cases that, during an engine change or in any type of cylinder-head work, a wire was pinched under the valve cover gasket, and the “L” terminal wire was either cut, grounded or crossed, causing an unnecessary no-charge problem that was challenging to find and fix.

**A Farewell**

In 1992 I started teaching in the APRA Electrical Clinics, the first one in Ft. Lauderdale, FL. I then started writing my Auto Electric Corner column for Electrical Connection, which was the APRA’s publication of that time. It then changed names, first to Global Connection, and now Reman Connection. By my last count, I have written over 275 Auto Electric Corner columns and quite a few other tech articles for the paper regarding various subjects and/or industry news of that particular date.

Along the way I met a lot of wonderful people, and many of them became my friends. I received many words of encouragement from my readers, and this was truly the fire behind my commitment to writing a monthly column, while keeping it informative and readable. Most information was and still is based on my actual hands-on experience during my daily work in my shop. It has covered a wide area of rebuilding, diagnostics and also finding electrical/electronic gremlins, whose frequency have increased exponentially since the introduction of computers and advanced electronics.

So now, after nearly 25 years, I would like to bid farewell to my readers, friends, and colleagues. This is the last column I will write for Reman Connection and the APRA. I would like to thank the many people who showed faith in my work or encouraged me, as well as those who hired me to conduct private seminars for their employees and conduct their training programs all over the US and Canada. The list is too long to thank everyone, but most of my gratitude goes toward APRA, whose previous president Bill Gager was a big encouragement. I am sure the current management will have the same goal of promoting the remanufacturing concept and to move the industry forward.

In the end, I hope I have contributed to the Electrical Rebuilding industry that has been a significant part of my life. This is the industry that I enjoy and am still involved with on a full-time basis, running my business even after 7 years into retirement. I am still willing to share whatever I know with my peers at any time. Until I see you again.

*Mohammad Samii can be reached via his website at www.sammysautoelectric.com*
Charging Batteries

by Dean Conner

Last time, we discussed battery testing equipment. Today, we will talk about battery charging! After testing a battery, we know whether we need to replace it or charge it. If we are going to charge the battery, we must first decide how to proceed. How do you charge a flooded-cell lead-acid battery, as opposed to a gel battery or an absorbent-glass-mat (AGM) battery?

Flooded-Cell Lead-Acid Battery:
To charge a flooded-cell lead-acid battery, we disconnect it from the system, clean the terminals and put the shop charger on it. During our charging procedure, we set a two-hour timer and periodically check to make sure that the battery is not overheating, spewing acid, smelling like rotten eggs or having smoke come out of its vents or cells. If any of these conditions occur, we discontinue charging the battery and replace it. After completing a successful charge, we let the battery sit (cold soak) for at least an hour. (Overnight is better. But in most cases, this is not practical.) We then test the battery to see if it can pass one of the tests described in our previous article. This is pretty straightforward and in line with what most of us have been doing for years.

AGM (Absorbent Glass Mat) Batteries:
Here is where it gets tricky. AGM batteries have a very low resistance to a charge, unlike flooded-cell lead-acid batteries. Just rolling the shop charger over and putting a two-hour charge on this one, can damage your customer’s battery. A lower charge rate must be applied to this battery. The charge is more of a float-charge, which takes temperature into account. These batteries are more susceptible to “thermal runaway” than the flooded-cell lead-acid batteries. The best thing to do, in my opinion, is to buy a charger that is made specifically for charging this type of battery (see Figure 2). We do this to take the guess work out of the charging. There is a charger for every budget. You can get really fancy and expensive or stay basic and more affordable. I do not recommend one charger over another. You can research them online, ask around or check with some of the vendors that carry them. There are many chargers on the market that have a switch to change the charging mode, to be able to charge all different battery types. We use a charger with an “AGM switch” when we
need to charge AGM batteries. You will have to experiment with the time when charging these batteries. Since they have low resistance to a charge, they charge much faster than conventional flooded-cell lead-acid or calcium/calcium (sealed lead-acid) batteries.

**GEL Batteries**

Gel batteries charge similarly to AGM batteries, but are even more prone to damage if you are charging at too high of a rate. It is my understanding, from the material I have read, that the AGM charge rate will not harm gel batteries. All of the gel batteries that I have encountered are used for backup on electrical equipment, and many come with their own automatic chargers. In our area, there are big Group-31 and Group-8D batteries used on large crew boats and supply boats. They are installed in air-conditioned wheel houses and have dedicated gel chargers. They are very expensive, and they last a very long time. Sometimes we see these batteries last 10 to 12 years, according to their date codes.

In closing, care must be taken when testing and charging batteries with new technologies that come into your shop. What works with one technology will not necessarily work with another. The cell phone industry has shown us that—with their lithium-Ion batteries and thermal runaway causing all kinds of trouble. Next time we will talk about alternator set-points and batteries.

I always welcome your questions and comments!

You can reach me at:
dconner@connersrepair.com or 985-399-0003.

See you next time!!

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Rebuilders Automotive Supply

How long has your company been providing cores to the remanufacturing industry?
RAS has been a global full-line buyer of cores for more than 45 years.

What is the story on how the company was started?
Rebuilders Automotive Supply, known as “RAS,” started out in the back of an old pickup truck in 1972 by Theodore Eckstein. Ted was the owner and President until he retired in 1996. Ted was a true entrepreneur and auto enthusiast until his passing in 2003. Robert Grady and Steven King began working at the company in the 1980s and currently serve as President and Vice President, respectively. Employing over 120 people.

What geographical area do you provide service?
With operations in Coventry, Rhode Island and Tampa, Florida, RAS has customers and vendors in the US, Mexico, Canada, China, Europe and South America.

As a core supplier, what are the biggest challenges supplying the needs of remanufacturers today?
With the proliferation of part numbers it can be challenging to forecast the needs of our customers. When we do have visibility to demand we use our systems to directly interface with the salvage and scrap yards to make their sales of cores to us a seamless transaction.
What do you believe are the biggest opportunities and threats facing the industry over the next five years?

Aftermarket material being sourced from China is a significant concern to us especially when there is limited visibility to demand.

Advanced electronics is a big opportunity for our industry.

What value do you find in APRA membership? What other ways does APRA Membership help expand your business opportunities?

APRA keeps us up to date on what’s new in all facets of our industry. What other ways does APRA Membership help expand your business opportunities? The seminars and shows bring us together and help form relationships. By understanding each other better we can serve our customers better and help strengthen each other.
The words switch, relay and solenoid are sometimes used interchangeably by people throughout our industry, and this has caused some confusion. It happens, in part, because all three devices are used to control current flow, and the definitions employed to describe them "overlap". A case in point is the Integrated Magnetic Switch, or IMS, found on Delco-Remy 39MT starters (see Figure 1). It is often referred to as a relay. So, is it really a switch, a relay, or a solenoid? Read on and decide for yourself.

A switch is any electrical component that is used to open, close or otherwise alter current flow within a circuit (see Figure 2). While we may immediately think of a common on-off toggle switch when we hear that word, a switch does not necessarily have to be controlled by a lever, button or knob. A switch may also be activated by any sensing mechanism that uses temperature, pressure, or other dynamic force capable of creating movement. This includes being electrically controlled. Therefore, the word switch is used generally to describe a wide array of devices that can be utilized in different situations to control current flow. By this definition, the IMS is a switch, as are all relays and solenoids.

A relay is a device that is activated electrically by a low current or signal in one circuit to open or close a higher current in another circuit (see Figure 3). Most of us picture a Bosch cuberelay, which uses electromagnetism created by current passing through a coil on the low current side to close or open mechanical contacts on the high current side. But in today’s world, there is a growing movement toward using a solid-state relay or SSR. An SSR has no coil or contacts. Instead, it is a semi-conductor device which can be activated by a very low current. It contains a thyristor or transistor which controls the high current side.

A solenoid is an electromechanical device, that uses a coil of wire wound around a movable iron core to do work (see Figure 4). The solenoid behaves like a relay when a low current passes through the coil and creates a magnetic force, causing the iron core to move and accomplish specific tasks. The task could be: moving a starter drive into cranking position, opening a fuel...
valve or closing a set of contacts. Most starter solenoids today perform more than one function, and most of those have two coils.

Having defined these devices in a technical sense, we will explain each in further detail and cover some of their more common malfunction symptoms and their causes.

**Switches**

Electrical switches have evolved considerably since their inception. Today, some switches only signal “intent” to an electronic module, which in turn activates the circuit. These switches seldom need to carry more than a few thousandths of an amp. In the past, headlight switches on passenger vehicles commonly handled 20 amps or more for extended periods of time. The headlight switch of today merely signals a module which activates internal SSRs that power exterior lamps.

When replacing or installing a switch, your primary concern should be its load-carrying capacity, expressed as an amperage rating. This is assigned by the switch's manufacturer, based on the size, composition and construction of the current-carrying surfaces, and the spring tension holding the contacts closed. Keep in mind that current flow will change dramatically, both when the contacts are closed and when they are opened. It is at these times where arcing occurs and most contact wear takes place.

When purchasing switches, remember that the rating is only as reliable as the manufacturer. Each switch also has a voltage limit, which has more to do with contact separation, arcing and safety. This normally is not a concern in the low-voltage applications found in most vehicles. Of course, electric cars using high-voltage battery packs are a whole different story and require unique solutions.

Like all other components of electrical circuits, every switch introduces some resistance into the circuit. While switches are seldom replaced until they fail completely, a suspect switch can be tested for voltage loss by applying a controlled load through its contacts and measuring the voltage drop across the terminals. If the switch is good, the reading should always be less than one tenth of one volt.

As the load is increased, the voltage loss increases, as you can see in Figures 5 and 6. To control the load, we tested a 75-amp switch by wiring it in series with the output terminal of an alternator on our test bench. Most switches can be overloaded briefly without damage. Remember that all lost voltage creates heat. It may be normal for a switch to feel slightly warm during constant-duty use. But if it feels hot, there is either too much resistance in the contacts, or they are being heavily overloaded.

**Relays**

Relays have been in use for more than 150 years. A relay was one of the two main components of the telegraph that Samuel Morris patented in 1840. (The other part was a momentary switch that he named the "key"). All relays employ a stationary iron core with a coil of wire wound tightly around it. The most basic relay consists of five primary parts (see Figure 7):

1. a wire coil wound around an iron core
2. a steel yoke attached to the iron core
3. a hinged steel armature attached to the other end of the yoke
4. a spring attached to the armature that applies force to hold it away from the iron core
5. a set of contacts, one moving (attached to the armature)
and the other stationary.

The operation of this basic relay is simple. A small amount of current is passed through the coil to magnetize the iron core. That, in turn, pulls the armature down to close the contacts, which can carry a much higher current than the coil requires. If you were to reposition the stationary contact, the same relay could normally be closed, then it would open when activated (see Figure 8). The switch nomenclature (NO and NC) refers to normally open and normally closed.

By adding a fifth terminal and a third contact to the same relay, you can switch between two different circuits—one normally closed which opens when activated, and the other normally open which closes when activated (see Figure 9). This relay can switch between two circuit paths.

More complex relays are used to accomplish just about any type of switching requirement. For example, vibrating contacts are used to control voltage and limit amperage in a mechanical generator-regulator. Another example is the generator cutout-relay, which is a dual-coil relay—one coil closes the contacts, while the other coil holds them closed.

Relays are rated by amperage, but they are voltage specific because of the coil. While you could safely use a 120-volt switch in a 12-volt application, the same is not true for a relay. Relay contacts are also less forgiving than most switches. They should never be overloaded, not even momentarily, because the contacts could be permanently damaged.

The most vulnerable part of a relay is its contacts, simply because they wear from arcing with use. The resulting uneven contact surfaces increase the inherent resistance, which can cause them to overheat, stick in the closed position, or fail to close altogether. As with any other switch, you can test relays for voltage drop across the contacts. Since the contacts of most relays cannot be inspected, this is a good indicator of their condition.

We tested a popular 50-amp Bosch relay at both 20 amps and 40 amps (see Figures 10 and 11). As you can see, the voltage drop is higher than we found in our mechanical switch. Any relay that loses more than one tenth of one volt should be considered suspect, especially if it is in a continuous-use application.

Solid-State Relays

Because of improvements in semi-conductor technology, SSRs are being used more today in many applications. They have no moving parts, and they can now carry loads of up to 100 amps. A solid-state relay has several advantages over an electromagnetic relay, such as: much higher switching speeds, smaller size, longer life and the ability to be controlled by extremely low current.

However, SSRs will probably never completely replace electromechanical relays on vehicles for several reasons. The first is the voltage drop that is inherent in all semi-conductors. While contacts in conventional relays have some resistance that causes a small voltage loss, each SSR has a specific voltage drop on the load side, which can be as high as one full volt. That loss in electrical energy is converted into thermal energy—heat that must be dissipated.

That heat (which increases with the load being carried) is a bigger problem than the voltage drop. High amperage SSRs require a heat sink or air circulation to survive. There are ways
to compensate for the voltage drop in most SSR applications, because it does not change with load. As such, it can be dealt with more easily than a voltage drop in a set of contacts (which changes with wear).

SSRs are also more vulnerable to short-term overloading failure. When they do fail, they have a tendency to do so in their “closed” state. Failing to open could create safety concerns in some applications. This failure mode is the exact opposite of a mechanical relay, which would most likely not close when it fails, resulting in an open circuit.

**Solenoids**
The defining characteristic that differentiates a solenoid from a relay is its moving core. If a movable iron plunger is present in a device, it is a solenoid—even if it only closes a set of contacts. Typically, a solenoid's coil is wound on a bobbin that has a brass or stainless steel sleeve inside the bobbin. This allows the plunger to be near the coil to gain maximum magnetic influence, while the plunger can slide freely inside the sleeve without harming the wire’s insulation.

Solenoids come in many different configurations. Some are designed to perform specific mechanical functions. Solenoids can be used to actuate valves, move levers or close electrical contacts. The most common solenoids in our industry perform two functions: shifting a starter drive into cranking position and closing a set of contacts. Any solenoid that closes contacts is also considered a switch.

Solenoids that perform a single task typically require only one coil. They are energized by current flow through that coil, which creates a magnetic field to pull the plunger. When current is removed, the magnetic field collapses, and a spring returns the plunger. If the solenoid has contacts, a second spring is used to break the connection.

However, dual-purpose solenoids, the most common type found on starters since the 1970s, have two coils that are dependent on one another. These are sometimes called “dual-stage” solenoids, and the coils must be balanced, with an identical number of turns in each (see Figure 12). The stronger coil, wound of a larger gauge wire, is called the "pull-in coil". It draws high current to pull the plunger inside the coil. This action engages the starter drive and ultimately closes the contacts. One end of that coil is connected to the solenoid’s switch terminal, and the ground side of that coil is connected to the starter’s motor terminal. Simultaneously, current also flows through the "hold-in" coil, which is also powered by the switch terminal but grounded directly to the solenoid’s case or a dedicated ground terminal. That coil is wound with a smaller gauge wire, resulting in a lower current draw.

This arrangement allows current to flow initially through...
the pull-in coil and the starter motor in series. The resistance of the pull-in coil limits amperage to the motor, causing it to rotate slowly as the pinion moves toward the ring gear. This gradual rotation ensures a smooth meshing of the two gears. It also prevents the plunger from closing the solenoid’s contacts until the pinion is fully into the ring gear and the engagement is complete. This prevents the pinion from milling against the ring gear.

Once the contacts close (see Figure 13), the motor terminal receives full battery voltage to crank the engine, which causes the “pull-in” coil to lose its ground. (With positive voltage at both ends, no current can flow through it.) This leaves only the “hold-in” coil to do the job of keeping the contacts closed during cranking.

Following engine-start, power to the switch terminal is removed. At this point, the solenoid’s contacts are still closed and are now applying positive voltage to what previously was the ground side of the “pull-in” coil (see Figure 14). This allows current to flow backwards through the “pull-in” coil to the switch terminal, which is no longer powered, but connects to the “hold-in” coil which is grounded on the other end. With the coils now in series, the same current flows through both (but in reverse direction through the pull-in coil). Since the polarity of the pull-in coil has been reversed, its magnetic field has also been reversed. With both coils being balanced with an equal number of wire turns, their magnetic fields are equal in strength. But they are opposing one another, so they cancel each other—releasing the plunger and breaking the contacts with the help of the springs.

The condition of any starter’s solenoid contacts can be tested the same way as the contacts in a switch or a relay. We checked a new Delco-Remy PMGR starter in a free-spin test to get a baseline voltage drop (see Figure 15). With the starter drawing 100 amps, you can see that the voltage drop was just 0.01 volt.

### Starter Solenoid Failure Modes

Understanding exactly how a starter solenoid works will help you to diagnose a problem when one arises. Below are a few common failure modes, along with possible causes for each and the test methods that you can use to identify and isolate them.

**No crank and no click** – When you get no response from a starter, the first test should always be verifying that you have correct voltage. Attach your meter’s ground to the starter’s case or the ground post if it has one. Verify that you have a charged battery connected to the solenoid’s battery terminal. It should be 12.6 volts (and no lower than 12.5 volts). Otherwise, check and charge the battery before proceeding. Next, test voltage on the solenoid’s switch terminal. With the key turned to start, the voltage on the switch terminal should be at least 12.0 volts. Lower voltage readings indicate a problem on the vehicle or with the battery. A remote starter switch can be used to bypass vehicle wiring for test purposes.

If voltage is good at the switch terminal, and the symptom persists, move your meter’s ground lead to the solenoid’s motor terminal. When you turn the key to start, the meter should read close to battery voltage, because the resistance through the motor’s circuit to ground is minimal compared to the solenoid’s coil. If the voltage is low or goes away altogether, it indicates a problem inside the starter—an open armature, open field coil or bad brush connections. If it is very close to battery voltage when you turn the key to start, and it still does not pull in the plunger, then you may have a bad solenoid, a binding plunger or a drive stuck on the splines.
Clicks but no crank – When you hear a solid click but get no response from the starter, it usually means that the contacts are not closing. Verify voltage first, to be sure it is sufficient to close the contacts, as described above. If the voltage is good on the solenoid’s switch terminal, most likely, the problem is mechanical, not electrical. In other words, something mechanical is limiting the plunger’s movement. Double check the plunger and shift lever for damage and ensure they are correct for the starter. Measure the pinion’s at-rest location on the shaft in relation to the starter’s mounting flange, and compare that to the position of the ring gear in relation to the mounting pad for the starter on the transmission or engine. For example, some starters were made to be mounted using spacers. If the spacer was misplaced or lost, it would put the ring gear too close to the pinion, limiting drive and plunger travel and preventing the contacts from closing.

Chatters rapidly, no crank – When you hear a starter chatter rapidly, it is almost always an open ground connection in the solenoid’s hold-in coil or voltage dropping away on the switch terminal. The majority of hold-in coils are wound with fine wire and spot welded to the solenoid’s steel case, out of sight. You can easily test for this with the solenoid removed from the starter. Secure a good ground to the solenoid’s case, power the switch terminal and push the plunger in by hand, far enough to close the contacts. Once they are closed, slowly remove your hand. The hold-in coil should keep them closed if it is good. At this point, to verify that the weld is secure, lightly tap the solenoid on a hard surface, while being prepared to catch a flying plunger in the event the weld is broken.

Crank but stays engaged – When the starter cranks the engine, but it fails to disengage, there are several possible causes. Checking for voltage on the solenoid’s switch terminal after the key is released should be your first test. There should be none. Even a few volts on the switch terminal is sufficient to throw the solenoid’s coils out of balance and prevent disengagement. Disconnecting the switch wire and cranking with a remote switch is another test to eliminate that possibility. Of course, a solenoid imbalance is another possible reason, as is welded contacts, caused by extended cranking with low voltage. Solenoids can become imbalanced when coils short internally, which allows current to essentially bypass some coil wire turns. Internal shorts can develop from vibration or overheating from extended use.

If a solenoid’s plunger can be rested freely inside the coil’s...
sleeve without a spring, you can do a simple balance test by powering the solenoid’s motor terminal with operating voltage and grounding the solenoid’s case. The plunger should move freely with absolutely no magnetic attraction. If you suspect that the starter was cranked with low voltage, causing the contacts to stick—look inside. If that happened, the proof can be found there (see Figure 16).

Delco-Remy’s Integrated Magnetic Switch
What do you think now? Is the Delco-Remy IMS a switch, a relay, or a solenoid? The given name is magnetic switch. But relays and solenoids are both types of magnetic switches, similar but distinctly different in one way—the iron core. If it is fixed, the IMS is a relay. If it moves, it is a solenoid. We dissected one so that you can decide for yourself (see Figures 17 and 18).

You may have noticed that we mentioned very little about different types of electrical loads, how each influences arcing differently, how that affects contact wear and the need for suppression devices in modern circuits. Look for more on those subjects in a future issue.

Authors’ note: The basis of this article comes from a presentation given by Dan Smith at an APRA training clinic (June 2010). For many years (and for good reason), Dan has been known throughout the electrical rebuilding industry as “Mr. Solenoid”. We thank Dan for providing his source material and also for his tireless work promoting education throughout the remanufacturing industry.
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Many car owners are still under the impression that an AC system is maintenance free and they only visit the AC specialist in case of problems.

- But did you know that your AC system loses approx 15% of its charge every year.
- And on older vehicles the leak rate via hoses sealing washers and O-rings and joints is often much higher than 15%
- Every system has a receiver drier / filter that collects moisture, oil sludge and small metal particles and it will continue to do so until it breaks down. If the filter drier breaks down its inside Desiccant will spread out in the entire AC system – in most cases a broken filter drier will destroy the compressor, block the parallel flow condenser and expansion valve and orifice tube – and why take such a high risk?
- We also often see corrosion in the system – mainly in the compressor. Corrosion appears when the moisture and refrigerant mix with each other and turns into acid

As we all know it’s always cheaper to prevent problems from happening than to repair the problems – and all related damages related herewith.

Based on the above mentioned we recommend following tasks to be carried out every 12 months. The points can be used as your guideline:

1. Inspect the free run pulley on the alternator – if it “locks up” it will destroy the breakaway hub on the AC Compressor (because the vibrations and shocks from the engine will no longer be absorbed and they will hit the weakest point which is the delicate break away hub that is built into the compressor pulley) Airstal recommends to replace the alternator free run pulley every 150 000km – if you are in doubt about the mileage – replace the free run pulley.
2. Inspect all drive belts for wear and damages – over time rubber belts get small cracks and also the structure of the material changes due to the big changes in temperatures and possible contact with chemicals / oil (caused by leaks from the engine etc)
3. Please carry out an UV leak test – most systems are factory fitted with UV dye included so it will be easier to search for small leaks and catch them on time before the entire system breaks down. Please see Airstal ATSB 01 / 02-2015 concerning small leaks in modern AC systems with “direct drive compressors”
4. In case of leaks Airstal recommend to find the root cause to the problem and resolve it.
   Adding leak stop and other chemicals into the AC system is very often a temporary solution and in some cases such products may even hurt the inside parts and cause internal corrosion in the compressor.
5. Please carefully inspect all AC hoses that are nearby the exhaust pipes or manifolds – the history shows that sometimes the inner plastic lamination changes it structure and “de-laminates” itself from the inside walls of the rubber hoses. Such problems are very difficult to find and the best you can do is to carefully watch the high pressure gauge to look for some fluctuation (for instance between 15 -18bar) Such difficult problems will also destroy the compressor if not found in time (The compressor will be lacking both lubrication and refrigerant in such situation)
6. Carry out a full performance test of the system which at least should include following

- Check that all buttons and illumination in and around the AC display / control panel are functioning correct.
- Inspect the condenser for dirt between the fins and also make sure that all fins are undamaged – often the condensers are suffering under heavy corrosion and this will bring down the cooling capacity and raise the...

...
discharge pressure unnecessarily in the entire system.

- Check the function and the speed of the condenser fan – also check that it actually rotates in the right direction. Sometimes cars have been wrong assembled after a front crash repair or other electrical repairs.

- Check the temperatures on the suction and discharge hoses – it gives you a good indication of the cooling capacity of the entire system. Please observe if the pipe to the evaporator is freezing (if there is ice on it) or if it stays around 2 degrees Celsius which is optimal. In cases where you see ice on the hoses to the evaporator it might be related to a control valve problem inside the compressor or a defect compressor cycling switch / thermostat-amplifier or a thermostat. At least the compressor does not cycle off at the correct evaporator temperature and the root cause has to be found and re-solved.

- Carefully check the pressures on the high side and the low side at a maximum test. (High side should be between 15-20 bar and low side between 2.5-3bar) Make sure that the gauge needles are showing stable results - no “flucturing” is acceptable.

- Check the function of the compressor clutch and measure the voltage drop between the battery + and the positive connection on the magnetic coil.

- Check the clutch gap; be aware that not all cars have an electromagnet clutch anymore (The air gap between the pulley and the clutch plate. Should be between 0.5 -0.8mm)

- Check the speed of the blower motor and make sure that all levels of speed are available.

- Inspect the cabin filter – there are two versions available – a simple paper version and a “city” version containing “active carbon” Airstal recommend the “Active Carbon version”

- Check the operation/function of all ventilation louvers in the dash board

- Make sure that the drain under the evaporator collects and leads the water out of the cabin and out underneath the car. (This is easy to check with high ambient temperature and the AC system on max.)

- Check the quality of the oil in the entire AC system – for this purpose you will need an oil diagnostic kit which consists of a sight glass + hoses + quick couplers. Many AC problems can actually be prevented by a yearly oil analysis

- In case of any dirt in the system it’s recommended to drain the system for oil and refrigerant and carry out a full flush of the entire system. There are many very good flushing kits available on the market and it’s no problem to bypass the expansion valve / orifice tube / filter drier.

use double end capped OEM oil because it’s much more resistant for moisture and it has also better durability than the cheap oils that are on the market. In case of questions related to oil qts, please feel free to contact Airstal and we will have the answer to your questions.

- Add approx 7.5ml dye to the oil – the dye will over time help you to find small leaks by the help of an UV flashlight.

- After a complete AC flush it will be necessary to replace the receiver drier / orifice tube.

- Recharge the the system and run the performance test from A-Z

- It’s recommended to give the car an OZON treatment for 30-60 minutes in order to kill all bacteria’s that might be on the evaporator surfaces.

“The above mentioned points are just some of the most important ones during a regularly AC service and we would be pleased to receive constructive feedback to this TSB in order to make it even more complete....” This technical service bulletin was provided by Bo Hansen at Airstal. With questions or comments, you may reach Bo at bo@airstal.com.
A
PRA is pleased to announce a brand new benefit exclusively for members: the APRA SocialLink mobile app.

This mobile app makes it easy for members to interact and engage on-the-go with the entire APRA network of members. Right from any mobile device, members can easily connect with other members, engage in discussions, receive relevant industry updates and grow their industry network.

APRA SocialLink also includes specialized forums to interact.

The top value of the APRA SocialLink is the “Search Community” feature of the App.

Members can easily search by an individual’s name or a company name to search the association’s database of over 2,000 industry leaders. Members can email or call the contact right from the app. In addition, members can add business colleagues to their own personal connection list. Contact information for all members is always up-to-date because it is directly connected to the APRA database and includes new member information as soon as they join.

There are many additional features from APRA SocialLink that provide value to members, including:

• **Stay Current:** Access to the latest news and updates from any device, allowing members to stay in the know wherever they are.

• **Networking Feed:** Engage other members in APRA by providing them relevant industry news or company information within a single feed

• **Membership Renewal:** Renew a membership right from their phone.

• **And more.** This is the first version of the Mobile App. APRA will be enhancing it based on member feedback to increase the ability of members to interact and stay connected on-the-go.

APRA SocialLink solves the problems other social media sites cause those in the remanufacturing industry.

1. **Purely Business:** Other social media sites include personal information in the news feed. APRA SocialLink is strictly for industry contacts, company news and industry information.

2. **Targeted & Relevant:** Other social media sites are watered down because their wide scope to the point that they are a ‘mile wide but an inch thick’. APRA SocialLink is highly focused on the remanufacturing industry so the contacts and news feed are relevant to the interest of members.

3. **Results Driven:** Other social media sites are entertaining, but do little to help business people succeed. APRA SocialLink is only available to APRA members meaning connections made are with companies that can quickly and easily do business with each other.

“In the past, APRA members were able to interact with the other members of the association through our events, print directory or on their desktop,” stated Scott Parker, APRA Association Manager. “Now, the APRA SocialLink provides members a powerful new tool to stay connected with industry information and contacts while they are on the go.”

Getting started with APRA SocialLink is easy:

1. Search and Download “SocialLink” in the App Store or on Google Play.

2. Login with your username and password: Generally, your username is your email. You can easily reset your password if necessary or contact APRA for assistance.

3. Start exploring and connecting with the APRA network.
Since 2004 most AC systems had been equipped with direct drive compressors – which mean that the compressor cannot be disconnected from the drive line. The performance is regulated by an electronic control valve within the range 3-100%

Such systems are extremely sensitive for small leaks and if not repaired in time a small leak can cause a total breakdown of the entire system. The reason for this is following:

Many new AC systems have a system charge around 500 grams of refrigerant and as long as the system is new everything is ok. – At the time when this TSB has been made the European legislation accepts leaks on max 40g/year for a passenger vehicle.

Let’s assume that the car has a leak of 100g/year (This is also considered as a small leak – even though it’s higher than the allowed 40g/year)

The driver is using the car every day and one day he notices that his car does not „blow cold air anymore” …

The car is brought to the work shop and they quickly find out that the system charge is too low and they perform a leak test and locate and Re-solve the problem. Now the work shop takes an oil test of the remaining oil In the AC system and it turns out that its black and dirty and the decide to take a closer look at the compressor to see if it has internal damages.

After having the compressor opened the workshop can now see that the pistons and cylinders have serious scratches/seized and the only right thing to do is to replace the compressor and the filter drier/ expansion Valve and the parallel flow condenser and hereafter make a serious flushing of the entire system.

But how could a small leak result in such serious damage to the compressor and the entire system? The reasons are as following:
1. The breakaway clutch was not activated due to too low torque – which means that the compressor was still running „smooth” enough according to the OEM specifications.
2. When the system charge „go low”, the circulation of oil will be reduced and the lubrication of the entire system will be reduced accordingly.
3. If the leak is not located early enough the system will furthermore be polluted by small aluminium particles released from the pistons and the cylinder inside the compressor.
4. The pressure sensor in the system does not protect the compressor against small leaks and before it will shut down it will be too late.

Bottom-line: Small leaks are very dangerous in modern AC systems (produced from 2003 and upwards).

This technical service bulletin was provided by Bo Hansen at Airstal. With questions or comments, you may reach Bo at bo@airstal.com.
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Hotel reservations at the host hotel, Bally’s Las Vegas are available for as low as $119 - $159/night. Rooms are currently available for the entire aftermarket week so you don’t have to change hotels if you are staying the whole week - book early for best availability. Reserve your room by calling 800-358-8777 or reserve online at www.apra.org/2017BigRHotel to avoid $15 phone reservation fee.

Four New Event Partners Announced

APRA is signing on new Event and Media Partners to continue to grow the #1 Reman Show. APRA is proud to announce the following new partners for Big R:

Event Partners:

Media Partner:

If your organization is interested in becoming an event or media partner of the Big R show, please contact Scott Parker at sparker@apra.org or call (703) 968-2772.

APRA Announces the new Reman Pavilion at the Big R Show

More and more warehouse/distributors and other end buyers are attending the Big R Show. Here is your chance to gain affordable access to this group to build your sales.

For the first time APRA has added a Reman Pavilion at the Big R Show. It is available exclusively to APRA Remanufacturing Members looking to build their brand and market their product affordably. And it is easy as APRA is even offering a discounted backdrop banner so you won’t have to set up a booth or move it to AAPEX. Interested in being part of the Reman Pavilion or securing a booth? Contact Scott Parker at sparker@apra.org or 703-968-2772.

Big R Trade Trade Show 79% Sold - Only 11 Spaces Left

The all new APRA Trade Show continues to attract exhibitors at the #1 Reman Show. Phase 1 is 79% sold with only 11 booths left in the premium area. Contact Scott Parker at sparker@apra.org or 703-968-2772 to secure you space.
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Cancellation Policy: Cancellations through September 4: A $20 service charge. Between September 5 - October 25: $20 or 50% refund of the registration fee (whichever is higher). No refunds after October 25.

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**SUBMIT YOUR REGISTRATION**

Credit Card Only: Email accounting@apra.org or fax 703-753-2445

Check or Credit Card: Mail to 7250 Heritage Village Plaza, Suite 201, Gainesville, VA 20155

Questions: Call 703-968-2772 or email info@apra.org

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**Book Your Hotel Room Now**

**Bally's Las Vegas**

**Room Rate:** $119-$159 (+ additional resort fee of $29)

Call 1-(800)-358-8777** and ask for the Big R Show rate or go to www.apra.org > events by October 3 to book at the discounted rate. Be aware that rooms may sell out early.

**Please note that there is a $15 surcharge for making reservations via phone. To avoid this charge, make your hotel reservations online at apra.org > Events.**

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October 28-30, 2017 • Bally’s Las Vegas

The Ultimate Networking & Educational Event for the Remanufacturing Industry

• Network with 1000+ Reman Industry Leaders.
• Grow your business - sell, order & close deals!
• Keep current with industry trends & developments.
• Interact with top supplier/vendors.

Big R Show: Members Attend for just $20
The APRA Big R Show will feature the latest products and services for the remanufacturing industry.

Members register for just $20 for the trade show and reception. Education seminars and lunch with a keynote speaker are available for an extra fee.

Discounted Hotel Rooms
APRA has secured discounted rooms for members as low as $119/night - $159/night at Bally’s. You can extend your stay in the discounted APRA block for AAPEX. For details, visit www.apra.org/2017BigRHotel

Big R Trade Show: Reserve Your Booth Today at the #1 Reman Show
The Big R Trade Show is selling quickly. Contact Scott Parker at sparker@apra.org or 703-968-2772 to reserve your affordable booth at the #1 Reman Show and gain exposure. This year, the show will feature a Reman Pavilion for the first time.

For more information, visit www.apra.org/2017BigR