## The Coming 42-Volt Electrical System, by Randy Rundle

The electrical systems of automobiles are about to undergo a monumental change. That change will have a profound effect on the cars we service in the coming years. Beginning in the year 2005 (some say sooner, some say later), the operating voltage of automotive electrical charging systems is to be upgraded to 42volts. The actual working vehicle voltage will be tripled to 36 volts, while the output from the charging system will be tripled to 42 volts.

If this 42-volt stuff sounds a little far-fetched, imagine what it must have sounded like during the 1950s when the voltage of automotive electrical systems was upgraded to 12 volts. Just like in the 1950s, we have reached the practical design limits of automotive electrical charging systems. This has come about in part because of the increased electrical loads from on-board computes, sensors, and related emissions hardware.

In addition, the introduction of modern accessories like GPS navigation systems, e-mail and Internet-capable radios and cell phones, have all helped to increase the electrical demand placed on automotive charging systems. If you spend a few minutes studying the situation, it becomes easy to understand why a 12-volt electrical system can no longer keep up with the increasing electrical load.

Having learned from the past, modern engineers knew the practical design limits of today's automotive electrical system were fast approaching. They also knew that at the current rate electrical accessories were being added to new automobiles, a jump to 24 volts would be a temporary fix good for ten years at best. The question became how much the voltage could be increased and still not become a safety concern.

As you might expect, it is not just the electrical load of modern accessories that is of concern to engineers. Meeting new and tougher emission standards and the increased federal fuel mileage requirements has also become a factor. In addition, there are other engineering challenges to consider.

For example, by increasing the voltage to 42 volts, all of the vehicle's accessories (water pump, a/c compressor, power steering, etc.) could be powered by electricity. The horsepower drag from engine accessories could be eliminated, and fuel mileage could be increased by nearly 10 percent. Gas mileage increases usually come in small amounts in the range of one or two percent. A 10 percent gain all at once is like winning the lottery to the engineers.

Extensive research determined that 50 volts was the practical safety limit for increased voltage. With that in mind, 42 volts was selected as the new voltage standard. According to the safety engineers, if you are exposed to a 42-volt electrical system shock, you would definitely get a good buzz. However, the chock would likely cause you to drop or let go of the connection, and you would not suffer permanent physical damage.

### A Brief History

The Society of Automotive Engineers actually began looking at increasing the voltage of automotive electrical systems in 1988. They got a less-than-warm reception from the automotive community, but nevertheless continued to study the issue up until 1994 when the project was abandoned.

In late 1995, a consortium was established, headed by MIT Professor John Kassakian, to again promote the increase to a 42-volt electrical system. The timing seems to have been much better. Because of the huge volume of sport utility vehicles being sold in recent years, the average corporate fuel mileage has been steadily failing. A change to gain 10 percent mileage increase across the board looks pretty darn good to both the manufacturers and the government. By the way, did you every wonder why GM bought the GEO brand? Corporate average fuel mileage of course.

The consortium today represents most all of the major automotive manufacturers throughout the world. Some of the companies involved include BMW, Daimler/Chrysler, Delphi Automotive, Ford Motor Company, General Motors, and Toyota.

If you are thinking about joining the consortium, you will need to ante up some serious bucks; the dues are $50,000 a year. Nevertheless, the consortium is now 115 members strong, and represents 26 companies.[1]

The first order of business for the consortium was to establish some basic standards. The move to 42 volts will involve major reengineering and redesign of almost every electrical components, from light bulbs to engine management computers. One of the first big decisions will concern the starting/storage batteries.

[1] Note from MIT: As of December 2001, the consortium actually had 53 member organizations.

Some members want to have a small 12-volt charging system for lighting, and a 42-volt battery and charging system for everything else. Others want to reengineer the lighting and go completely to 42 volts. The goad of the consortium is to establish standards early on, so suppliers can gear up for production.

While most electrical accessories will benefit from the changeover and become more efficient, the one notable exception is incandescent light bulbs (light bulbs with filaments), which need to maintain the same wattage regardless of the voltage.

Tungsten is currently used as the filament material in an incandescent light bulb because it is one of the only materials that will incandesce at high temperature without melting or flowing. The engineering problem with incandescent bulbs occurs when the voltage is increased. In order to maintain the same wattage the filament inside of the bulb will have to be built thinner. That exposes the filament to more damage from shock and vibration.

Another option being considered is a battery within a battery, the small battery inside being 12-volts to power lighting accessories.

Still another idea is the switch to high-intensity discharge lamps which work on the same principle as overhead street lamps. These lamps require higher current, which would now be available. Also being considered is using neon for taillight and interior lighting. While more expensive, these lights could be easily adapting into modern shapes.

Interior lighting is a big challenge because there are over 100 incandescent bulbs in the average modern automobile interior. Fiber optic lighting has also recently been considered as another possible solution.

**42 Volt Benefits**

One of the biggest benefits of the proposed 42-volt system comes in the wiring and signal distribution. By increasing the working voltage of the electrical system to 42 volts, the physical size of the wiring harness can be reduced (in theory) to a third of its current size. (In reality, the durability and manufacturing processes may limit the size reduction to about 50 percent.)

Connectors will get smaller and look much like those found inside your computer. That will mean lower cots, easier to build wiring harnesses, in smaller packaging. Smaller body perforations will also provide a manufacturing cost savings.

**The Real Scary Stuff…**

Higher voltage should also end the use of mechanical relays and traditional fuses and/or fusible links. The 42-volt wiring harness would feature solid-state switching and self-diagnostic capabilities. Switches will be located on a circuit board much like a computer motherboard.

Some of the biggest efficiency gains will come from motors and solenoids. Electric window motors could be reduced to one-third their present size, representing a significant space savings. Solenoids could also be reduced to one-third their current size, while still being able to provide the same output or greater.

Drive-by-wire technology will likely become a reality. Drive-by-wire systems would eliminate the need for a steering column and related steering linage. Think of this as an advanced version of the changeover from throttle rods and linkage to cable throttle systems. Brake-by-wire will also likely become a reality.

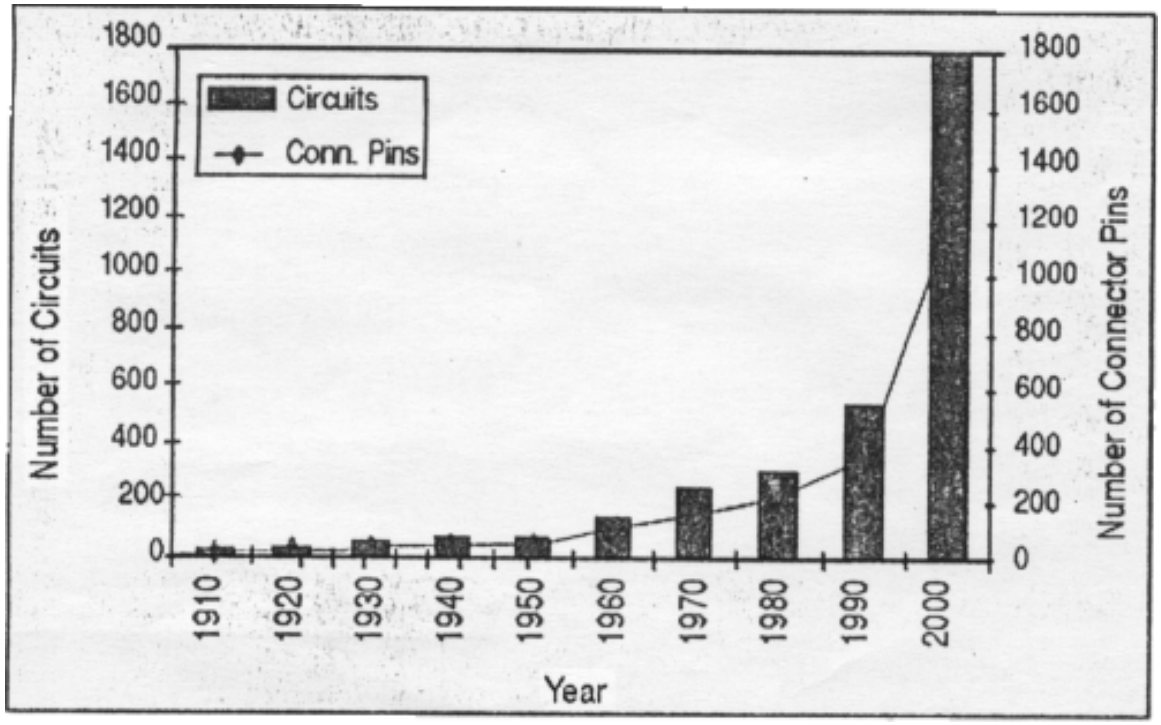
**What Else Are They Up To?**

No more belt-driven engine accessories, all of the former belt-driven accessories would now be powered by electric motors. No more engine-valbe train! Push rods, camshafts, wuld all be gone, replaced by solenoid-actuated valves with a variable timing feature, computer-controlled for a wide range of driving conditions.

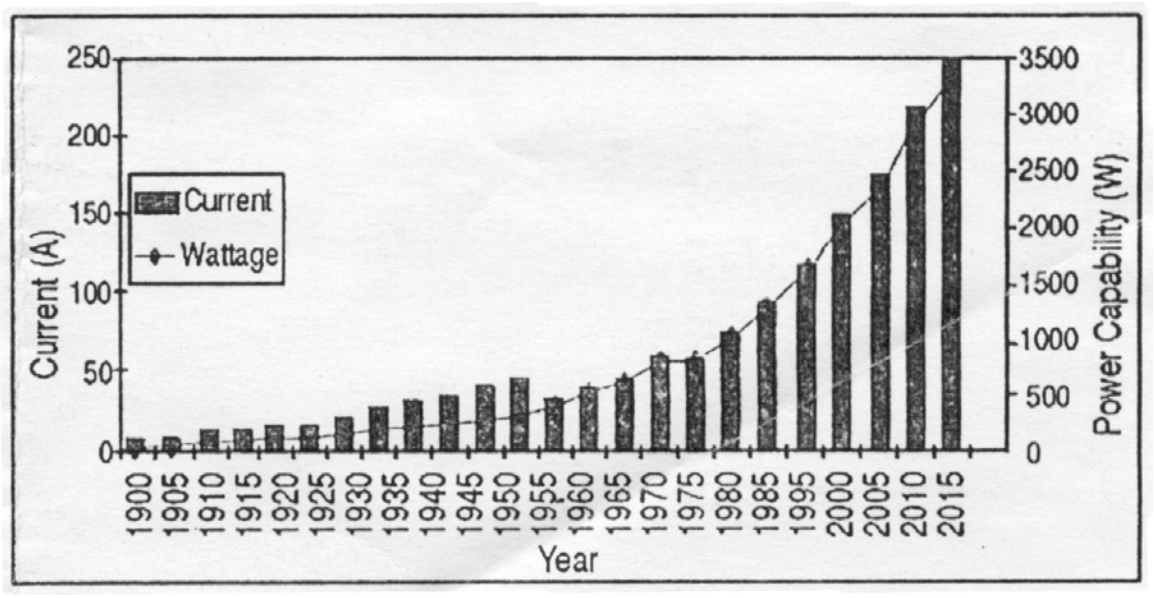
Electrical charging systems would also be capable of full-rated output at idle and low rpm. The alternator with a rating of 100 amps would be able to provide that output at idle and low rpm as well as at highway speeds. Think of this a being the same way the electricity works in your house. How fast all this happens remains to be seen. It is likely Europe will be the testing ground for much of this due in part to our legal system her in the states.

Meanwhile I have included some “visual aids” to help you better understand how the electrical load has increased since the early days. I hope you find this as interesting as I did.

Randy Rundle, Fifth Avenue Antique Auto Parts, Clay Center, KS




The number of circuits in a typical automotive wiring harness
has grown considerably over the years
(United Technologies Automotive)




The current demand for automotive electrical systems
has also increase steadily over the years