

---

## THE UBIQUITOUS SPARK PLUG

---



Daniel W. Parker  
Enerpulse, Inc.  
2451 Alamo SE  
Albuquerque, NM 87111

Most people have heard about them and use them every day. Fewer people know they start the combustion process in hundreds of millions of engines ranging from the family car to the family lawnmower. Still fewer yet could locate the spark plugs in either of these vehicles. Then there are the mechanical elite who not only know what they are and where they are, but can actually change spark plugs - the intrepid do-it-yourselfers.

### EARLY DEVELOPMENTS

The spark plug has existed in one form or another since the 1880s, when British physicist, Oliver Lodge, invented his version and started the Lodge Plug Company. Shortly thereafter, in 1898, the automotive industry was inundated with spark plug patents from such notables as Nicola Tesla, Robert Bosch and Carl Benz. Frenchman, Albert Champion, moved to the U.S. in 1904 and founded the Champion Ignition Company, which later changed to AC Spark Plug Company and ultimately spawned the two spark plug companies of AC Delco and Champion. And in the 1930s, Royce Martin formed the First Electric Autolite Spark Plug Company, known today as the Autolite division of Honeywell.



*Tip designs tried to make up for low power.*



*Polonium" radioactive" spark plugs*

Throughout its development the spark plug succumbed to every whimsical design idea attempting to overcome its inherent flaws. Gold and silver was added for better conductivity. Polonium (yes the very radioactive stuff that kills spies) was added to improve ionization. The copper electrodes gave way to nickel-clad copper, tungsten, platinum and iridium to improve durability. The electrode geometries went through every conceivable design contortion (multiple electrodes, split electrodes, grooved, side, halo, etc.) each promising marginally better performance.

## THE GLARING FLAW

Despite significant efforts over the past 120 years, the spark plug, much like golf clubs, has changed very little in real function or power. Its basic design has one glaring flaw: only 50 watts of peak power to the spark. Power is what couples the electrical system to the combustion system and ignites fuel. The more power you have the better. Today 50 watts of electrical power (limited by the spark plug design) is regarded as sufficient for combustion. This paradigm, the lack of a high-power alternative and the reality that no more onboard power can be spared for ignition (it is needed for DVD players and moon roofs) left the spark plug frozen in time.

## THE PARADIGM SHIFT

A few entrepreneurs who since the very beginning of the spark plug's widespread usage, challenged this notion theorizing that a spark plug with more power would improve the pathetically inefficient internal combustion engine. They believed that the addition of an electrical device, called a capacitor, to the spark plug could boost ignition power with better combustion efficiency. The capacitor could compress the power of the ignition and thus increase the power output of the plug. The first patent to this end was awarded in 1919. But alas, the device and all similar attempts were so clumsy that they could not endure the vibration and heat of the engine.

Nearly 50 years passed before the Swaser Company tried its hand at a high power spark plug. Like its predecessors, Swaser designed a capacitor that mounted to a spark plug, but their design benefited from modern materials. It lasted longer than the earlier attempts, but not long quite enough to be considered seriously for modern cars. In 1996 the Swaser device was ultimately liquidated into the hands of one, Louis Camilli, a physicist, ex-major league baseball player and entrepreneur who actually understood something about electricity and internal combustion engines. Camilli, with the help of the Sandia National Laboratories and the plastics industry was able to re-engineer the Swaser design and make it durable to 100,000 miles. At last, a device called DirectHits® was created that could increase the peak discharge power of a spark plug from 50 watts to 1 million watts.



*The DirectHits® capacitor mounts on a standard spark plug to boost spark energy.*

## THE FIRST REAL ALTERNATIVE

As compact as DirectHits® was it added almost 2 inches in length to the spark plug, which posed some installation challenges in the very cramped engine compartment of modern vehicles. It also came at a time when the auto industry decided to move from a centralized coil to a decentralized coil mounted on top of the spark plug, the very location destined for DirectHits®. Once more the efficiency benefits a high power spark plug could bring to the internal combustion engine was delayed. But, this time the technology actually worked and worked well.

Chrysler Corporation tested DirectHits® and found it reduced cycle-to-cycle variation in the engine by as much as 50%. It increased cylinder pressure by 7%, reduced hydrocarbons by 60% and greatly improved fuel efficiency. It could smooth out nervous idles and help cold start performance on cold winter mornings. It was the real deal, but only enjoyed modest sales success due to the complications of installation and the growing number of coil-on-plug designs.

Armed with the DirectHits® technical success and the coil-on-plug reality, Camilli put to the task of compressing the size of the capacitive element so it would fit into the footprint of a standard spark plug. After 3 years and millions dollars, the first pulse plug was made in 2005. It was called a pulse plug because its technology is based on pulsed power, a technology used to fire lasers and reactors. Pulsed power technology compresses energy by storing ignition power and releasing it in an instantaneous pulse. Like a camera flash intensifies light, pulse plugs intensify ignition power.



*Like a camera flash intensifies light, the pulse circuit in pulse plugs intensifies ignition power.*

## A BREAKTHROUGH IN THE MAKING

Under the name Pulstar™, these new pulse plugs fulfilled all the promise conceived almost 100 years before and started making their way into the automotive industry. Today, Pulstar™ has been installed into thousands of vehicles as a drop-in replacement for all spark plugs. Laboratory data and customer experience confirm that pulse plugs do in fact improve combustion efficiency resulting in improved fuel economy, engine performance, cold starting and towing capacity as compared to any spark plug in the market.



### “BUGGY WHIP” TO GLOBAL WARMING

Although the development of pulse plugs has been long and costly, their future is very bright. Two billion spark plugs are sold each year and like the proverbial “buggy whip” destined for obsolescence. The primary reason is that replacement of spark plugs simply restores the vehicle to its initial inefficient state while pulse plugs improve efficiency with the real potential to reduce our dependence on foreign oil and lower greenhouse gases. In North American alone 400 million spark plugs are replaced each year in the 250 million existing cars and trucks. Replacing spark plugs with pulse plugs can immediately and painlessly achieve our national goals faster than any new legislation can and ultimately become the ubiquitous *pulse plug*.