PART 1 PAST, PRESENT and FUTURE

THE HISTORY OF THE DIESEL ENGINE and THE ADVANTAGES OVER THE PETROL ENGINE

One hundred and twenty years ago, a German inventor dreamed of creating an engine that would revolutionize the transport of people and products. Today, his dream is reality and the engine bearing his name remains one of the most efficient and practical in the world.

Rudolf Diesel's vision was to create an alternative to the inefficient and resource-devouring steam engine. He hoped to design an engine that would use a radically new system of combustion to power a burgeoning industrial revolution. This "thermal! engine would use the principle of compression to ignite fuel. When air is trapped in a sealed chamber and compressed to an extreme degree, it gets very hot ó hot enough to ignite certain liquid fuels. Before the diesel, engines relied on fire (or sparks) to combust fuel and create the mini explosions necessary to drive the metal cranks and shafts that were replacing the muscled limbs of man and beast.

By 1897, just four years after his initial experiments, Diesel had a working compression ignition engine that operated as he had envisioned it and achieved a remarkable 75 percent efficiency, much better than the 12 percent achieved through steam power.

Before 30 years were out, the diesel engine had become the standard for powering heavy transport, from large vehicles to locomotives and boats. That diesel standard is true even now, but these days, you can add RVs to the list. While diesel powered motorcoaches traditionally have been more expensive than their gas counterparts, the gap is narrowing in recent years, and Class A diesels are now competing directly with gas coaches at entry-level price ranges. As petroleum costs rise, the RV industry in North America is likely to further embrace the diesel for its superior fuel mileage and longevity.

Diesel's 1893 patent for his new engine design.

The Fuel Fracas

Even as Rudolf Diesel began designing his new engine, a remarkable thing was happening that would effect his invention and change the energy landscape of the world in a dramatic way. Although petroleum was used for medicine and weatherproofing by Native Americans as well as for light and heat in China as far back as the 4th century, the industrial Western world was just beginning to stumble upon it, drilling wells in Pennsylvania and Canada. Initially, petroleum was only used for lighting oil lamps, and the market for it grew slowly. But new uses for internal combustion engines – including Diesel's – would change all that.

In his speeches and writing, Rudolf Diesel stressed that his engine could be fueled from a variety of sources, most notably, vegetable oils. In fact, at the 1900 World's Fair in Paris, the Otto Company displayed a small, unmodified diesel engine running on peanut oil. Diesel believed that there was great potential for biomass fuels and diesel engines to empower farmers and smaller agrarian communities, allowing them to hold their own in a time of growing monopolies and industrialization.

But as petroleum stormed on the fuel scene, propelled by men like John D. Rockefeller, it clearly had none of the weaknesses of vegetable oils or other biomass fuels. It was not dependent on crops or the weather and it was cheaper and easier to extract. The stuff literally gushed out of the ground at certain sites. The internal combustion engine took hold of a growing transportation industry continued on and petroleum's importance exploded, out-competing other available fuels. From 1860 to 1880, oil consumption in the United States grew at an astonishing rate, from 500,000 gallons to 20 million gallons. When Henry Ford rolled the first Model T off the line in 1908, worldwide oil consumption had risen to 10 million barrels per year. By the late 1930s, the world was consuming two billion barrels a year. The Age of Oil had begun.

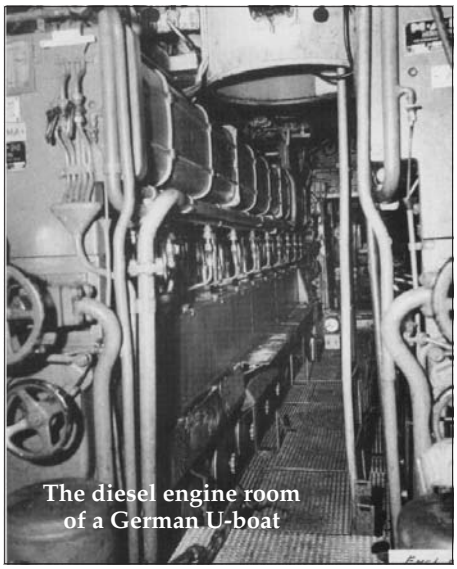
Coming to America

Rudolf Diesel visited the United States with his wife one time to promote his engine, taking copious notes and making several predictions that would prove incredibly accurate. After seeing the immense amount of land and natural resources in this country and the role these things played in the American mindset, Diesel pontificated that the word "efficiency" was not nearly as important in the U.S. as it was in Europe. He thought that his heavy and efficient engine would gain slow acceptance in the American market, but that once it was embraced, it would play as big a role in the United States as anywhere else. This indeed came true. With the marriage of diesei engines and locomotives in the U.S., his engine was certainly embraced and widely used.

Diesel also had some prophetic words when it came to air pollution. He believed that pollution and waste were not unfortunate by-products of industrialization, but signs of poor engineering, and he felt that for industries to be sustainable, they would have to become efficient and clean. This appeared to differ from the American model, and Diesel guessed that air pollution would become an important issue in the U.S. – one that would some day play a role in determining the design of diesei engines for the American market. One hundred years later, as engineers at Caterpillar or Cummins can tell you as they prepare lower emissions engines in recent years, that bit of prophecy hit the bull's eye dead center.

A Disturbing Death

In September of 1913, at just 55 years old, Rudolf Diesel disappeared from the deck of the steamship Dresden crossing the English Channel from Antwerp. His hat and coat were found neady folded under the stern railing. His notebook was found on a bedside table in his sleeping quarters, with a cross drawn below the date. Several weeks later, the crew of a Belgian Steamer discovered a body in the Channel. They removed the personal effects and threw the body back to the sea, as was the custom. Rudolf Diesel's family identified the personal items as his belongings and, in Germany, the death was assumed to be a suicide. Diesel had closed all bank accounts before leaving, owed a substantial sum on loans and left a bag filled with twenty thousand marks



The diesel engine room of a German U-boat

for his wife Martha. English newspapers, however, speculated at possible foul play by the Germans or French. Diesel had planned to meet with English inventor Sir Charles Parsons to discuss plans to use the diesel engine in the British Naval fleet. The engine was already being used in German submarines, which gave them a distinct naval advantage at the outset of World War I, so it wasn't a stretch for the English to call foul. Others have guessed that Diesel may have committed suicide not only for financial reasons, but because-as a pacifist and scientist with friends on both sides of the waróhe was faced with the grim reality that his invention intended to better humanity was now to be used to draw blood on a massive scale. While the circumstances of Rudolf Diesel's death are likely to remain obscure, it is clear that his life made a lasting and revolutionary impact.

Otto and Diesel

It's fitting that inventors who sparred during their lives would birth engines that would go on to compete on the world stage for many years. Nicolaus Otto was the German inventor of the internal combustion engine that preceded the diesel, using a spark to ignite fuels. This engine would evolve into the gasoline engine, powering the "Otto-mobile." The two brilliant men were contemporaries, and Nicolaus Otto was one of many who sued Diesel during his life, claiming he'd stolen the idea for his engine.

Although gasoline and diesel engines were diverse enough to coexist, when it came to consumer automobiles the "Otto cycle" engine would soundly win the first round, especially in the United States. Using a diesel engine in a passenger automobile was unheard of until the 1970s, and even then by only two manufacturers - Volkswagen and Mercedes Benz. American engineers focused on gasoline-powered muscle cars to meet the demand for increased acceleration and horsepower. Fuel efficiency had yet to become a concern, but this attitude changed somewhat during the oil shocks of the 1970s. American automakers such as GM began flirting with diesel engines, installing them in limited models, but the result was essentially a hastily modified gasoline engine that still favored acceleration over efficiency, and many GM diesels had big problems like cracked heads, cracked blocks and stuck pistons. The entry-level diesel cars were also noisy and spewed black exhaust, leaving the American public with a very bad first impression. When oil prices dropped, it was an easy return to gas thirsty muscle cars.

Diesels Today

Modern diesel engines are a far cry from these growling smoke monsters of the disco era. In fact, several European diesel passenger vehicles in production average greater than 45 mpg, and some even surpassed that, getting upwards

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of 70 mpg. Two components - the turbocharger and the intercooler - have significandy increased the power and greatly improved fuel combustion in diesels, producing vehicles with superior fuel mileage and equivalent acceleration, speed and comfort to their gasoline cousins. A turbocharger forces more air into the combustion chamber, creating more complete fuel combustion. An intercooler cools intake air, making it more oxygen rich, which further aids combustion.

The method of fuel injection is another difference between new and old diesel engines. Older diesel models typically used indirect injection, which involves swirling fuel in a pre-chamber before injection into the cylinder. A well-built indirect injection engine will run smooth and tough, but is not as fuel efficient as modern direct injection engines. The most recent direct injection engines are electronically controlled to spray highly pressurized fuel direcdy into the cylinder. These engines already have a reputation for high efficiency, quiet operation, rapid acceleration and low emissions.

The most recent Cummins engines available in Monaco motorhomes are a perfect example. From the Cummins ISB 300 in the LaPalma and Cayman models to the ISM 500 available in the Executive and Signature Series, these engines feature turbochargers and intercoolers, plus a Common Rail Direct (CRD) injection method that eliminates the distributor injection pump, instead storing fuel in a "common rail," a high pressure reservoir that branches off" to computer controlled nozzles. The results are impressive: a constant flow of fuel produces quicker

MODERN DIESELS VS. GASOLINE ENGINES

- **Fuel efficiency** – Diesel engines are more efficient than gasoline engines of the same power, resulting in lower fuel consumption. A common margin is 40 percent more miles per gallon for an efficient turbodiesel.
- **Weight** – Naturally aspirated diesel engines are heavier than gasoline engines for two reasons; it takes a larger capacity diesel engine than a gasoline engine to produce the same power. Second, a diesel engine must be stronger to withstand the higher combustion pressures needed for ignition, resulting in a durable, overbuilt engine.
- **Power Output and Noise –** Traditionally, diesel engines were noisier and had more narrow torque bands than gasoline engines. With improved technology (such as two-stage injectors) and electronic controls in the latest generation of common-rail designs, these weaknesses have been addressed.
- **Reliability and Endurance** – The lack of an electrical ignition system in diesel engines greatly improves the reliability. The high durability of a diesel engine is also due to its overbuilt nature, as well as the diesel's combustion cycle, which creates less-violent changes in pressure when compared to a spark-ignition engine. Diesel fuel is a better lubricant than gasoline so is less harmful to the oil film on piston rings and cylinder bores. It is routine for diesel engines to cover 250,000 miles or more without a rebuild.
- **Cost** – Due to their overbuilt nature, most diesels have a higher up front cost than gasoline counterparts, however, a better fuel economy and longer engine life can offset this cost over the course of ownership.

DIESEL BELIEVED THAT THERE WAS GREAT POTENTIAL FOR BIOMASS FUELS AND DIESEL ENGINES TO EMPOWER FARMERS AND SMALLER AGRARIAN COMMUNITIES, ALLOWING THEM TO HOLD THEIR OWN IN A TIME OF GROWING MONOPOLIES AND INDUSTRIALIZATION.

throttle response across every rpm, while constant injection pressures help optimize timing for increased fuel efficiency and lower emissions. In addition, as seen in the most recent ISB engines, they run seven decibels quiter at idle than previous versions, translating to 80 percent less noise inside and out.

A Clean, Efficient and Sustainable Future?

The future is now when it comes to even cleaner diesel engines. Cummins is proving that with current efforts to produce engines in 2007 that will reduce paniculate matter (soot) and nitrogen oxides emissions by 90 percent in order to meet Environmental Protection Agency regulations. These engines will feature a particulate filter and cooled EGR (exhaust gas recirculation) to accomplish this feat. Paired with Ultra-Low Sulfur Diesel fuel (ULSD), which inherently produces fewer particulates, these efficient engines will also help to dramatically lower air pollution over time. It's safe to say that Rudolf Diesel would nod in approval.

A man of extraordinary long-term vision, Diesel made a statement near the end of his life that may prove to be yet another accurate prophesy. He said, "The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in course of time as important as petroleum and the coal tar products of the present time."

Recent world events and movement in the biofuels industry have upped the stock of vegetable oil fuels, bringing the issue of sustainability to center stage. There is understandable enthusiasm for the idea of growing fuel on American soil-bolstering local farm economies and national energy security. The massive growth of the biodiesel industry over the last five years indicates strong consumer support for sustainable fuels, and advocates suggest that additional research and funding could eventually position biodiesel as a key fuel in our country's energy balance.

In the second installment of this series, we'll examine the validity of that statement, the most recent Cummins position on biodiesel as well as the impact it has had on the RV industry.