The STEAM AUTOMOBILE Bulletin

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Chuk Williams Steam Speed America streamliner at 147 mph.
Photo courtesy of Randy Maxwell, www.kafeenkonseps.com

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STEAM AUTOMOBILE CLUB of AMERICA, Inc.

Dues worldwide are $35 for one year, $68 for two years, $99 for three years. **$15 for students with ID.** This includes a monochrome print copy of the *Bulletin* in the USA, Canada and Mexico. In all other countries, the *Bulletin* is obtained as a full color pdf file from the club website. If the monochrome print is needed, add $40 shipping per year. Pay dues and donations at www.paypal.com. Select: Send Money, enter Recipient's Email: treas1@steamautomobile.com, amount in US Dollars and note stating what the money is for. By mail, include a Membership Form which can be requested from Dave Lewis or downloaded from: http://www.steamautomobile.com/application/memform05.htm

2015 Annual SACA Meet

Sponsored by the Chicagoland Chapter
Tom Kimmel's steam shop, Berrien Springs, MI

Friday through Sunday, September 18 - 20, 2015

Contents

President's Notes

Ken Helmick

As you can see from the magazine cover, the Steam Speed America streamliner ran at Bonneville in September. Unfortunately, the car was wrecked on its first run and driver Chuk Williams was severely hurt in the crash; fortunately he is on the mend and should recover completely thanks to the car's strong construction and Bonneville safety rules. The complete story will be found further inside; in the meantime I'd like to offer Chuk my wishes for a speedy recovery.

While recently browsing old issues of SACA's earlier publication, the *Steam Automobile*, I was struck by the number of remarkable claims, confident predictions and announcements of imminent production made for steam automobiles during the Clean Air years of the late 60s and early 70s. Forty-odd years later, many of these reports appear to have been far too optimistic, reflecting the proponent's enthusiasms more than a sober analysis of the technical, legal, social and economic conditions needed to make them occur. It's no secret that over-promising and under-delivering left light steam technology with a negative reputation that still lingers. Although SACA is a small club, it has been around for a long time and seems to have some influence beyond mere numbers; if we wish to promote this technology we need to be very moderate and accurate in our reporting and assessments lest we needlessly provoke further skepticism. Enthusiasm is good but if applied excessively it can be counterproductive. This brings me to the last (September-October 2014) issue of the *Bulletin* where I feel we did much the same as the *Steam Automobile* did decades ago.

In the article concerning the Cyclone Power Technology generator set sold to the US Army TARDEC command it was stated: "We have seen these (engines) run with no external water supply and emitting zero uncondensed steam, and nothing flapping around or requiring attention. Fired up at meets, they can perch on a rickety typewriter table indoors just humming along like an electric motor. Totally unspectacular in appearance and operation." Like many claims during the Clean Air Years, this is an overstatement. A Cyclone power plant has been run at only one meet, the 2005 SACA event at Berrien Springs, MI. This engine had little in common with that in the article having only two cylinders, different valves, different steam operating conditions and no "spider bearings". No analysis of performance, or even smoothness, was possible since it was not connected to a load. There was no rickety table; it was rigidly affixed to a sturdy steel stand. The power plant never ran unattended; the demonstration was brief and completely supervised; unlike an electric motor it emitted significant fumes and noise. Perhaps the current engines at the Cyclone facility have been more perfected in the past 9 years but such advancements have not been demonstrated at our meets. We cannot make such claims and be considered a reliable source of information when we try to promote light steam technologies.

The second difficulty I find concerns unsubstantiated statements or quotes regarding customer needs and intent; if the information being put out is not useful for planning then there is the risk that everything associated with the information will be discarded. It is one thing to report what sort of product or service a steam power developer is offering and quite another for the developer to attribute intents to the customer. In the case in point, Mr. Schoell is quoted as saying that TARDEC is enthusiastic about the engine and this assertion is repeated later in the article. Naturally, Mr. Schoell is enthusiastic about his work but neither he nor SACA is employed by the Army and are not in a position to act as representatives. Likewise, if the club is to cultivate credibility we should endeavor to limit statements regarding customer motivation and perceived benefits to the customer. As a case in point, Mr. Schoell is quoted as stating such engines "…can have an even greater impact on the prime movers themselves, the tanks and trucks especially, where strict dependence on diesel and JP-8 has always been a planning hurdle in deployment and supply". I will admit this seems logical and perhaps many would agree. The problem is that my 24 years' experience in the Navy and Reserves tells me the military perceives its needs differently as expressed in Department of Defense Directive 4140.25, known as the Single Fuel Program (SFP). This document directs land and naval forces to each use a single fuel. Army Regulation 70-12 "Fuels and Lubricants Standardization Policy for Equipment Design, Operation, and Logistics Support" implements the DOD mandate by directing that a single fuel, jet propulsion-8 (JP-8), be used within all theaters by all deployed active and reserve Army components. Jet fuels are specified because aircraft engines are the most demanding, single fuel supplies simplify logistics problems because any fuel delivery can be used anywhere it is desired, including the aviation assets which demand the most specific fuels. For SACA to pass along the impression that the DOD is ready to abandon SFP in favor of products that a single manufacturer has not yet developed cannot help the club in its mission to promote practical light steam power.

This was not meant to imply that SACA denigrates the work of Cyclone. At the same time, we have a responsibility to our readers, and our mission to promote light steam power, to serve as a trusted source of information. I take full responsibility for this article being printed with the previously mentioned passages in place, I apparently did not take the proper steps to ensure that it was edited to be more factual and accurate. My only defense is that I am new at the job and still learning, steps have been implemented to reduce the chances of such mistakes being printed again.

The 2014 Fall Meet at Berrien Springs, MI went off from September 18-20 as planned. For reasons both obvious and unclear, the attendance was about half that of the meet last year although a good time seemed to be had by all. Well, no one came up to me and complained anyways, but that could just be because I threatened to turn the president's job over to anyone who did. It's amazing how often that causes morale to improve!

This low turnout led to less money being raised, although the overhead was essentially unchanged, leading to a deficit in the accounts. Actually, the meet usually runs a deficit but this year even more so. This ongoing deficit, combined with the fact that the fairgrounds are already booked to another group for "our" weekend next year, has led to the decision to hold the meet at Tom Kimmel's steam shop. This isn't necessarily a bad thing, besides saving money it also gives attendees real hardware to study and discuss during breaks in the meet. We should be able to actually turn a profit next year by changing venues.

The Time Trials present another difficulty; one that members can volunteer to solve if they wish. One reason for using the Fairgrounds is that they have about two miles of paved roads on which to run cars and a long rear entrance at which we can hold the Time Trials. The cost of renting the grounds was $1,000 but we paid an added $1,000 simply to hold the Time Trials there. Moving the meet prevents us from using the Fairgrounds for the trials, something we could not do in any case due to the event already scheduled for that weekend next year. Furthermore, Time Trial prizes were donations to a fund that has slowly dwindled; the fund will be depleted when the prizes are sent to the participants of the September meet. Members can form a new committee to find a venue and secure funding if they wish and need only contact me at the address shown on the inside cover.

The annual elections were held at the September meet. I would like to welcome new Board Members John Bowditch, George Knight and Tim Nye. Likewise, Lonny Claypool was confirmed in his appointment as the new SACA Webmaster. I would like to thank the outgoing Board members Karl Petersen, Jerry Hackett, Tig Eldridge and Dick Olivier for their service. I also give special thanks to Scott Finnegan, without whom we would have no SACA website, or SACA Forum on the website, for both members and non-members alike to discuss light steam topics. (www.steamautomobile.com)

The club by-laws were revised with nine new amendments, these being too lengthy to print in this article. The entire club by-laws will be made available sometime in the upcoming months, whether by a longish Bulletin article or by a separate enclosure. The amendments were mostly aimed at making SACA more accessible to the regular membership and giving members a greater say in the operation of the club. Under the old rules a club officer or board member had to be nominated by a member of the Board of Directors in order to stand for election. Under the new rules any member can nominate any other member (including themselves) for any position. I bring this up because we need volunteers to fill the following positions: Vice President, four Board Member spots, the Bulletin Editor and SACA Storekeeper. Anyone interested in seeking election to one of these positions, or interested in nominating someone else (please contact them first and ask their permission) is encouraged to write me.

An anonymous donor has given SACA $10,750 for the preparation of a new website. Membership Secretary Dave Lewis has been working with an internet and graphics design firm in New Jersey to bring this project to fruition. Webmaster Lonny Claypool has been involved in the discussions from a technical viewpoint and Scott Finnegan has been very helpful in facilitating the transition. When the new site goes online we will be sure to tell everyone and hope that you will give it a visit.

The club currently has a site to post videos on YouTube, as well as a page on Facebook, these this can be reached at: http://www.youtube.com/SteamCars and https://www.facebook.com/pages/Steam-Automobile-Club-of-America/245361968920082

SPECIAL REQUEST! It would help our web presence greatly if we had additional photos or video to put on the website, YouTube or Facebook. It's hardly a secret that membership has fallen over the years and the internet is now the most important venue for attracting new members.

If any of you have skills with either Facebook or YouTube and would like to assist in administering the sites, please let me know and we'll get you on the team!

The repeated theme in this message is that I am calling for volunteers and participation. I perceive SACA to have a long running weakness of being too closely run by too few people. This not only limits the club abilities to what that few can manage, but it deprives many others of making a meaningful contribution and having a hand in passing it along to those who follow. I'd dearly love to see the club grow, sponsor more events, encourage more projects and be a lively force for many years to come.

That's all for this month, folks!

Chuk Williams Steam Speed America at Bonneville

Ken Helmick

It was about 2:40 P.M., September 6, 2014 on the Bonneville Salt Flats World of Speed event sponsored by the Utah Salt Flats Racing Association. Driver Chuk Williams was travelling about 140 mph during his first qualifying run in the Steam Speed America. Chuk recalls what happened next: “When I pulled the chute release, nothing happened. The T handle didn’t feel right. I tugged on it several times and then looked over at it to see if I could see anything wrong. When I took my attention away from the control of the car for those few moments, I lost control and that caused the accident. The accident investigator thinks that I let off the throttle before I pulled the chute, but that is not the case. I always pull the chute under full throttle and gradually ease off.”

Chuk, Robin Roarke and the automobile arrived at the Bonneville Salt Flats on September 2nd and were soon joined by their crew composed of SACA members Jim Anderson, George Knight, Nick Mesmer, Tom Stoecker, Myles and Val Twete. Tim Nye had set out for Bonneville back in early August to join the team but two months of rain arriving in one week made the dry lakebed wet, causing Speed Week to be cancelled and forcing the team to reschedule for September. As it turned out, this rain influenced events a month later.

In the weeks prior to arriving at Bonneville, Chuk tested the power plant about 8 times a day on the dynamometer, the little engine consistently producing between 77 and 80 HP. After arriving at Bonneville the engine was tested 6 more times while the burner was adjusted for the difference in altitude. The engine was originally built for the PSL (Planing Steam Launch) project. Both SACA members, Art Gardiner designed the engine and ground the camshaft while Jim Tangeman did the remainder of the machining. The PSL engine started life as a 1982 Chrysler 3 cylinder, 2 stroke outboard motor powerhead similar to that shown in Figure 1.

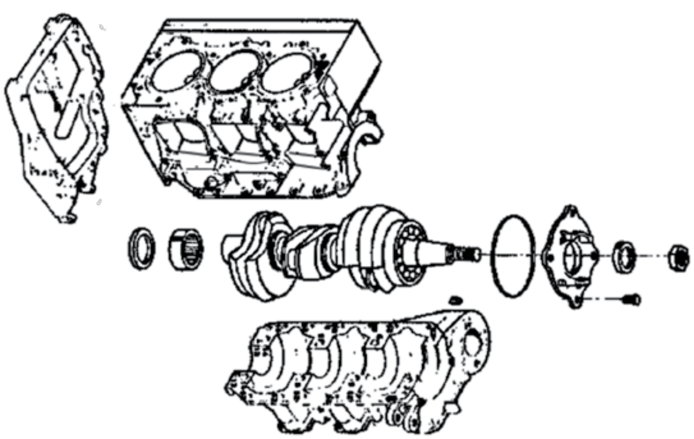


Figure 1

A new cylinder head and pistons along with International Harvester cylinder liners turned this two cycle ‘uniflow’ gasoline engine into a dual overhead cam, poppet valve, counter-flow steam engine. The cylinder head shown in Figure 2 is instructive as it provides a clear template for successfully converting IC engines to high pressure steam without significant compromise.

The exhaust poppet valve was of typical IC construction, the admission valve was constructed with a ‘reverse angle’ on the

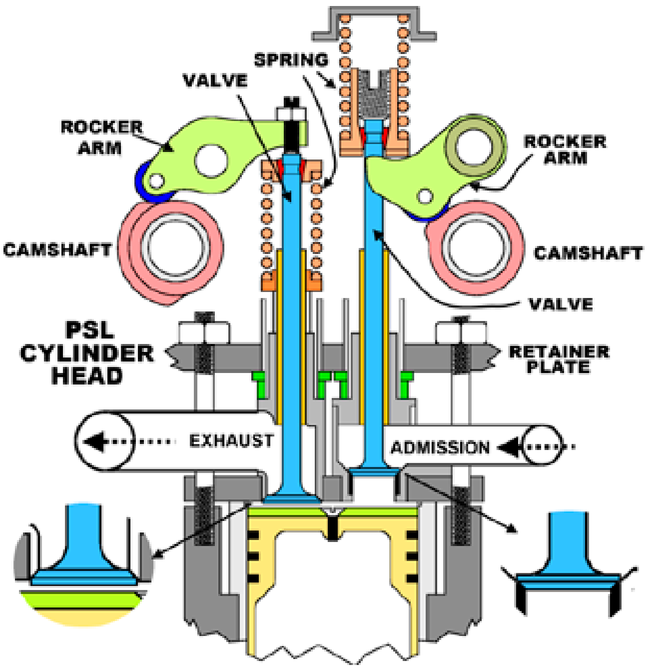


Figure 2

seat which caused the valve to be opened by being lifted rather than depressed. This admission valve design causes the high pressure from the steam generator to push the valve closed rather than open; this causes a tight seal and eliminates the need for an excessively strong valve spring to hold the valve shut against such pressure. The cylinder head is a flat plate with holes bored in the face that is bolted to the top of the engine. Each valve body is a separately fabricated unit that is held down the cylinder head by a retainer plate. Essentially it is a modular type of construction.

Photo 1. Chuk Williams photo

The cams are of sliding, multi lobe construction. They spin and operate the valves just like an IC cam, but by sliding the cam along its axis the operator brings different lobes into contact with the rocker arm. The lever at the top right of the engine in Photo 1 slides both the admission and exhaust cams, giving the engine a choice of cutoffs and reverse. At short cutoff valve acceleration can become very high due to the need to open and close the valve so rapidly. Art designed the cams to have a polydyne profile and limited peak acceleration to about 450 gees, which gives the engine a maximum design speed of 2400 RPM. A standard automotive clutch mounted to the rear of the engine allows Chuk to idle the engine while warming the steam chest and allows the engine to drive the feed pump providing water to the steam generator even when the car is at rest.

Myles Twete, riding as passenger in the push truck, noted that Chuk's car was fishtailing a bit even though not fully under its (forgive the phrase) own head of steam. Chuk naturally noted this as well; due to the heavy rains a month previously, the salt flats were not as bone dry as when he had run back in 2012. He compared the cars handling on the dry course as being like "running on rails" while the slightly damp salt was sticky and the experience was like "driving on slush"; he thinks there might even have been some rear wheel slippage and this was definitely seen on other vehicles. As the car approached 40 mph the push truck dropped back and the streamliner gained speed, Chuk was monitoring the superheater tube temperature display.

Lining up for the push start. Jim Anderson photo

A few months previously during testing on the dyno, the tubes had overheated and failed catastrophically, destroying the tube nest. Thanks to heroic efforts by the finned tube supplier and SACA members Tom Kimmel and Terry Stout the tube nest had been replaced in near record time and the testing resumed. See Figure #3.

By adding thermocouples to the tubes as well as in the steam flow, Chuk was able to determine that the tube tended to overheat ahead of the normalizer, which controls the steam temperature leaving the generator. This indicated that the burner had supplied more heat than the steam flow in the tube could carry away, a tendency that was aggravated when the engine was running at lower speed and drawing less steam. This is understandable when you consider the method used to feed water to the steam generator. The water to the steam generator is limited to 1200 PSI by a relief valve that transfers excess flow back to the feed water tank. An

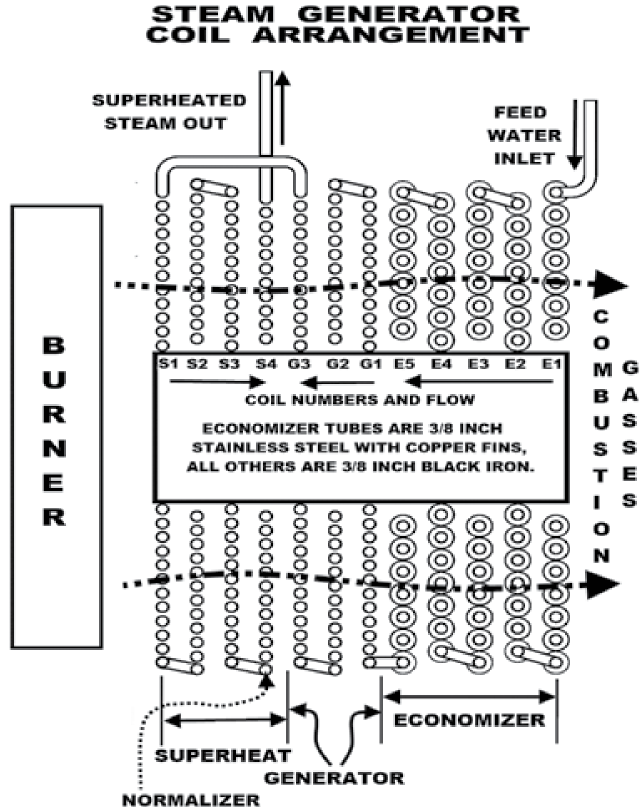


Figure #3

adjustable, pressure-compensated flow control valve regulates the feed water flow into the steam generator; this regulator was set by trial and error to match the flow to the burner's maximum firing rate. An optimum solution would be to develop a control system to vary the burner firing rate in rough proportion to the steam flow as it varies but this couldn't happen due to time and economic limitations; in any case, the engine was supposed to be setting a speed record so partial load considerations were less important than in a road car. During testing it had been found that the tube temperature rose too quickly as the car accelerated and the engine increased its speed slowly. George Knight suggested dumping the steam generator pressure from about 1000 PSI to about 150 as the tube temperature approached its upper limit; the sudden pressure drop would cause the temperature to

Tube Nest. Chuk Williams photo

drop rapidly. As it turned out, this worked and the vehicle performance wasn't badly affected because the tubing was still hot enough to produce pressure almost instantly once the dump valve was closed. During the first three miles of the run Chuk had to monitor tube temperature and periodically dump the steam generator until the engine speed was high enough to produce a safe rate of steam flow through the tube nest.

After the first mile the car was up to just a hair over 100 mph. The car still continued to fishtail a bit, the increasing airflow across the vertical stabilizer on the tail did not entirely keep the car steady. Nonetheless, the speed mounted; between the first and second mile markers the cars speed averaged nearly 115. Contrary to what one might expect; Chuk's goal during this run was not to set the steam land speed record. The rules established by the USFRA, Utah Salt Flats Racing Association, require new drivers to qualify at progressively higher speeds before being licensed to race up to the next faster level. For this run, Chuk was limited to a maximum speed of 150 mph. Ordinarily, after the run, he would show his time slip to the officials; they would upgrade his license to the next level, a maximum speed of 175 mph.

Just what constitutes the steam land speed record is a bit unclear as it depends on who defines the record.

In 1906 the Stanley brothers fielded a car driven by Fred Marriott which was the undisputed fastest car in the world, travelling at the amazing speed of 127.659 mph on Ormond Beach in Florida. In the 1980s SACA member Jim Crank assembled a steam LSR automobile. He originally intended to modify a GM 353 series two cycle Diesel engine into a uniflow steam engine until fate made him a different offer. At little more than scrap metal prices he had the opportunity to buy the remaining hardware of the Lear Steam Bus project. With the turbine from that project in hand (it was literally that small); he set about assembling a car. From Jim's description of the difficulties encountered trying to mate a very high speed turbine to a car's rear wheels, one sometimes suspects Jim is still debating whether the Jimmy Diesel might not have been the easier project. In 1985 driver Bob Barber took the turbine steamer to 145.607 mph at the Bonneville Salt Flats, where it is still considered the record for the mile. Others, however, claim the record is unofficial since the French Fédération Internationale de l'Automobile (FIA) wasn't present to certify the result. In 2009, the British Steam Car Challenge team, operating out of a dry lake bed at Edwards Air Force base in California took to the track in a vehicle weighing 6600 pounds, heavier than the Crank and Williams cars combined. After a couple of months tuning the car team member Charles Burnett made runs in opposite directions of 136 and 151 mph for a combined average of 139.843 mph. Driver Don Wales later set an average speed of 148.308 mph in the car. The FIA was monitoring this event and the Brits recorded team leader Burnett's time as the record for the more prestigious mile record and Wales for the kilometer. Pick your record. The British team covered the mile faster than the Crank/Barber team but did not record it for the mile. The American team recorded their mile but the FIA doesn't recognize it, though other groups do.

None of this was probably going through Chuk's head at the moment. From the start, Chuk had been holding the engine at about half throttle. Between miles 2 and 3 Chuk still had to dump steam to hold the superheater tube temperatures in check, yet even while venting the steam generator perhaps six times in 3 miles and throwing away energy he covered that mile at an aver-

Jim Anderson photo

Chuk Williams photo

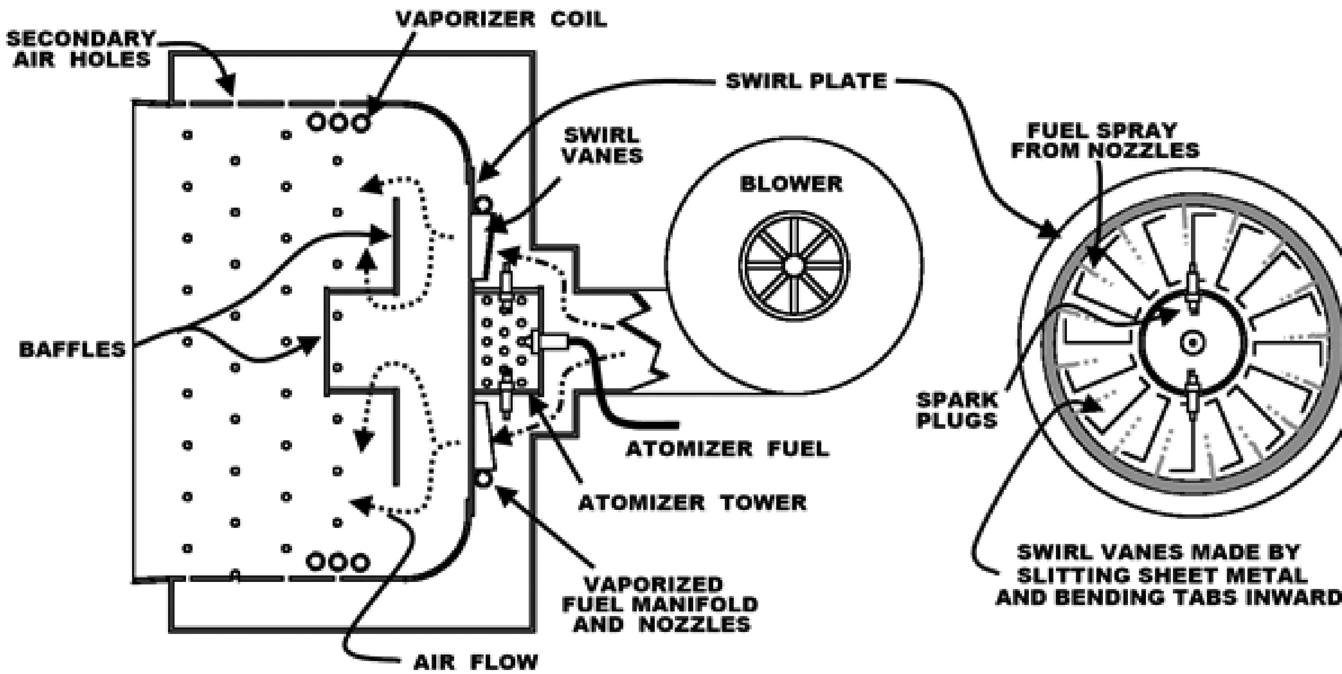


Figure #4

age speed of almost 122. Passing the 3 mile point he opened the throttle to somewhere between two-thirds and three-quarters and the increased steam flow caused the superheater tube temperature to stabilize. While accelerating Chuk occasionally monitored his steam generator combustion gasses via an O2 sensor display; if the fuel/air mixture became a bit rich or lean he would adjust it via a remotely operated needle valve in the main fuel bypass line controlling fuel to the burner. This burner was loosely based on a variety of jet engine combustion chamber with some modifications to make it suitable for backyard construction and operation on the ground.

The steam generator was heated by a post-mix vaporizing burner of receiving air from a centrifugal fan that delivered over 600 CFM at 10 inches of water pressure (see Figure #4). The air is delivered to a can that covers the back and sides of the burner and from here it is distributed to the combustion chamber. The primary air is deflected outwards by a disc in the back of the combustion chamber; the disc having 16 tabs slit into the disc with radial, even spacing. The tabs are bent inwards to form vanes which cause the airflow to swirl in a circular pattern around the combustion chamber. An atomizer tower seated on the back of the disc, facing the air flow, contains spark plugs and an atomizing fuel nozzle. This atomizing tower is used to initially light off the burner, with the blower running at low speed. A repurposed aircraft windshield washer pump delivers gasoline to the atomizer nozzle at about 4 gallons per hour.

In the 30 to 45 seconds it takes the atomizer assembly to heat up the blower speed is increased as the main fuel pump capable of delivering over 25 gallons per hour is turned on with the bypass needle valve fully open. This fuel passes through a vaporizer coil in the combustion chamber where it is vaporized and superheated to about 900 F. The hot gasoline vapor is then directed to the fuel manifold resting on the back of the swirl plate; this manifold has 16 jets, one per swirl vane, through which to pass the vaporized fuel into the air stream.

Secondary air vents in the combustion chamber casing allow further air to mix with the combustion gasses towards the end of the combustion chamber; this secondary air flow helps cool the housing and provides for complete combustion of any unburned fuel. During this time the electrically driven feed water pump is cycled on and off manually to provide just-sufficient cooling flow. The bypass needle valve is slowly closed while monitoring the fire via a video cam. As the maximum firing rate is reached the O2 sensor meter is used to trim the air/fuel ratio for the optimum blue flame burn and the electric water pump is left to run constantly. The engine is started during the fire-up procedure with the engine driven water pump providing additional water in proportion to engine speed.

One variable that Chuk didn't have to fiddle with was the steam temperature going into the engine; it was rock steady at 800 degrees F. As noted earlier, the steam generator was fitted with a Doble-like desuperheater (or normalizer). This device consists of a small tube that bypasses a small flow of cool pressurized water from just before the relief valve to the middle of the superheater via an electronically actuated ball valve fitted with an orifice to restrict flow. Only a small amount of water is necessary to greatly influence the temperature as water absorbs quite a bit of thermal energy when vaporized. Art Gardiner commissioned SACA member Don Beck to develop the control system to operate the desuperheater. Don built a micro-computer capable of controlling the steam temp using Picaxe components that he assembled himself. His controller did a superb job of controlling the output steam temp, keeping it within 10-15 degrees either side of the 800 degree setpoint. Don's controller did such a good job because he had programmed it with a rate-of-change algorithm that varied its response in step with the rate-of-change inside the steam generator. Chuk's assessment was that "It did a helluva job!"

Chuk averaged almost 136 MPH over the fourth mile but the damp salt was still giving him problems and combined with the

continued from page 9

need to monitor tube temperature, he had experienced difficulty keeping the car on a straight heading. The tach was showing 1750, so knowing he was close to his target speed of 150 and seeing the 4 mile mark flash by-he pulled the chute. The chute handle moved perhaps half an inch-it takes about an inch and a half to release the 'chute. The car was still accelerating as it is unsafe to let off the throttle before deploying the 'chute, this evolution was similar to the way navy carrier pilots use afterburner when making an arrested landing. Chuk pulled on the handle a couple more times as the car covered the next mile in just a hair less than 25 seconds. He had completely rebuilt the parachute release system before leaving Florida-replacing both cable releases and making sure everything worked well. After installation tests had been very successful, the cables moved easily and the chutes deployed readily. Given that the release mechanism had been thoroughly tested and proven, he was very puzzled as to what have gone wrong.

Chuk looked over to inspect the tee handle and took his eyes off the road for a fateful moment. As later reconstructed, the car took two abrupt zig-zags at this point. Since the steering wheel travels one turn from lock to lock and the wheels turn no more than 5 degrees maximum, there can be little doubt that the slick surface was magnifying his momentary lapse. At this point a crash investigator found no evidence of the car being on the track for a distance of between 1/16 and 1/8 mile; video shows the car airborne at this time as it rolled in midair. When the streamliner touched down it landed inverted and tail first, then it appears to have made four more zig-zag rolls. Then the car turned perpendicular to its direction of travel and started to "pencil roll" about twice per second. Chuk recalls his vision narrowing and a bright white light enveloping him, just as do jet fighter pilots when they enter a gee-induced blackout. The accident investigator had done tests with accelerometers and based on his experience the spinning vehicle was pulling somewhere between 7 and 10 gees; pilots usually black out at about 9 but Chuk wasn't wearing a gee suit nor intentionally tightening his abdominal muscles and grunting to delay blackout. The heavy electrically driven feed pump and CO2 bottle travelled more than 1000 feet from the crash site, indicating the forces involved. It is unclear how many times the machine rolled but it came to a stop about a half mile from where it went airborne. The cars frame and roll cage were bent by the forces they encountered and the clean-up crews reported they had picked up some 1600 pieces of debris over a half mile stretch.

As rescue workers arrived they found Chuk conscious but with no memory of what happened, natural with a blackout. He was promptly evacuated by helicopter to a hospital in Salt Lake City where it was found he had a broken arm, broken fingers, and compression fractures in the vertebrae of his back and a hemorrhage behind his left eye that caused some concern for a while. He and many observers feel he is lucky, but sometimes you have to make your luck. The construction standards required to run at Bonneville are high and strictly enforced to ensure cars are not only safe to operate but provide protection in an accident. Chuk studied cockpit design notes from Tom Burkland, an individual well-regarded amongst the Bonneville crowd for his knowledge of safety issues. Mr. Burkland recommended a close fitting cockpit and roll cage, under high gee forces the driver will be pushed into the structure almost immediately before having the opportunity to build up great speed inside the vehicle. Chuk's car was tailored to fit him with a very tight fit and the helmet having about 1 inch clearance from the cockpit frame on either side. Despite the broken bones Chuk had no bruises anywhere on his body, testament that the close fitting design prevented him from thrashing around inside the cockpit. As a guess, the broken bones were probably due to very extreme gee forces caused when the car impacted the ground; it appears such forces can be strong enough to cause bones to break under their own artificially enhanced "weight" even when the human body is well protected from impact.

It is axiomatic that accidents rarely have a single cause, usually there are contributing factors. In this case these factors seem to include the relatively slick track conditions, the failure of the parachute to open, Chuk's lack of experience driving a streamliner, taking eyes off the track when the chute failed and a power plant that distracted the driver too much.

As steam nuts, the question is, would the car have broken the existing record? Consider Figure #5.

The streamliner passed the 5 mile marker at 147.367 mph having covered the last mile at an average speed of 144.094 mph. This is about one and a half mph slower than the Crank/ Barber Steamin' Demon record of 145.607 set at Bonneville in 1985. While it is true that the FIA doesn't recognize this record, it also appears the Bonneville folks don't always give the FIA records much truck, as Huck Finn would say. Although the Brit-

Jim Anderson photo

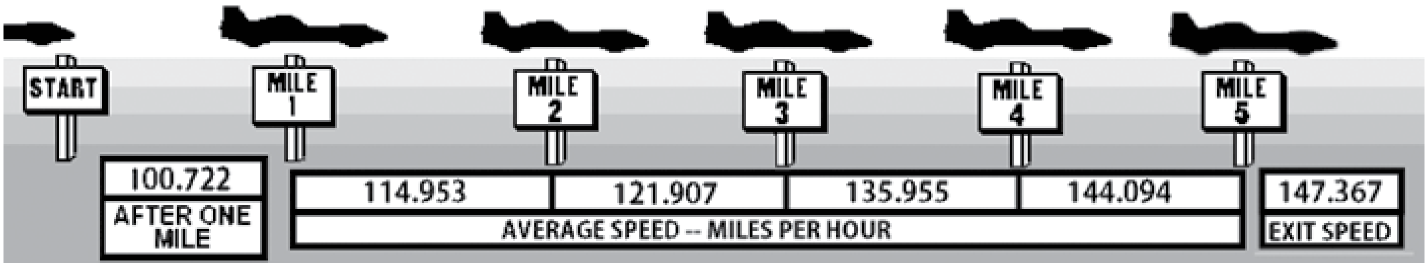


Figure #5

ish Steam Car Challenge team recorded an FIA sanctioned record of 139.843 they also averaged 148.308 over the same course but recorded that speed for the kilometer.

What has to be considered is that Chuk never used full throttle on the run, he was restricted to not passing 150 mph and he was trying to abort the run a mile early due to track conditions. But even with only about 65 to 75 percent throttle his average was within about 4 ¼ mph of the best British effort. During the many dyno runs the engine performed very consistently, giving a good idea of what it would do on the course. While tuning the engine at Bonneville it behaved very much as it did in Florida and during the run on the salt Chuk reports that the readings were consistent with the dyno. As mentioned previously, the PSL engine consistently delivered from 77 to 80 HP at 1800 RPM on the dynamometer. At 1800 revs the car is geared to travel 151 mph; Chuk recalls the tachometer reading between 1750 and 1775 during the last mile. The engine is rated at a top speed of 2400 rpm based on the valve acceleration, although this figure is very conservative for an overhead cam design and reflects industry practices for pushrod engines.

Art Gardiner calculated that the car used about 60 HP to reach 150 MPH, which agrees nicely with Chuk's estimate that he was probably a bit below 75% throttle. The car weighs 2000 pounds and Chuk estimated a frontal area of 8.5 square feet, with this data Art calculated a top speed of 170 to 180 MPH. Wishing to check this but being too lazy to do the math myself, I had found a calculator on the internet that estimated the horsepower needed to produce a given speed. I had previously estimated the cars weight to be about 2000 pounds (it is SO much better to be lucky than skillful!) and about 9 square feet frontal area based on a couple of photos. I admit my area estimate may be a bit less accurate than those of someone who can walk around the car with a tape measure but it never hurts to be a bit conservative. Assuming a very good, but not stunning, drag coefficient of 0.23 (conservative, remember?) the calculator estimated about 167 to 169 mph. This is a bit below Art's calculation based on better data but still at the lower range of his calculations and well above the record. If I make the frontal area 8.5 and assume a nicer drag coefficient of 0.21 the speed comes out right in the middle of Art's calculations at 175 to 177 mph.

Yes, based on the numbers the Steam Speed America streamliner seems easily capable of besting the current record. Its presumably "lower technology" piston engine appeared to have fewer teething problems and allowed the car to challenge the current record on a less than ideal surface while the driver was trying to deploy the chute. I fully expect this to become one of those never ending "what if" arguments, although given the size of the steam community I don't expect to see any History Channel episodes committed to it. But I'm president of the Steam Automobile Club of America; our British counterparts might have a different take. Figuring the steam automotive community actually needs a bit of controversy now and then to motivate progress, I asked Jim Crank for his opinion because he constructed one of the land speed record holders and because Jim almost always provides a quote guaranteed to provoke discussion if not outright feuding:

"As far as I am concerned, my car was the first steamer to break the 1906 Stanley record and in doing that I was, and am, satisfied. Chuk's car had much better streamlining than mine; but as Fiberfab was providing part of the funds, I was obliged to use their body."

"This long standing question about who owns the land speed record in MPH for steam is something I couldn't care less about, and it may still be my car. We knew about the FIA; but I choose to ignore them as their opinion is not of interest and doesn't mean or contribute anything. Consider the absolute disaster they have made of Formula One racing, blundering micromanaging in the worst possible way. If the Brits choose to put emphasis on an FIA stamp of approval, who is to question their decision? My thought was that holding an FIA record doesn't begin to pay for building and running a car, so who needs them?"

"Except for very poor and dangerous salt conditions, it is obvious to me that Chuk definitely could have taken the land speed record for steam by a nice margin and I certainly applaud his effort. Just thank heavens he wasn't injured even more considering the magnitude of his accident. It seems no one else has, or soon will have, a running car to contend the record."

And as for Chuk? He commented: "I cannot tell you how much I regret losing my damn car….*our* car because so many people contributed money to build it."

"Tis a real shame our time at Bonneville turned out the way it did. The car was pulling strong all the way through the run, even though I was dumping steam to control the tube temperature and I wasn't giving it full throttle. We had at least 10 mph left at the end of the run and possibly as much as 20 mph or more!"

"I feel very lucky to come away from this with a broken arm, a couple of broken fingers, and three fractured vertebrae. If any of my safety gear had failed, the ending would have been very different indeed. Many, many heartfelt thanks go to the crew who literally picked up the pieces, loaded everything into the trailer, and drove the rig to Tom Stoecker's place in Illinois for safe keeping. Robin Roarke, Jim Anderson, Tom Stoecker, Nick Mesmer, George Knight and Tex Deville - all gave invaluable time and energy to even make this attempt possible. Also, many thanks go to Myles and Val Twete for providing support and jumping in to help."

"To all our friends-thank you for your endless support!" <|>

2014 Class B — PEBBLE BEACH CONCOURS d'ELEGANCE® — Early Steam Cars

PEBBLE BEACH, Calif. (August 17, 2014) --The event marked the centennial of Maserati and included first-time features of Ruxtons, the first American passenger cars with front-wheel drive, and Streamlined Tatras, technological wonders built in Czechoslovakia. A jaw-dropping display of 20 Ferrari 250 Testa Rossas was placed at one end of the show field, and cars exhibiting the curvaceous coachwork of Fernandez et Darrin posed at the edge of Carmel Bay. There were also special classes for Postwar Rolls-Royce Phantoms and Eastern European Motorcycles, and a display honoring cars that participated in the 1914 French Grand Prix.

First conducted in 1950, Pebble Beach Concours d'Elegance® (www.pebblebeachconcours.net) has grown to be the world's premier celebration of the automobile. Only the most beautiful and rare cars are invited to appear on the famed 18th fairway of Pebble Beach Golf Links®, and connoisseurs of art and style gather to admire these masterpieces.

Although this official press release does not mention the Special Class for Early Steam Cars, we have included material from the programme with remarks and photos by Karl A. Petersen unless noted.

Class B Early Steam Cars

B-01

1892 Philion Road Carriage*

National Automobile Museum (The Harrah Collection), Reno, Nevada

Achille Philion was a traveling showman known as "The Marvellous Equilibrist and Originator." He began working on his steam carriage in 1887, and took the unfinished machine with him wherever he went, to work on it as time allowed. The carriage was first run in 1890, was patented in 1892, and was displayed at the 1893 Chicago World's Fair. This is the only example of the Philion steam carriage ever built. Steam was a common motive power then and coal was used as fuel (this was later changed to oil); a chauffeur sat behind the boiler and was responsible for maintaining steam. The carriage could be steered from either the front or the rear, and a speed of 8 mph was possible.

On display only and not judged. This is straight from the museum placard which continues: Mr. Philion's steam carriage appeared in the movies "Excuse My Dust" with Red Skelton, and "The Magnificent Ambersons" with Orson Welles. Donated by: Harrah's Hotels & Casinos. Adopted by: John R. Kelley, Jr., III.

B-02

1900 Skene Spindle Back Currier Cameron & Company Runabout

Richard C. Paine Jr. Automobile Collection Charitable Trust, Camden, Maine

The J. W. Skene Cycle Company in Lewiston, Maine, built their first steam car in 1900, and advertising that year claimed it had 125 cars under construction at its factory and a showroom in Springfield, Massachusetts. But throughout its one year of existence, the company was constantly in search of investors and capital, and it quickly went out of business. Skene boasted that every part of their light steam buggy was made at their works, which distinguished it from many assembled machines. The design was conventional, using a vertical 2-cylinder 5-hp engine, single-chain drive, and tiller steering. An unusual feature was that a single-passenger body could be fitted as well as the typical two-passenger Stanhope. This is the only surviving Skene steam car in the world.

The car is at the Seal Cove Automobile Museum in Mt. Desert Island, Maine. The museum notes, "The Skene was acquired in England by the Richard C. Paine Jr., Automobile Charitable Trust in 2010, and was damaged in transportation requiring its complete restoration. One of a few Maine built automobiles known to

exist, the Skene was originally owned along with at least one other by an American citizen who came to Europe in 1917 to fight in the first world war and was killed. The cars were then locked up in a barn, and although known about, were not available to purchase until the early 1970's, Leslie Maynard Leighton, the noted Maine steam car authority, secured the cars for an English friend who arranged for the Skene to go to Reg Parsons in England for restoration; Mr. Parsons subsequently purchased the car. The Skene has participated in several London - Brighton runs, and has been invited to be shown in August, 2014, at the Pebble Beach Concours d'Elegance."

The museum photo above shows the car as it arrived at the Museum last May after extensive restoration by Mark Herman of M.S. Herman & Company.

The car was invited for display and not concours judged.

B-03

1902 Toledo Model A Stanhope Runabout

Nick Howell, Penzance, England

Toledo Model A presented by Nick and Chris Howell with your editor strolling by on the left with the briefcase. (Photo: Kent O Worth)

Introduced in 1901 at the New York Auto Show by Colonel Albert Pope's American Bicycle Company built the Toledo, the Toledo was called it the "Billings," after its designer, Frederick Billings. Later that same year the company, renamed the International Motor Car Company, produced two models, the Toledo and the Westchester, but by the end of the year, it was only producing Toledos. In 1902, a companion model, similar with an internal combustion engine, was offered starting, and by 1903 the steam cars were no longer offered. The Pope Motor Car Company took over in 1903 and vehicles built thereafter were sold as the Pope-Toledo.

This dry historical note is merely deep background material for fascinating stories of the acquisiton of the car and its recent activities shown in this Bulletin.

B-04

1905 White Model E Touring Runabout

Michael Ersland, Chickasha, Oklahoma

In 1898 Thomas H. White, founder of the White Sewing Machine Company, purchased a Locomobile steam car but found its boiler unreliable. His son, Rollin H. White, improved the design and then patented it before persuading his father to allow him to use a corner in one of his buildings to build the new automobile. This became the White Motor Company of Cleveland, Ohio, which built what were arguably the finest quality and best performing steam automobiles in the early years of the twentieth century. Rated at 10 hp, this Model E's two-cylinder engine was very powerful for the two-seat runabout body. This particular car is known as "Black Bess." Its former owner, F. C. Fenner of Los Angeles, drove it in the first Los Angeles to Phoenix road race (also known as the Cactus Derby) in 1908. Black Bess was one of two Whites in a field of seven cars to undertake the trip.

This car has been known for its extensive demonstration and tour work, a real powerhouse, and the work that takes to keep it going is always interesting. I expected to see lots of evidence of this history, but after looking it over and standing downwind of the car, all I could smell was fresh paint instead of cylinder oil. It has just been white-glove restored for this concours! It is not a "display" car like some others in the class, but received full judging and won best of class.

B-05

1907 White Model G Runabout Prototype

Mitch & Wendy Gross, Scarsdale, New York

Stamped with serial number “1 GR,” this car was the first White Model G built and was part of the White Steam Car display at the 1907 New York Auto Show. In 1907 the Model G was the company’s largest and most powerful car with a 30-hp compound engine powered by superheated steam at 750 degrees Fahrenheit. The Model G chassis was originally designed to provide larger passenger capacity and comfort for the touring and pullman body styles, but with this lighter runabout body it is a very fast performance vehicle. A total of 902 Model Gs were built, but only a few were runabouts. Today only five Model Gs remain, and this is the only known original runabout. A 1907 White steam car became one of the first vehicles in the White House when President Theodore Roosevelt allowed the Secret Service to use the car behind his horse-drawn carriage.

B-06

1908 Stanley Model K Semi-Racer

Richard C. Paine Jr. Automobile Collection Charitable Trust, Camden, Maine

Built by the Stanley Motor Carriage Company of Newton, Massachusetts, this is one of only three surviving Model Ks in the world and the only one that has been carefully preserved. It is the road-going version of the famous 1906 Stanley that set a land-speed record. On January 26, 1906, at Ormond Beach, Florida, the rocket-shaped Stanley broke the two-miles-in-one-minute barrier at a speed of 121.6 mph. In the one-mile trials that followed, the car did the mile in just over 28 seconds, or 127.66 mph. The steam-powered Stanley Rocket held the record as “The Fastest Car in the World” from 1906 to 1910, when Barney Oldfield broke the record in a gas-powered Mercedes. Stanley built 25 of these 30-hp Semi-Racers, which sold for $1,800 each.

B-07

1909 Stanley Model R Gentleman’s Speedster*

Stan Lucas, Long Beach, California

This car is one of eight Stanley Model Rs left in the world. Properly called the Stanley Steam Car (the Stanley brothers hated the name Stanley Steamer), the Model R Gentleman’s Speedster was one of five models listed in the 1909 Stanley catalog. It sold for around $1,500 with or without an optional convertible top. Its 20-hp, twin-cylinder engine is simplicity itself with only a dozen or so moving parts. It will cruise at over 50 mph and climb steep hills with ease. Steam powered cars were simple to drive with no changing gears and impossible to stall, but the biggest disadvantage was the starting process which could take 30 minutes and involved a blowtorch rather than a key. This Stanley has been cared for in the current owners collection for 16 years and is used often.

B-08

1902 White Model B Stanhope

Tom Goyne, Denver, Colorado

This car was considered the most advanced American automobile of 1902. It far outperformed other steam and electric cars and was generally preferred for its silence, smoothness and reliability. Two American presidents, Theodore Roosevelt and William Howard Taft, were owners of White steamers. To propel the car, a gasoline-fired steam generator supplies up to 450 PSI of steam at 800 degrees to a 2-cylinder engine delivering 6 hp. The steam generator is unique in that the steam runs through a se-

ries of spiral coils rather than boiling in a large cylindrical pot, which makes it very quick to get steam up. It is built exactly as a horse-drawn carriage would have been in 1902 with a strong lightweight body of hickory and maple. Only ten complete Model B Stanhopes remain and only two or three can be driven. This car has been in many famous collections over the years including those of Lindley Bothwell and D. Cameron Peck.

B-09

1904 Turner-Miesse 10 HP Rear Entry Tonneau

Jack & Kingsley Croul, Corona Del Mar, California

Jules Miesse, of Brussels, created his first experimental steam car in 1896, and by 1902 the three-cylinder Miesse steamer was being built under license at Wolverhampton, England, by Thomas Turner and Company. The Turner-Miesse engine is set transversely in an armored wooden chassis with the cylinders mounted horizontally. By 1907, Miesse in Belgium had abandoned the production of steam cars in favor of a new petrol-engined model, but Turner of Wolverhampton continued to build steam cars of the original pattern until 1913. This original example of the 10 hp model has had five owners from new. <|>

Clean Sweep Finish for White Steam Cars, 1-2-3

Karl A. Petersen

Of the eight cars fielded, all the White cars finished one-two-three which reminds us of 1905 headlines when the cars were sweeping track records. In this case, the owners had plenty of time to prepare, but there are always those last minute trackside jitters.

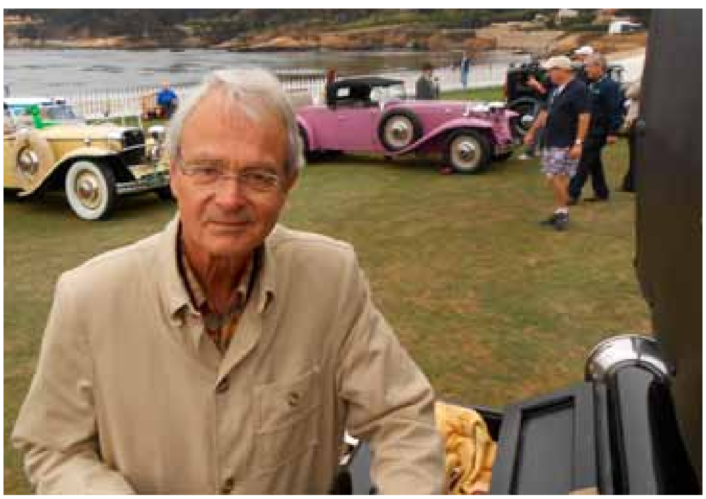
The Class B: Early Steam Cars Class Winners are:

First Place in Class went to 1905 White Model E Light Touring Body, Michael Ersland, Chickasha, Oklahoma.

Here are Susie Ersland and son Ryan finally giving in to a picture which does not feature their fine Black Bess, the car.

As mentioned, this car had just undergone a thorough restoration and the three Erslands bringing it from Oklahoma were justifiably pround of their work. Here, Mike and Susie Ersland, in a daze, gaze over the crowd as they motor towards the award stand.

Second Place in Class was taken by the 1902 White Model B Stanhope Steamer, Tom Goyne, Denver, Colorado. There was a little firing-up drama with smoke and flames. Here Tom tolerates



an interruption as he polishes off a little soot on his copper tank before the judgeing. It is not the first time Tom has been given a top award for a White at Pebble Beach, and deservedly so.

Third Place in Class was acheived by the 1907 White Model G Runabout Prototype of Mitch and Wendy Gross, Scarsdale, New York.

Not just a White owner/driver, you may remember Mitch and Wendy's 1905 Stanley Model CX on display at the Stanley Museum and on the cover of the *Bulletin*, Vol. 22, No. 2 of 2008. Sporting matching period dusters, the owners were in great demand for photos throughout the day.

As the sun comes out, Mitch Gross and Jay Leno compare White experiences between interruptions for photo shoots.

Here Mitch and Nick Howell talk about Nick's impending drive to the rim of the Grand Canyon in the Toledo.

This provides a nice lead-in to another award. The concours is by invitation and many special classes are set up each year such as this one for Early Steam Cars. Besides the obvious three awards given in each class, there are a dozen awards with special topics, such as the finest open car. The Chairman's Award, however, when given, is at the discretion of the organizers and has no precise requirements. This means you can't "try" for it.

Each owner's preparation of their car and fielding it at Pebble Beach is a grand story, but the buzz was a little bigger on one car and on the quest of a couple of brothers. There were plans for an historical re-enactment of the first drive to the Grand Canyon. Their blog has been heavily followed for some months, what with changing out a boiler and, oh, surprise, an entire burner and the piping and the problems with crating and just about missing the shipment and twelve (TWELVE) days in customs while they x-rayed the crate (!!) and so on. Just think of the changed arrangements for vehicles, transport, motels, crew...who needs food? Perhaps the assistance of Jay Leno in opening his garage and staff to smooth the road picked up a little more interest.

So, the **Chairman's Award** was presented to Nick Howell, Penzance, England, with his 1902 Toledo Model A Stanhope Runabout and the joy was shared by his brother Chris, by all the readers of the Blog at toledosteamcar.com, and, of course, by Jay Leno, Bernard Juchli and all the crew at the Garage. <|>

Photo: Jeb Fach copyright.

To the Canyon, slowly

HOW DO YOU GET TWO BRITISH BROTHERS, A FEW CARLOADS OF STRANGERS AND A 113-YEAR-OLD CAR DOWN MILES OF DIRT ROADS TO THE GRAND CANYON? WITH PATIENCE. AND TEA.

Amy B Wang, The Republic | azcentral.com

About midway into the journey — after the transatlantic passage, after the reassurance from one of Jay Leno's mechanics, after the tires were caked in mud, while the two drivers were behind a trailer in the woods changing into their pants and suspenders — the 113-year-old car caught on fire.

Up until then, everything had been fine, really.

The trip, while a bit unusual, seemed reasonable. Fated, even: This wasn't the car's first time to make the drive.

The 1901 Toledo was a rare beast known as a steam car, powered by a burner, a boiler and a steam piston, built before internal-combustion engines were the world standard.

British collector Nick Howell had purchased the Toledo at a 2004 auction. Not long after, he had discovered that it was the very same car that had made the first automobile trip to the Grand Canyon more than a century earlier — a groundbreaking journey that had taken days and been described in at least one history book as "a trip from Hell."

Halfway around the world, more than a century later, Nick had been enthralled by the discovery. Naturally, there was only one thing to do: Ship his car back to the United States and make the same trek.

Chris Howell takes pictures with his iPad as his brother, Nick, fiddles with the engine of their 1901 Toledo steam car. The two plan to recreate a historic drive from Flagstaff to the Grand Canyon in the car, which made the same trip in 1902. (Photo: Amy B Wang/The Republic)

After all, Nick is fond of saying, cars were meant to be driven. He phoned his younger brother, Chris, in Buckinghamshire to ask if he would accompany him. Chris readily agreed.

Nick Howell and members of the support crew put the Toledo steam car in the trailer after they completed the historic drive from Flagstaff to the Grand Canyon. (Photo: Mark Henle/The Republic)

The idea soon captured the imagination of a small but passionate group of outdoors and car enthusiasts. Jay Leno offered them space in his garage. Arizona trails experts volunteered to map and scout the route in advance so the brothers could follow as closely as possible the original route. Others stepped up to provide food breaks — with tea — and to trail the Toledo to support it.

None of them had ever met Nick or Chris Howell. But over weeks of mass emails, the Howells and the Flagstaff crew assembled a detailed itinerary that described even the slightest turn.

As interest in the trip grew, a photographer doubled as public relations person, insisting that the brothers be able to "have the adventure" and maintain the sense they were doing this alone. At least one volunteer reassured everyone the trip would go smoothly. After all, the roads today were in far better condition than they were 112 years ago, and the Howells would have far more support than the team had in 1902.

By the time the group converged on their first stretch of dirt road below the San Francisco Peaks, they were a full campaign.

The steam car was fully refurbished. They were driving almost half a dozen chase vehicles with four-wheel drive. The group included one of Jay Leno's mechanics, a steam car expert who was close as one gets to a certified maintenance guy on a 1901-model anything.

They had rain gear, water for both human and vehicular consumption, fully charged cell phones and a generous supply Tetley tea. How could the trip possibly fail?

But there they were, on the morning of the second day, with the air smelling of forest drizzle, fresh mud and, then, the unmistakable scent of burning car.

Day One

The convoy gathered in the forest just outside Flagstaff at 7:30 a.m. Tuesday is a sight: a ragtag group surrounding Nick and Chris Howell, observing as the British brothers gingerly unloaded their shiny black antique vehicle into the clearing.

It was there, at the junction of Highway 180 and forest road 151, that the Howells would begin the trip.

Nick, 63, had spent nearly eight years meticulously restoring it. In the cool Flagstaff morning air, he donned a long blue lab coat over his dark T-shirt to fiddle with the steam car's engine and — with his mop of white hair and spectacles — looked not unlike a cross between Bill Gates and Bill Nye.

Chris Howell gingerly unloads a 1901 Toledo steam car from a clearing in the forest near Flagstaff, at the junction of Highway 180 and Forest Road 151. (Photo: Amy B Wang/The Republic)

While Nick tinkered with the steam valve, Chris joked with the handful of people who gathered to send the brothers off. ("Did you bring the lariat so we could attach the horses?") Chris, 61, wore jeans and a black t-shirt with a picture of the Terminator that read "I'll be back." His booming laugh echoed through the woods. He snapped some pictures with an iPad. Occasionally he pretended to kick his older brother in the pants.

As Nick continued to make adjustments to the engine, Chris plopped one device after another on the steam car seat, gadgets that would have seemed alien in 1902. There was a GoPro camera with a Gorilla clip. Each had a two-way radio "so we can say 'we're lost!' " and a GPS with the route pre-programmed.

"We just have to follow the blue line," Chris said. "It's not the yellow-brick road. It's the blue line."

At last, with the boiler cooperating, the car began emitting a high whistle and a cloud of white steam.

The preparations were complete, save one thing. The brothers disappeared quickly behind their trailer to take off their clothes.

In a moment they returned, in heavy brown pants, suspenders and tweed vests.

Of course they were always going to change into period costumes, Chris said. They wanted to stay true to the spirit of the 1902 drive. The found some historically appropriate, turn-of-the-century clothing on the Internet.

"You can't sit here in jeans and a T-shirt with Arnie in front!" Chris cried.

The blowing steam created an even, high-pitched whistle as the car chugged away from the clearing at cruising speed, 10 mph.

"Is that tea brewing over the hill yet?" Chris joked. Then, as the car nearly disappeared from sight, one of the brothers yelled: "Yahoo!"

0.1 mile out

The Howell brothers made frequent stops because of steep inclines and their "temperamental" vehicle. Here, Chris Howell examines the engine of their 1901 Toledo steam car. (Photo: Amy B Wang/The Republic)

Just out of sight of the bystanders, the Howells stopped. The steam valve had popped open, the equivalent of a modern-day car accelerator jamming, Nick said.

"A 112-year-old," said Chris. "It's a bit temperamental."

The steam valve jammed repeatedly over the next mile, owing to the incline of the first part of the road. With each attempted restart, huge plumes of white steam billowed from underneath the Toledo.

"We'll be here all day," said Brian Blue, a Flagstaff resident who, along with about eight others, volunteered to trail the brothers and help support the trip. In Blue's Jeep were 30 gallons of water, a bicycle air pump and a variety of other equipment.

"We're trying to double their time," Chris said with a laugh.

"They" meaning Los Angeles photographer Oliver Lippincott and company. They were the first ones to do this trip, in this car.

The year was 1902 — the Toledo was practically factory-new then — when Lippincott had planned the outlandish journey: driving the roughly 70 miles from Flagstaff to the South Rim of the Grand Canyon. He had been accompanied by a local guide and two reporters from the Los Angeles Herald.

The first automobile party arrives at Grandview Point on the Grand Canyon's South Rim on Jan. 12, 1902. Oliver Lippincott is driving. (Photo: GRAND CANYON NATIONAL PARK #05122)

They had estimated the trip at seven hours, so they packed no food, and of course, they had no iPad.

The actual drive had taken anywhere from two day to two weeks, depending on which account of the journey is to be believed. They feared for their lives, hallucinated images of wild animals, ran out of water. Some sought refuge in a hunter's cabin along the way. Disoriented with hunger, one of them dreamed of a turkey dinner and flew into a murderous rage upon discovering an inaccurate mileage marker on a road sign. He walked the last 18 miles of the route.

Their stories can be found in the breathless, abundant prose of the 1902 style. At least one history book records it as "a trip from Hell."

The Howell brothers, in 2014, had few such worries.

Alan Travis, a local antique car enthusiast, and Arnold Schmidt, a California resident and steam car specialist who met the Howells through Tom Martin, were part of the chase team. Schmidt reassured the bunch that once the engine got warmed up, it would "be a better car."

"Right now with all that white steam coming out, it's not efficient," he said. "As soon as that white stuff goes away, it'll be twice as efficient."

Nick (right) and Chris Howell continue on their attempt to recreate a historic drive from Flagstaff to the Grand Canyon in a 1902 Toledo steam car -- the very same vehicle that made the original trip 112 years ago. (Photo: Mark Henle/The Republic)

For the time, though, Travis and Schmidt agreed it would be best to hitch the steam car to a 21st-century vehicle so that it could make it up the initial incline. Five minutes later, the Toledo was strapped to Blue's Jeep. In the rearview mirror, Blue could see the brothers are grinning, but the only communication was by two-way radio.

"Do you have your own brakes or should I stop on an incline?" Blue asked the brothers. "Over."

"We have brakes, obviously, but it'd probably be sensible to stop on an incline," Chris said. "Over."

Blue: "Roger that."

There was a long pause, and then Blue radioed again.

"Did I mention my towing rates? Over."

"Uh, I didn't hear you. No copy."

5.5 miles out

The steam car continued to stall at each significant incline. Each time, Chris hopped out of the vehicle, pushing the Toledo from behind while his brother tampered with the car. After a slow jog, Chris would hoist himself into the moving vehicle.

"I started this at 220 pounds," Chris said. "Maybe I'll end up at 180!"

Despite the challenges, the brothers and the support crew have fallen into an easy banter over two-way radio. Might the steam car have an easier time traversing these roads if they dumped Chris?

At 11:15 a.m., plump raindrops began falling from the sky. The brothers were utterly unfazed. The day before, forecasters had predicted a monsoon storm would pass through Flagstaff. (Some in the support group had circulated an e-mail asking if the trip should be delayed. "No!" Nick had written in a reply-all. "We are Brits.")

"If it's a little bit of drizzle, we'll put the coats on and keep going," said Chris. He did put on his fedora.

"It'll make us feel at home," Nick added, pipe still hanging out the corner of his mouth.

15 miles out

Winds and rain forced the Howells to cut their first day of driving about 15 miles short and transport the steam car back to Flagstaff. They would have to make up for it the next day. (Photo: Amy B Wang/The Republic)

Thunder eventually gave way to a steady, light rain. In the Jeep, Blue switched his windshield wipers to a faster setting. Over the two-way radio, the jokes were fewer and farther between, though the Howells were now clipping along at 10 mph, oblivious to the rain.

At the 15-mile mark, the damp and chill was too much for even a pair of British brothers — and the Howells admitted it. They stopped and threw on unmistakably modern rain coats.

At 3 p.m., about 17 miles in to their 62-mile journey, the Howell brothers called it a day. Both of them were drenched.

“This is a wrap!” Chris said, high-fiving anyone around him.

The rest would have to wait for the second day.

Day Two

In a clearing off Highway 180 and Forest Road 417, 9½ miles farther north than where they left off the day before, Nick and Chris Howell were taking turns heating up the Toledo.

It was a familiar ritual by now, the blowtorch to start the burner, the many minutes of uneven simmering, until the boiler was finally up to temperature. While they waited, the two ducked behind their trailer to change into their period costumes.

In the momentary distraction, someone left the fire-inspection door open.

Nick Howell takes a break at Moqui Stage Station.
(Photo Mark Henley/TheRepublic)

As the burner hummed away, small flames begin creeping out of the compartment, licking the wooden body of the car.

Alan Travis, the car enthusiast from Phoenix, professes to be more of an internal-combustion vehicle expert, but even he knew something was wrong.

“Hey, uh, look at your fire a little bit!” he shouted to the brothers.

In truth, it wasn’t a very big fire. The wooden trim was just beginning to scorch. Nick blew on it, heavily, puffing out the flame. He fiddled with a gas valve until the flame shrank away.

But Day Two of was not off to a particularly great start.

44.7 miles to go

Today Travis and Arnold Schmidt, the steam car expert, trailed the steamer in Travis’ Volkswagen, to provide mechanical support whenever anything went wrong. They estimated the Howells were going 13 mph. Practically speeding.

Two miles down the road, Nick lost control of the steering and the steam car lurched left into a muddy pit.

By some miracle, it stayed upright, and the brothers examined what went wrong. A steering pin had nearly slid out of a bar on the car. If it had disappeared into the mud completely, they would have no longer been able to steer the car at all.

“Thank you, the ghost of the Kaibab, or whatever!” Chris said.

Schmidt suggested wrapping tape around the beam so the steering pin doesn’t fall out again.

“No!” Nick cried. “That’s going to spoil the look of it.”

They settled on brushing the steering pin with a red gel sealant Schmidt referred to simply as “old car glue,” and pushing the pin back into its hole.

“Now where is this tea stop?” Nick asked. “Tea’s more important.”

Chris Howell pushes his brother, Nick Howell and 1902 Toledo steam car up a hill. (Photo: Mark Henle/The Republic)

35.5 miles to go

Travis and Schmidt had begun measuring the trip in “calamities per mile.” The car’s steam valve-jamming by then was a regular occurrence. Each time, the brothers frantically tried to slow it down on an incline, which causes the car to lose steam rapidly.

Each time, they had to stop and wait another five to 10 minutes for the steam pressure to build up again.

The right sleeve of Nick's white button-down shirt from GentlemansEmporium.com was speckled with dirt.

But all of their frustrations seemed to evaporate when they descended from the Coconino National Forest into ranchland. Gone were the pinyon pine and juniper trees, replaced by a panoramic expanse of sagebrush, thin grasses and yellow and lavender wildflowers.

Nick and Chris spotted individual grasshoppers and beetles trying to cross the road. Both of them saw a roadrunner for the first time. ("Quite good fun.") Above, enormous clouds filtered windows of light and cast shadowy shapes onto the hills.

On the flat ranchland, the steam car was performing remarkably well, only stopping occasionally at the direction of Tom Martin, the photographer. Martin instructed the convoy of support vehicles to hang back for at least a mile. He wanted to capture the perfect shots of the Howells re-creating their adventurous drive, alone.

The group broke for lunch at noon, and for the first time, there was a sense of urgency. They were at least five hours away from their destination — and that was with no more calamities per mile. If they couldn't make it to the Grand Canyon today, was everybody willing to extend the trip? The brothers and the crew joked: Short of taking Martin's camera away, how could they make the drive go more quickly?

The Howells balked at trailering the Toledo through the rest of the ranchland, but they agreed to one concession: Any more inclines, and they'd accept a tow.

"Let's carry on," Nick said.

Chris Howell takes a water break on day two of their attempt to recreate a historic drive from Flagstaff to the Grand Canyon in a 1902 Toledo steam car -- the very same vehicle that made the original trip 112 years ago. (Photo: Mark Henle/The Republic)

In some ways, a tow makes the drive even more challenging. One quick jerk and the steam car could tip. Travis estimated the Toledo weighed a couple thousand pounds, compared to his Volkswagen's 9,000 pounds. If the steam car's tiller had come loose a little bit in yesterday's drive, it could snap easily.

"It would take that tiller right out of their hand," Travis says. "And they'd both fall right out, because the only thing they have to hold on to is the tiller. If something were to go bad, it would go very, very bad very quickly on a tiller car."

He points out the Toledo's wheels, too. Essentially bicycle tires, he says.

Nick and Chris Howell on cruise down Forest Road 9008A on day two of their historic drive from Flagstaff to the Grand Canyon in a 1902 Toledo steam car -- the very same vehicle that made the original trip 112 years ago. (Photo: Mark Henle/The Republic)

17.8 miles to go

The storm from the night before had created slick bogs of mud in the Kaibab National Forest, some as deep as three inches. Worried about time, the Howells decided to hitch the Toledo to Travis' Volkswagen for the long haul, until they could escape the mud.

"I wouldn't fancy having a stuck valve over this road," Nick said.

Nick (left) and Chris Howell (2nd from left) get assistance from support crew members Arnold Schmidt (right) and Alan Travis. (Photo: Mark Henle/The Republic)

And so the speed remained anywhere between 6 and 11 mph.

Instead of using the two-way radio, the brothers and the lead car developed an elaborate pantomime that involved Travis and Schmidt sticking their hands out of the windows to wave and point at rocks in the road, while Chris gestured wildly from the seat of the Toledo. He gave a thumbs up if the tow was going smoothly, waved his hands low to the ground if the Volkswagen needed to slow down and rolled his hands frantically like Tina Turner performing "Proud Mary" if the tow line fell too slack.

Nick (left) and Chris Howell takes a break after pushing their 1902 Toledo steam car up a hill. (Photo: Mark Henle/The Republic)

The excruciating dance continued for two hours, the attached cars — with arms protruding in all directions — twisting and moving slowly up the muddy road like some odd, mechanical arthropod.

In order to maintain balance, the brothers contorted themselves into comical positions with each bump and lurch. Still, they couldn't resist making faces, laughing and filming mud specks flying up from the steam car's wheels with their GoPro camera.

Travis and Schmidt shook their heads and laughed at what they saw in their rearview mirror. They tried to imagine how they would explain the last two days to their friends.

" 'We towed Laurel and Hardy through the mud in a 113-year-old car,' " Travis suggested. " 'Just so they could see the Grand Canyon.' "

5.3 miles to go

The convoy, now five cars deep, came upon a sign for sore eyes: "GRANDVIEW 2"

Grandview Tower at the South Rim was only two miles away.

Everyone turned right onto Forest Road 302. It's glorious

Nick (right) and Chris Howell get a tow from support crew member Alan Travis. (Photo: Mark Henle/The Republic)

road, more gravel than dirt. There was no hint of mud anywhere.

Emboldened, Travis upped his towing speed to 15 mph.

At 5:45 p.m., they arrived at Grandview Tower, and everyone cheered.

"Good tow, Alan," Chris said. "Good tow."

"We're cutting you loose, whether you like it or not!" Travis said, undoing the tow line. The brothers would complete the rest of their drive — just over three miles to the Grandview Point lookout — on their own.

On the last stretch, Travis pulled back. He wanted the Howells to have their moment. He held his breath as the steam car made a slow left turn onto Desert View Drive straight into the setting sun.

The brothers were in their element — Chris tipped his hat to drivers passing in the opposite direction, who were clearly startled at the sight of the steam car. In their lane, a National Park Service shuttle bus came hurtling around a bend and barely missed them.

More cars whizzed by, switching lanes at the last minute and narrowly avoiding the steam car. They couldn't have been going faster than 25 or 30 mph, but suddenly everyone else seemed to be in a great and unnecessary hurry.

A quarter-mile from the turn into Grandview Point, the Toledo stalled once more. They would need to build up steam again, one last time. As they waited, Nick and Chris looked back and see their support convoy, all with emergency blinkers on.

They had not met these people until two days ago, and for 48 hours, the group had followed the brothers through the mud at 10 mph.

"The support and the teamwork, just fantastic," Nick said. Chris nods his head.

They seemed on the verge of sentimentality before Nick added: "We could have done it ourselves, maybe, but it would have been four weeks and we'd be in a ditch somewhere…"

When they build up enough steam, the brothers gathered with several of the volunteers.

"This is it!" someone shouted.

"Team Toledo!" Chris yelled.

"Team Toledo!" the rest echoed.

The Howell brothers hopped into the steam car, while Schmidt and Travis ran behind and gave it a final push. The steam car sputtered ahead. Chris tipped his hat one more time as they made a right turn and disappeared toward Grandview Point.

At the Grand Canyon

Shortly before 7 PM the brothers puttered up to Grandview Point lookout on the South Rim in their 113-year-old vehicle.
(Photo: Amy B Wang/The Republic)

At the South Rim

Like startled pigeons, tourists dispersed to make way for the 113-year-old steam car emerging from the woods, then stepped forward cautiously to encircle the curiosity.

Nick and Chris stopped the car, then leaped out, whooping.

"We did it, brother!" Chris yelled while tossing his hat toward the canyon. The crowd erupted in spontaneous applause, even if no one was quite sure who the Howells were or what they just did.

Not missing a beat, Chris launched into a dramatic recount of their journey. Soon, the crowd's attention had been diverted completely away from one of the world's natural wonders.

As the sun set,one of the volunteers pointed out that perhaps the Howells should turn around, reminding them neither one has ever seen the Grand Canyon before.

"Should we go have a look?" Chris asked his brother.

"Ah, yes," Nick said, and they turned to walk toward the edge. "Biggest hole in the world!" <|>

http://www.azcentral.com/longform/life/az-narratives/2014/08/29/steam-car-grand-canyon-journey-longform/14834557/

Somewhere West of Laramie.... Below, Chris and Nick bask in the setting sun at the rim, the threatening clouds having completed their cold deluge.

Steven Theobald, son of the late Jeff Theobald in England wants to sell his Father's collection. The *Bulletin,* which his father enjoyed so much reading, provides a way to approach like-minded steam car enthusiasts globally, since Steven has decided to sell most of this collection on a Facebook page called "Steam Cars and Parts For Sale."

Steven extends an invitation for all to join, the more members we have the better it will be. Log onto Facebook with the link www. facebook.com/groups/533778613419320/ or search for "Steam cars and Parts For Sale".

As for cars that will become available.... There are two Stanley 735s and a fair mound of spares; the Keen Stemliner #1; a 1900 Locomobile; roughly 3.5 Brooks steamers rangine from lovely condition to rolling chassis; and the Hart, a Reliant Fox converted to run on steam. There are spares for Locomobiles, Stanley, etc., and a number of very nice live steam models.

Bugatti Steam Train

Richard Day and James Guest

I have been in contact with Richard Day of the Bugatti Trust for many years. He has very kindly given permission to publish his article in our magazine. Richard has been more than helpful and has passed Bugatti patents to me in the original French which I have had translated and shared with the steam world. His attention to detail speaks for itself. The only mild point needing clarification is where it states "90% cut off" really means 10%, which perhaps illustrates the possible gap (dare I say it) in Jean Bugatti's knowledge of steam.

He states that at 200 psi the power was greater than expectations. We would see this as a gift horse to produce a new set of cams with a further range of cut off earlier than 10%. A major opportunity missed. Being able to notch up to a shorter cut off would significantly affect fuel/steam consumption. These savings would have made the project even more tempting. In a way, had this locomotive been completed, it could have ushered in a new golden age for steam. ps: Fig 3 is a little gem.

This is from The Bugatti Trust, Prescott Hill, Gotteringham, Cheltenham, Gloucester, GL52 4RD (UK) Website: www.bugatti.co.uk/trust

--Doug Leeming

SOON AFTER the introduction of the petrol powered Bugatti railcars in 1933 it became apparent that they would be a great success. Ettore Bugatti's reputation as a designer and constructor of rail-

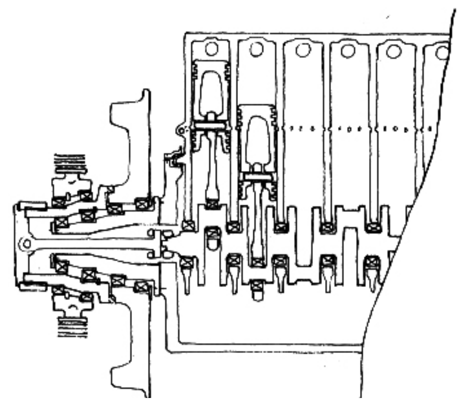
way equipment, as well as racing, touring and luxury cars, was at a very high level indeed, particularly in France. (In the Bugatti Trust Newsletter No 5 we outlined the remarkable story of the petrol railcar design [above] and development between 1931 and 1933) The success of the railcars must have been a boost to the self-confidence of this man who had always been confident of his own abilities.

Ettore Bugatti in '33

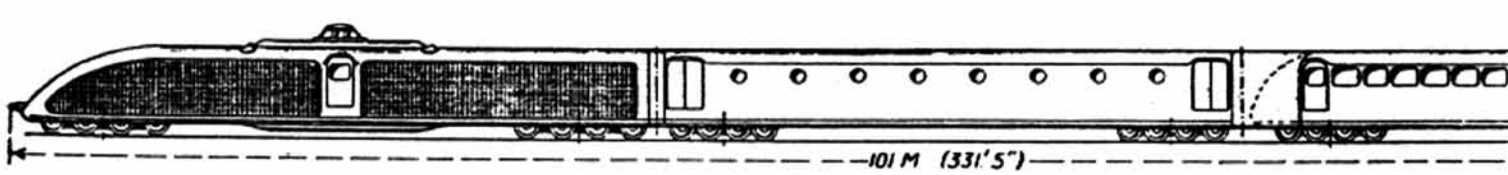
Ettore Bugatti continued to develop his ideas for long distance passenger transport.

By the end of May of 1934 he had prepared preliminary drawings of a steam train and its power units and invited the Director of the ETAT Railway Company, Raoul Dautry and his wife to Molsheim for the Whitsuntide weekend to demonstrate these recent ideas. The drawings had been hurriedly prepared by Noël Domboy in the Molsheim drawing office during the ten days prior to this important visit. The drawings consisted of full size longitudinal and cross sections of one power unit together with a side view of the complete train.

Raoul Dautry



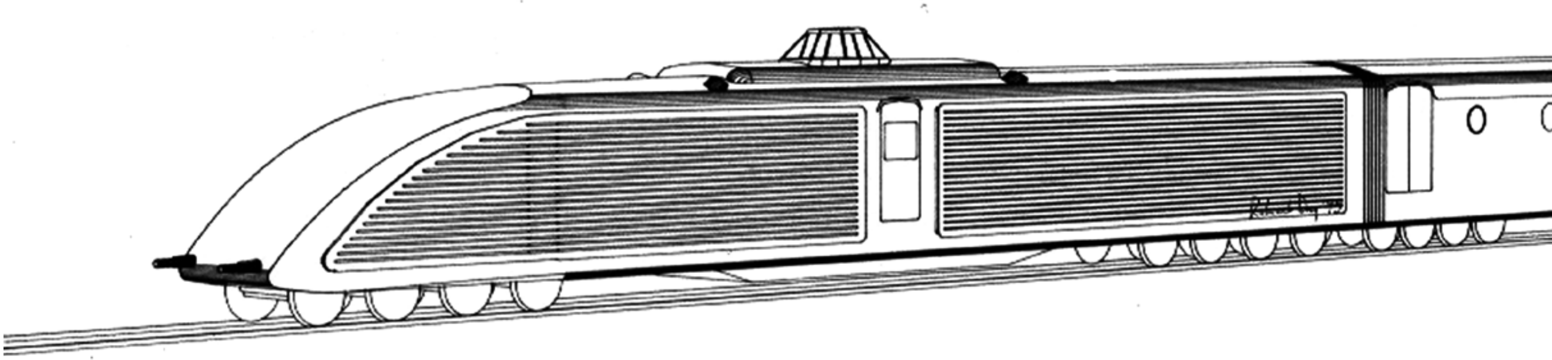
An interesting insight into Bugatti's method of working is given by Noël Domboy in describing his frantic ten days work preparing these drawings. Firstly Bugatti explained the project to Domboy emphasising its importance, telling him that the



64 cylinder locomotive

water and baggage tender

Computer model sketch of the train.



drawings would have to be completed and faultless in time for the arranged visit. In explaining the scheme in detail to Domboy he said that the ideas were the result of years of thought. He then left Domboy to get on with the job of the detail interpretation and realisation of the ideas. Only once each day at 9 p.m. did Bugatti inspect the drawings progress and discuss the following days work and any errors or the need for re-drafting, of which there was very little. The drawings were completed in time for the visit and the outcome was successful in that, on the Sunday morning, Dautry agreed to place an order for this new Bugatti train.

Dautry was a particularly significant figure in the railway world at that time. At an international railway conference at Zurich University in March 1932 he had given a masterly appraisal of the then current railway network problems and solutions for the future. From 1934 he was appointed Président de la Confèrence des Directeurs des Grands Reseaux Français.

TO UNDERSTAND the significance of the new Bugatti design we should briefly go back to early history and then outline some of the problems which were perceived to be inherent in railway engineering in France and internationally in 1933/34. From the days of George Stephenson locomotives had developed in terms of weight and power but some of the fundamentals had not changed. The simple arrangement of a pair of side mounted cylinders with pistons linked to driving-wheel cranks and a water filled boiler heated by tubes between the firebox at one end of the boiler and the smokebox at the other, was all still current practice in 1934. By that date the largest locomotives in the USA had cylinders which could develop 2000 HP each. The connecting and coupling rods to handle this power were necessarily large and heavy, which meant that at high speed the track was subject to large hammer blows from the vertical component of the dynamic forces involved, transmitted through the driving wheels. Damage was caused to the tracks, particularly the outer track on bends, exacerbated by the necessarily long rigid wheelbase of the driving wheels. Some of the many serious rail accidents in France in the early 1930s were attributed to this cause.

The large traditional steam locomotives also suffered the operational disadvantages of needing frequent stops to take on fuel (coal), large quantities of water, and to dispose of ash. In fact water and even coal could be picked up on the move but there was no equivalent solution to the problem of the disposal of hot ash. The range of a locomotive was limited by the capacity of its ashpan. In the designer's efforts to create locomotives of ever greater power, boilers and fireboxes had to be made larger, more ash was being produced, but there were finite limits on available space and ashpan capacity was strictly limited and became a critical factor. Larger conventional boilers also required more heat to start from cold. The process could take hours and consume several tons of coal.

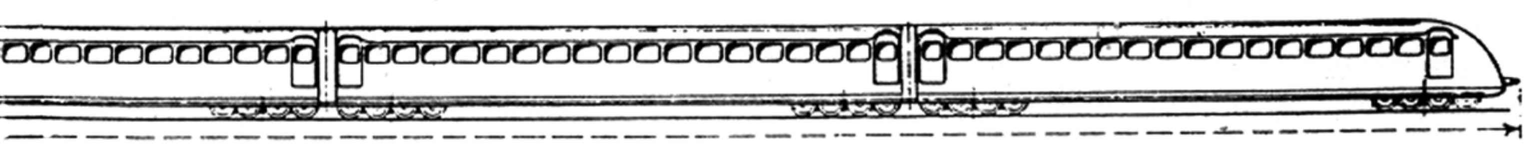
It could be said that by 1934 the conventional steam locomotive was nearing the end of its development potential.

Bugatti knew that his alcohol/petrol driven railcars would not be a final solution to such problems of national and international rail passenger transport services. (They had been developed originally to exploit a temporary glut of industrial alcohol, which existed in France in 1931.) Eventually it was partly for reasons of the high fuel cost that the petrol railcars became uneconomic and were decommissioned.

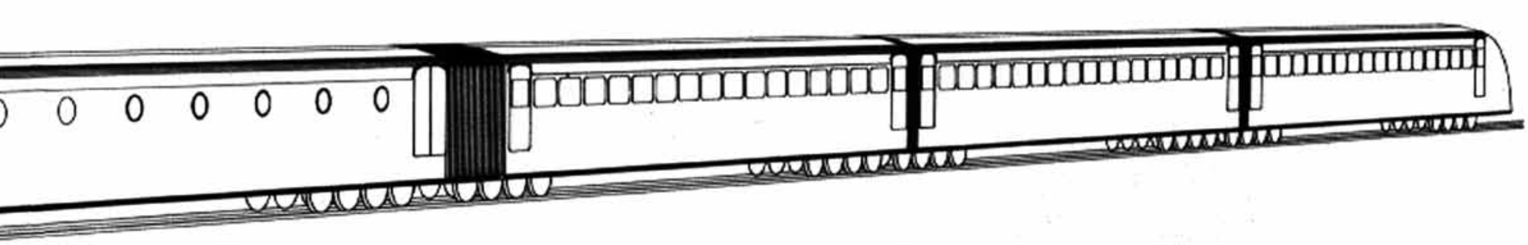
WE WILL NOW DESCRIBE the new Bugatti steam train as it was explained to Raoul Dautry with the help of Noël Domboy's drawings, during the 1934 Whitsun weekend, and show how its design incorporated the solutions to these basic problems.

The train consisted of five vehicles. The first was the engine and boiler unit. The 22m long lightweight body mounted on two four-axle power bogies was of similar form to the petrol railcars, but rather more streamlined. The driver was accommodated centrally in a roof mounted turret cab. The second unit can be described as the tender, 19.8m long. This contained water and fuel supplies as well as room for baggage. The front of the tender was connected to the engine unit and the rear incorporated a fairing that shrouded the front of the first of the trailer units. These trailer units (of which 3 are shown) are similar to standard Bugatti railcar passenger coaches. Noël Domboy said that his early drawing of the side elevation of the complete train was based more on conjecture than reality, but it certainly looked impressive.

DETAIL DESIGN WORK and the building of prototype assemblies and testing went ahead at Molsheim also on many of the other major components



three car passenger unit

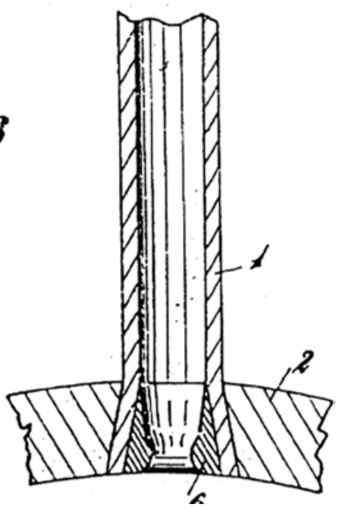


- boilers, burners, water feed and fuel pumps, condensers, pipework and control systems and on the vehicle and bogie arrangements.

The contracts with ETAT and PLM were for the supply and delivery of complete trains (locomotives, tenders and coaches) and there were various bonus and penalty clauses dependent on the train's performance subject to test. (For instance: a bonus of 15,000 francs for each 0.1kg of fuel oil used less than 5.5kg per km. A bonus of 10,000 francs for each kph average speed achieved above 95kph over the run from Paris to Lyon and a penalty of 25,000 francs for each kph less than 95.)

Apart from the problems associated with the late change of wheel diameter, there were numerous other technical difficulties to overcome. Bugatti had anticipated that the production of a successful high-pressure water tube boiler system would not be easy and he placed an order with Babcock & Wilcox for an equivalent boiler as a precautionary measure. Bugatti's own version incorporated numerous patented features including oil burner design and arrangement, form and method of construction of the water tubes and collectors and the method of fixing the tubes into the collectors, Fig. 3, (this last item was done by expanding the tube ends with conical ferrules - similar to his car sump cooling tube fixing detail).

Fig: 3



Work proceeded on all aspects of the train. Between March 1934 and the end of 1936 Ettore and Jean Bugatti took out more than thirty-five patents for concepts and details of this project in France alone. The dates and subjects of these patents clearly show the progress of the design process. It is an interesting catalogue of ideas but too extensive and detailed to cover in this article. Copies of the French patent specifications are available for research at the Bugatti Trust.

In addition to the technical difficulties, which caused delay there were management problems, not only at the Molsheim factory but also in the wider context of the French railways which affected ETAT and PLM. Bugatti failed to meet the contractual obligations of delivering the complete trains by the summer of 1936 (31st May 1936 for PLM). When the independent railway networks of France were incorporated into the national SNCF. Dautry and Mugniot and their own staff lost their control of these projects. Dautry, especially, felt that the best public interests of improving railway efficiency and safety had been forfeited by the new managers and he spoke of betrayal. As we know

Jean Bugatti.

Ettore Bugatti felt betrayed by the activities of his own staff at Molsheim and he withdrew to Paris leaving the advancement of the steam train project to Jean. According to Noël Domboy, Jean took up this challenge with typical vigour and enthusiasm. From 25th November 1936 the relevant patents are in Jean's name. (Ettore was designing boats.)

By the summer of 1937 at least the design of the 1000HP train existed on paper.

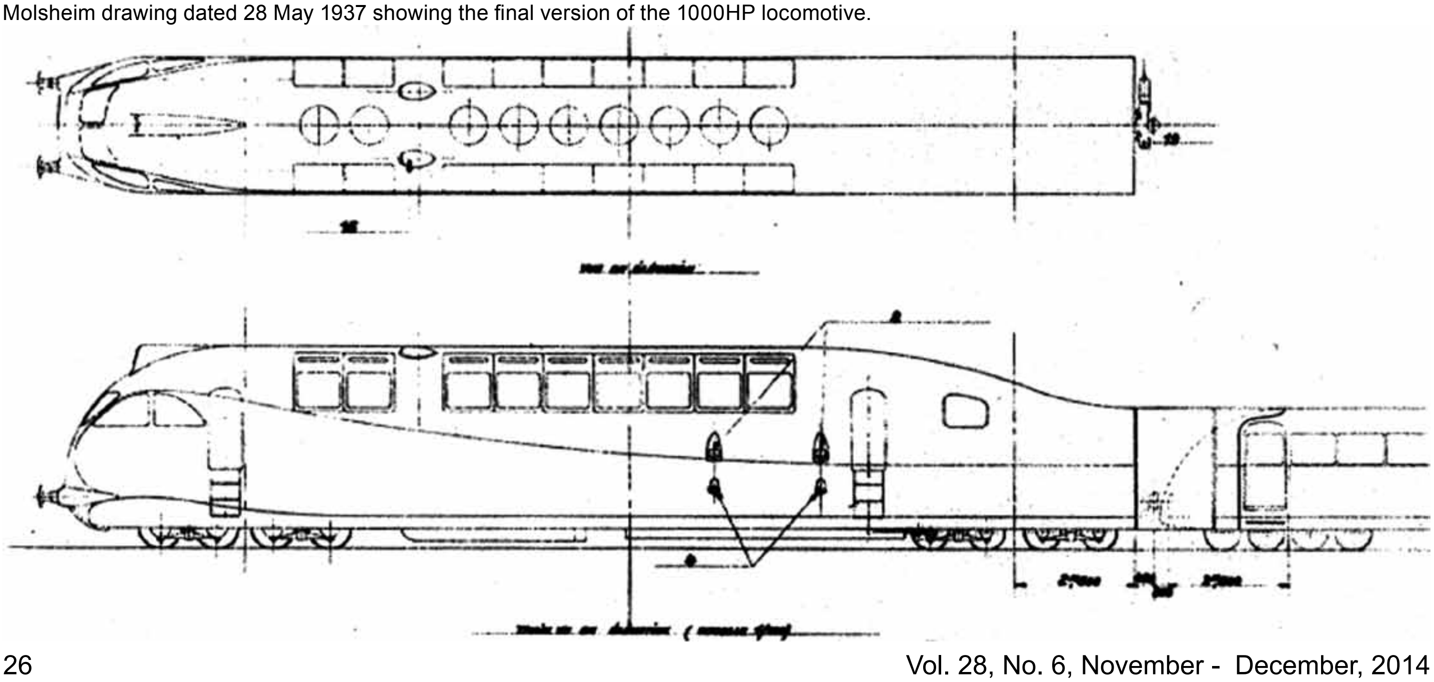
At this stage, numerous changes to the overall layout as well as to assembly and component details had been incorporated but the basic principles had not been compromised except that the drivers' cab had been relocated to the modern position at the front. It had been necessary to increase the height of the locomotive unit to the full 4.2m of the national gauge to accommodate the final version of the boiler system, which meant that the central turret cab idea had had to be abandoned.

The four axles of the front bogie each consisted of an 8 cylinder engine unit, as before, and the rear bogie was unpowered.

High pressure steam pipework which incorporated the Bugatti patented spherical joints were all housed at the front end, just behind the driver's cab.

This first steam train layout, as drawn up for Dautry's visit, was the 2000 HP version with all eight axles (two 4 axle bogies) of the front vehicle being powered. Each of the two bogies incorporated four

Molsheim drawing dated 28 May 1937 showing the final version of the 1000HP locomotive.



in-line eight cylinder single acting steam engines. (Eight power strokes per revolution for each engine as opposed to four with the four stroke petrol railcar unit.)

The bore and stroke were 125mm and 130mm giving a cylinder capacity for one engine unit of 12.76 litres (102 litres for the complete locomotive). Each unit was expected to produce 250 HP.

The Bugatti cast iron monoblock principle was used with the crankshaft bearings carriers bolted directly to the block.

There were nine roller main bearings and the big ends were split race roller bearings with detachable caps.

The pistons incorporated two sets of rings: an upper compression set and a lower water condensate control set.

The pistons were sufficiently tall to allow for a condensate drain from an annular groove in the cylinder wall positioned between the travel of the upper and lower rings.

Lubrication of the bottom end of the engine and camshaft drive was by dry sump with an external oil tank with distribution via pipework and oil gallery. In addition there was a gear driven Bosch lubricator to inject heavy steam oil into the inlet ports.

A remarkable feature of the engine was the valve operation. The integral cylinder head incorporated one horizontally mounted inlet valve for each cylinder and one exhaust valve on the opposite side. They were poppet type but the inlet valve had a double head arranged to give a compensating effect to prevent the external steam pressure opening the valve (double beat). The camshafts, one inlet and one exhaust, were mounted on either side of the block, and valve operation was via short vertical rockers.

Steam enthusiasts will know about 'cut off.' It is the method of controlling the duration of steam admission on each power stroke. Maximum inlet valve opening duration gives maximum torque and is used at very low speeds.

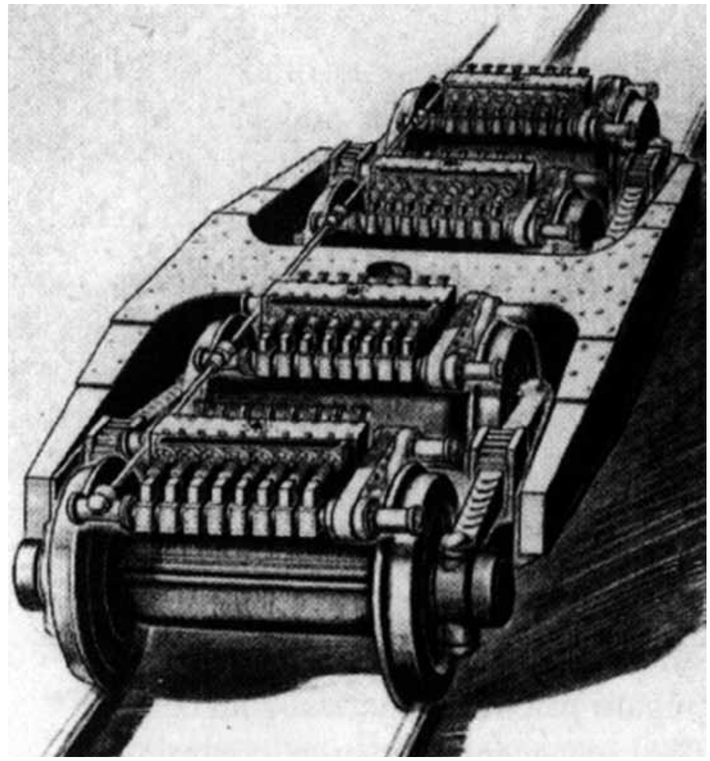
This mode uses the maximum amount of steam and is least efficient. At the other extreme "90%" cut off would use very little steam per stroke but there is more steam expansion within the cylinders and so more of the energy is utilised.

> "The steam train itself was a thing of beauty and a worthy forerunner of the modern TGV" *H G Conway - Magnum*

The Bugatti poppet valve steam engine achieved variable 'cut off' by the use of three dimensional cam profiles on both the inlet and exhaust cams. The complete camshafts could be moved longitudinally, while running, so that inlet valve closure timing was continuously variable. By moving the shafts through a central neutral position reverse running was obtained, also with the full range of cut off. To operate with these three dimensional cams, the followers were spherical (25 mm diameter steel balls) and were housed in the lower ends of the rockers.

The bogie design was new but some of the features of the petrol railcar bogie were retained. The bogie chassis was a fabricated steel box structure forming an 'H' shape. The four extremities of the 'H' arms were each carried by a pair of double cantilever leaf spring sets which were linked to the main axle bearing boxes which were outboard of the driving wheels. As with the earlier design the spring mountings allowed a small amount of lateral movement of all four axles.

The steam engine units were located transversely between the driving wheels with their crankcases acting as the rigid axle beam and the drive taken from each end of each crankshaft via short drive shafts.

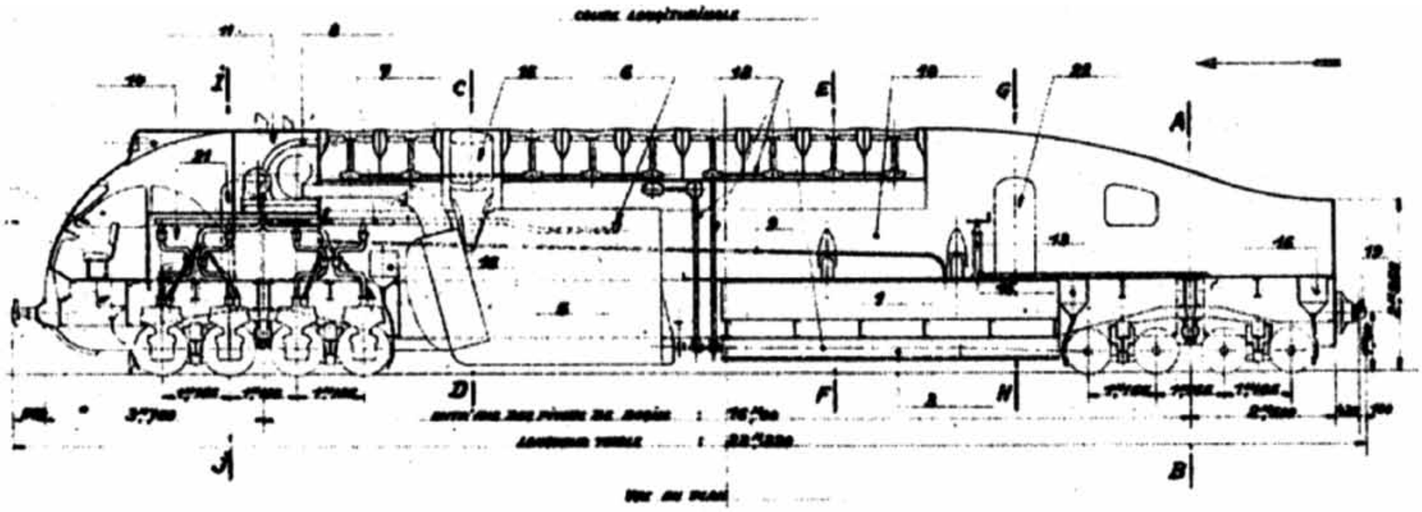


A sketch of a complete bogie

The driving wheel construction was similar to the railcar design and there was rubber isolation between the steel tyre and the wheel centre disc. The unsprung mass of one power axle unit was significantly less than a large conventional steam engine drive wheel assembly and the destructive dynamic forces normally generated by massive connecting rods, etc. were avoided. (That, at least was Ettore Bugatti's theory which was convincing to Raoul Dautry.)

The locomotive vehicle of this first steam train design was constructed on a steel chassis which was carried on each bogie by two coil spring side mountings (for lateral support) and one spherical joint at the centre to take the traction and buffing forces; all similar in principle to the petrol railcar. This front vehicle contained two oil fired water tube boilers (together able to provide 14.5 tons of steam per hour at 710 p.s.i.) with a forced draft combustion air supply and a pair of roof mounted exhausts per boiler. All of the engines' exhaust steam was to be condensed and re-circulated to the boilers via high pressure feed pumps. Nearly the whole of each side of the locomotive was covered with surface condenser units. To achieve the necessary flexibility between the boilers and the bogie mounted engines the main high pressure steam supply (and exhaust) pipes incorporated Bugatti patented spherical connections. The crew accommodation, control systems, brake operation, sanders, fuel feed pumps, etc. were also housed in this vehicle. We have described the 2000 HP train with its two powered bogies, which was the scheme presented in May 1934. In fact the first contract from ETAT, under the direction of Dautry, was for the supply of a complete Bugatti steam train but of only 1000 HP. This contract was dated 17th January 1935. The 1000 HP variant utilised one four engine power bogie and an unpowered trailing bogie and only a single boiler and set of ancillaries.

However the full 2000 HP train was taken up by the PLM Company. (Both ETAT and PLM were satisfied purchasers of Bu-



gatti petrol railcars)

At that time PLM was under the direction of Eugène Mugniot who was also a personal friend of Bugatti's. The PLM contract was dated the last day of 1935.

Eugène Mugniot

It was hoped and expected by Bugatti, Dautry and Mugniot and their technical staff that both of these Bugatti steam train proposals would offer the following advantages over conventional steam locomotive systems:

By multiplying the number of cylinders used (64 in the 2000 HP version) the individual components would be light in weight and the dynamic forces involved would be small, spread over a greater number, and the whole construction could be lighter.

By using heavy oil, fuel running costs could be reduced and fuelling would be by pump. (This was a particularly important consideration in France where coal resources were not plentiful)

Problems of ash disposal would be eliminated.

By using fully condensing engines, water consumption (and tank capacity) would be vastly reduced which would save on water loading frequency and time and also reduce the need to carry such large quantities of water.

The excellent bogie design (effectively proven by the petrol railcars) which incorporated a 'hierarchy' of means of suspension and damping, and the possibility of slight lateral movement of the axles, would greatly reduce track loading, particularly of dynamic loads generated by the driving components. (Radial steering bogies are a "new" innovation on the latest freight locos to run in Britain built by General Motors.)

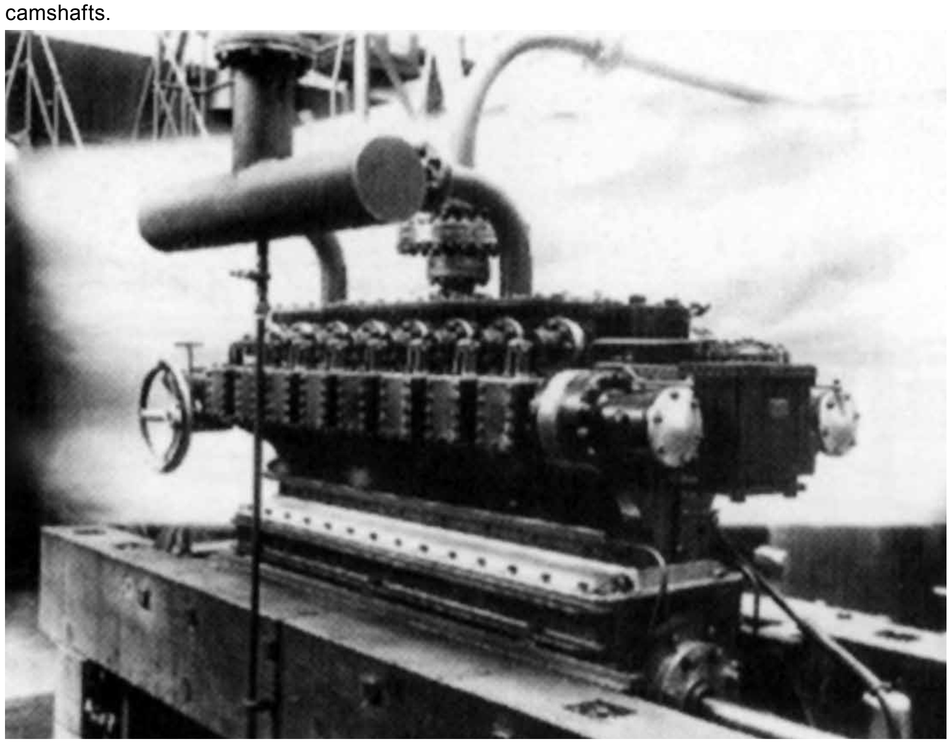
By the use of high-pressure water tube boilers, much greater efficiency would be expected. With their low water content, the system is lightweight and can give quick response time.

THE ETAT and PLM steam train contracts demanded a great effort from Bugatti and the Molsheim works (which was already committed to production of the petrol railcar sets). In addition to the friendship and good working relationship which developed between Ettore Bugatti and Dautry and Mugniot there was good liaison between the technical staff of the three companies. It was probably Dautry who most inspired this team spirit and the sense of working on a revolutionary and inspirational project. Jean Bugatti was also fully involved and some of the relevant Bugatti patents are in his name.

Bugatti's first priority was to prove his design of the multi-cylinder engine with its variable valve timing mechanism. The whole project was dependent on the success of tests of the prototype unit.

One of the factory heating steam boilers was called into service on a Sunday late in 1935 for this series of tests carried out by Edouard Bertrand for which, unfortunately, we do not have the figures. However, Bugatti declared that the power produced with only 200 p.s.i. pressure available was more than he had calculated and that it would therefore be necessary to increase the diameter of the driving wheels

The prototype steam engine at Molsheim showing the exhaust side. The high side mounted camshaft housings and the vertical rocker arms can he seen as can the Bosch lubricator between the camshafts.



by 20mm. This was a small but fundamental design variation, which resulted in considerable delay and expense to the whole project. (The driving wheel diameter was increased at this stage to 760mm which results in an engine speed of 1047 RPM at a vehicle speed of 150kph (93mph) and, for the 8 powered axle version, a total tractive effort of 350000N (79000lb) which is an impressive figure even by modern standards and approximately double that of a conventional locomotive at that time.)

The Bugatti boiler was mounted just behind the front bogie and its combustion air was supplied by centrifugal fan from a long roof mounted plenum chamber. Fresh air passed through two banks of condenser units (nine on each side) to enter the plenum chamber and once underway the air supply was further boosted by nine impellers, bevel gear and shaft driven from the front axle of the rear (unpowered) bogie. The water and fuel oil tanks were mounted at low level behind the boiler.

EVENTUALLY THE PROJECT was abandoned. For Jean to have continued with the development after 1937 he would have needed further financial and technical support which he no doubt attempted to obtain. The new regime of the French National railway system was not inclined to be as helpful to Bugatti as ETAT and PLM had been with Ettore from 1931 to 1936. The financial situation at Molsheim was serious and hopelessly inadequate to allow continued development of such an ambitious project alone.

One of the successful Bugatti petrol railcars on which much of the steam design was founded.

World-wide there were several other railway designers' and manufacturers' pre-war and post-war attempts to develop new solutions using steam with high pressure water tube boilers to advance railway technology. In the USA, for instance, Union Pacific tried oil-fired steam turbines, with condensers, to power a steam-electric system. None of these were such totally revolutionary designs as the Bugatti steam train and, ultimately, none of them was to prove successful.

THIS BUGATTI STEAM TRAIN article is copyright of the Bugatti Trust and is based on documents held at the Bugatti Trust and on the following reference sources:

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- Flight of (Steam) Fantasy, H G Conway, *Bugantics* Vol. 50.1
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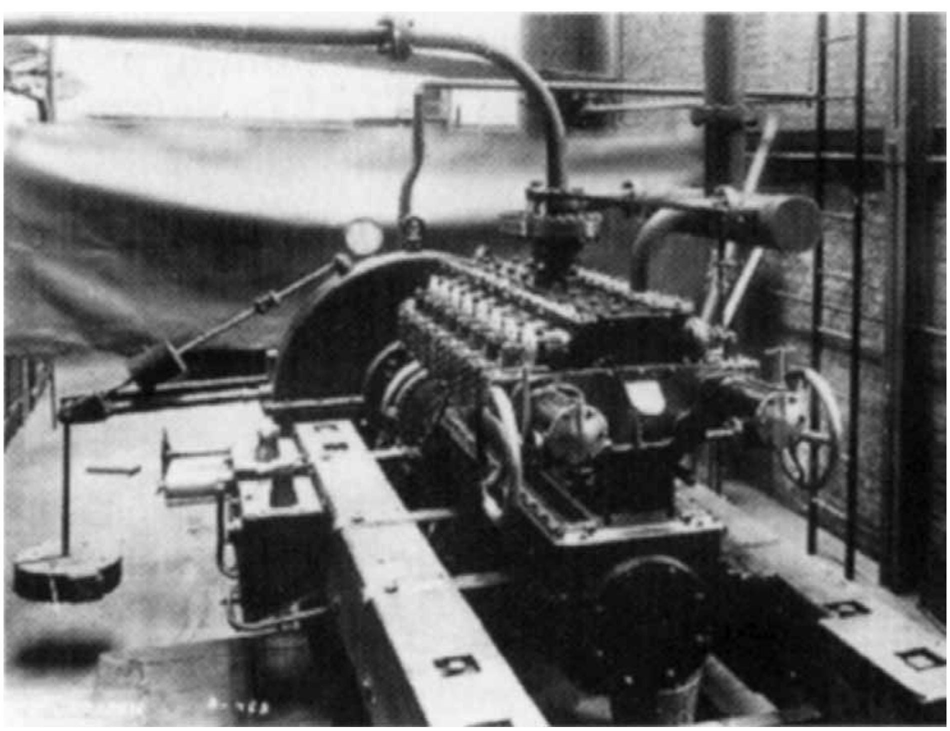
- International Railway Conference Bulletin, April 1937
- Domboy letters; Bugatti patents; Bugatti drawings; Bugatti patents.



The Trust holds most of the patents taken out by Ettore Bugatti and sons Jean and Roland. The position was outlined by Hugh Conway in a letter to *Bugantics* in the summer of 1980. Vol. 43, No. 2. Therein he bases his figures on an original list of patents prepared for EB by his office in Paris in July 1942. The original of this document is also held by the Trust.

The total shown at that date - 5 years before EB's death - was 427, and thus a total lifetime figure of 450 was considered reasonable. The years since have produced nothing to alter this assumption. Filing was mainly in France, Germany, UK and Italy, with relatively few in other countries. The patents are invaluable as references and as a fascinating insight into the way EB and later Jean were thinking.

The Trust is greatly indebted to Peter Corfield who compiled an overall listing in February 1993, using the same document of July 1942 as his main source. His listing is not claimed to be definitive, but is substantially correct, and is in constant use. He recently visited the Study Centre, and we hope that he may be able to comment further shortly. <|>

The CE-635 Coal-Electric Locomotive

National Steam Propulsion Company

The CE-635: A Coal-Electric Locomotive For The Eighties And Beyond Advanced Design — Proven Technology [1082]

I. EXECUTIVE SUMMARY

It was the high cost of maintenance which finally ended the 120 year reign of the first steam locomotives on Class I railroads in America. Both coal and oil were cheap in the 1950's, but the diesel electric promised greatly reduced maintenance costs through standardization. By 1962 no major railroad operated steam locomotives.

In the 1980's and beyond, it is the high cost of oil as well as uncertain supplies which will bring the railroads back to coal as a fuel. A modern coal powered locomotive must be economical to operate and be compatible with railroad operating practices if it is to be acceptable.

The National Steam Propulsion Company has designed a coal burning locomotive using a steam-electric drive which offers the railroads a significant cost savings, even if oil prices drop somewhat from their present levels. The payback on the NSPC locomotive is 2 1/2 years with oil prices at $0.90 per gallon.

A fundamental aspect of the product design is that it is built on existing diesel-electric chassis. Only the combustion system and steam engine are new. This feature reduces development and production costs, but more importantly, it minimizes the changes required in railroad operations.

The steam engine is a 3500 horsepower unit built on an existing diesel block. Coal is fired in the Wormser Grate, a patented fluidized bed boiler capable of burning the cheapest run-of-mine high sulfur coal while meeting all present and anticipated air quality standards.

II. INTRODUCTION

Railroads have been closely associated with coal since their inception in the early 1830's. The first steam locomotives burned coal although wood became the most common fuel until after the Civil War. By 1900 most railroads used coal as fuel. Railroads have both owned and hauled coal since the beginning. In fact, today, railroads transport more coal than any other commodity. So important was coal traffic to the Norfolk & Western and the Pennsylvania railroads that they resisted the growing pressure to dieselize in the 1950*s for as long as economically possible, continuing to refine their steam locomotives. By 1962 no Class I line haul railroad operated coal fired locomotives.

During the final years of the first steam locomotive era, there were three attempts to build steam-electric motive power. The Chesapeake & Ohio and the Norfolk and Western both built coal fired steam turbine electric locomotives. These units were very similar in concept and design: both were open cycle, although the C&O used a conventional fire tube boiler while the N&W employed a water tube boiler. The third attempt (some 15 years earlier than the other two) was a joint effort of the Union Pacific Railroad and the General Electric Company. This locomotive was designed to fire either bunker 6 fuel oil or pulverized coal. It was somewhat more advanced than the others, using a closed cycle as well as a water tube boiler. These attempts failed for the following reasons:

1. Costs were high - General Electric spent over $1,000,000 in 1938 with no end in sight.

2. There was no compelling reason to make them work since oil was cheap at the time, and the diesel promised reduced maintenance costs through standardization. C&O and N&W built steam-electrics primarily for political reasons.

3. There were a number of technical problems: complicated plumbing; freezing of the condensers in the case of the GE-UP locomotive; problems with the high pressure water tube boiler on the GE-UP unit; excessive firing rates and poor draft conditions on the C&O unit; poor turbine efficiency at partial loads; and finally both the C&O and the N&W locomotives had severe problems with fluctuating load conditions - when starting a heavy train, pressure dropped and performance lagged. All of these could have been solved if the incentive had been there.

The railroads changed from first generation steam locomotives to diesels in the 1950s primarily because of costly, labor intensive maintenance, not fuel costs. In the 1980s the high cost of oil has made coal attractive once again as a fuel for the railroad industry. Today a modern coal-burning locomotive will cost less than half as much to operate as the diesel-electric annually.

In addition to its high cost, oil is subject to shortages and cutoffs. Any conflict in the Middle East, whether internal or part of a world wide disturbance, can critically reduce American oil supplies, even if America is not party to the conflict.

Another favorable aspect of coal burning locomotives is the fact that coal is an abundant, native resource. In effect, every BTU of coal burned represents one of imported oil saved. Coal is, therefore, politically as well as economically attractive to railway management; it is especially so when one considers that the coal producers are among the railroads1 largest customers.

Clearly there is a growing market for a modern, practical coal-electric locomotive. The National Steam Propulsion Company (NSPC) has addressed this market with a coal-electric design based on applying advanced, yet proven steam engine and coal combustion technology to the existing diesel locomotive.

III. REQUIREMENTS FOR A MODERN COAL BURNING LOCOMOTIVE

The most important requirement of any new coal burning locomotive is that it be economical to operate compared to the existing diesel; it must have rapid financial payback. This means the locomotive must combine reasonable thermal efficiency with the ability to fire the cheapest grades of coal. It is to be expected that maintenance costs for a coal burning locomotive will be somewhat higher than for a diesel since there are two major systems rather than one. To be acceptable to the railroad industry, these increases must be kept to a minimum.

The second requirement of any new coal burning locomotive is that it be fully compatible with current railroad operating practice. Some of the specific conditions which must be met are as follows:

1. It must be capable of being mated with similar units and

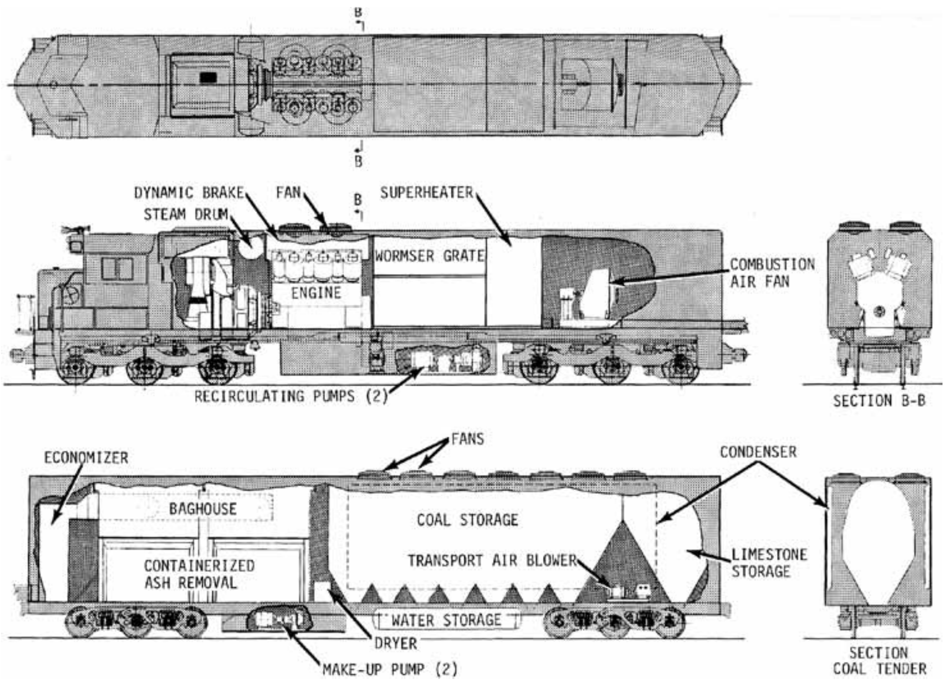


Figure 1. NSPC CE-635 Coal-Electric Locomotive

with diesels:

2. Any new locomotive should be in the same power range as existing locomotives.

3. Maintenance procedures and sparing should be changed as little as possible?

4. Operation of a new coal powered locomotive must not require more labor than diesels and retraining of existing labor must be kept to a minimum?

5. The expense of installing wayside fuel depots must be minimized.

Finally, any new coal powered locomotive must be environmentally acceptable, capable of meeting existing and anticipated emissions standards. In fact, to be consistent with the economic requirement, a new coal burning locomotive should be able to burn run-of-mine coal, since this is the cheapest coal available (about half the cost of double screened, washed, coal).

IV. TECHNICAL DESCRIPTION

A. The System

The National Steam Propulsion Company (NSPC) is currently developing the CE-635, a coal-electric locomotive which uses an existing diesel chassis and components, essentially replacing the diesel power plant with a small-cylinder reciprocating steam engine and a coal-fired fluidized bed boiler. The design is based on the SD 45-2 or the SD 50 locomotive as manufactured by the Electro-Motive Division of General Motors (EMD). EMD is the major U.S. locomotive manufacturer with about 75% of the domestic market. The NSPC power plant is also applicable to the General Electric C-36-7 chassis with minor modifications, operated together with other locomotives under master control.

National Steam retains most of the diesel electric unit, including the main and auxiliary alternators, traction motors, control system, and air brakes. The CE-635 requires a tender for fuel storage, and to house the filters which remove particulates from the exhaust gases. A layout of both the CE-635 locomotive and the tender is shown in Figure 1.

The CE-635 specifications are as follows. It will be a 3500 horsepower, 6 axle unit based on either a modified SD 45-2 or SD 50 chassis. The total weight of the CE-635 is 382,000 pounds? the tender weighs 300,000 pounds, fully loaded. Locomotives in this power range have dominated the market since their introduction in 1981. The locomotive will be capable of burning run-of-mine, high or low sulfur coal, while meeting present and future emissions standards. This feature is due to the unique coal combustion system patented by Wormser Engineering, Inc. of Woburn, MA, which is the core of the NSPC locomotive.

In order to provide 3500 horsepower to the main alternator, the NSPC steam power plant will use 32,000 pounds of steam per hour. To produce this, the Wormser Grate will fire approximately 2 tons of coal an hour and use approximately 380 pounds of limestone per percent of sulfur in the coal. The overall power plant efficiency will be near 18%.

B. The Steam Engine

The Steam Engine is a 12 cylinder reciprocating unit similar in arrangement to the existing diesel engine. Reciprocating engines have better efficiency than steam turbines over the speed range required in the locomotive application. The steam engine will have the same horsepower as the 16 cylinder engine it replaces. It will be a compound expansion unit using steam at 1000 deg F and 1000 psi in the high pressure cylinders and at 850 deg F and 180 psi in the low pressure cylinders.

The NSPC design is based on an existing diesel block, crankshaft, cylinders, pistons and piston rods. Also retained is the diesel camshaft drive. A cross section through the engine is shown in Figure 2. The figure shows an EMD block as the basis for the steam engine, but other blocks can be used. NSPC will fabricate steam cylinders, pistons and valves to fit the diesel block as shown in the figure. The steam piston rods are fastened directly to the diesel pistons which now serve as crossheads confining the side loads to the crankcase. The steam cylinders are isolated from the crankcase with gaskets and packing. Poppet valves driven by camshafts are employed. There are two separate lubrication systems. The crankcase is lubricated in the same way as a diesel engine except that the oil will not be contaminated by products of combustion and will therefore last longer. The steam cylinders are lubricated by injecting steam oil directly into the cylinders.

The CE-635 is fully condensing rejecting waste heat to the environment in order to recover process water. This means that the locomotive only has to carry make-up water on board to account for normal operating losses. The system will condense at slightly above atmospheric pressure, enabling simple venting of noncondensable gases, and eliminating the pumps, extra plumbing, and complexity associated with vacuum systems. Water will be returned to the hotwell (supply tank) by condenser steam pressure via a steam trap.

Condensing pressure will be controlled to within 1 or 2 psi by sequential operation of condenser fans and shutters. The fans will follow steam pressure and be sized to accommodate an extreme such as desert heat conditions. The shutters are intended to allow operation at below freezing ambients and will be controlled by condensate temperature; above freezing they will generally be wide open to minimize fan power.

C. The Steam Generator

Central to the NSPC design is the Wormser Grate two stage fluidized bed coal combustion system manufactured by Wormser Engineering of Woburn, MA. The Wormser Grate can burn the very cheapest grades of coal and produce 32,000 lb/hr of steam at 1000 deg F and 1000 psi while meeting all present and anticipated Federal and State air quality standards. Wormser Grate separates the chemistry of combustion from that of desulfurization by employing two shallow beds each less than a foot deep: a lower bed of sand and an upper bed of limestone. The upper bed is supported by a perforated plate through which the hot gas passes. Submersed in the lower bed are sparge tubes through which the combustion air passes. This is shown in Figure 3. The air has enough velocity to “fluidize” both beds causing them to resemble gently boiling porridge. The grate is started by preheating the combustion air until the sand reaches about 1200 deg F. Then coal is introduced pneumatically, and combustion begins. Coal is fired at 1700 deg F and combustion is nearly complete. Any unburned coal fines which might leave the combustion bed are burned in the limestone bed. This 1700 degree temperature is below that at which oxides of nitrogen are formed and below the ash fusion temperature. This means a major pollutant is eliminated immediately, and no clinkers are formed. Steam tubes pass directly over the bed in such a way that the hot sand is in contact with them when the combustion air is on.

The hot gases leave the combustion bed and pass through the limestone bed. Because they must traverse the entire depth of this bed, the rate of sulfur removal is very high, about 99%. The sulfur dioxide in the combustion gases combines with the limestone forming calcium sulfate - ordinary gypsum. The spent limestone can actually be used to make concrete. The limestone is continuously replenished with a limestone-water slurry. Spent limestone continuously drains from the bed and is carried to the tender. Of course, the Wormser Grate burns low sulfur coal even more efficiently than high sulfur coal. In this case no limestone is required; the upper bed is simply a second bed of sand in which the small percentage of coal fines escaping the lower bed is fired.

The gases leave the limestone bed at about 1550 deg F and pass into the waste heat boiler which contains the superheater. The gases exit the superheater and pass to the economizer which is on the tender. They leave the economizer and then go to the baghouse where the ash is removed.

By varying the combustion airflow and utilizing partitions in the beds a 12 to 1 continuously modulated turn-down can be achieved. This means that the CE-635 can follow changes in load in exactly the same manner as a conventional diesel-electric locomotive. The Wormser Grate is fully automatic and its control system will be integrated with the overall locomotive control system. The CE-635 operator controls will be practically identical to the existing diesel both in appearance and operation.

D. The Tender

The tender for the CE-635 is shown in Figure 1. It contains the baghouse for removing flyash from the exhaust gases, as well as 42 tons of crushed coal. Also on the tender is up to 12 tons of limestone and storage for the spent limestone. The tender houses the coal drier and the transport air blower as well. The tender will be supplied either as a passive unit or as a slug. A slug contains traction motors, but no prime mover. It draws power from the locomotive and is used to provide added tractive effort in starting heavy trains or on steep grades.

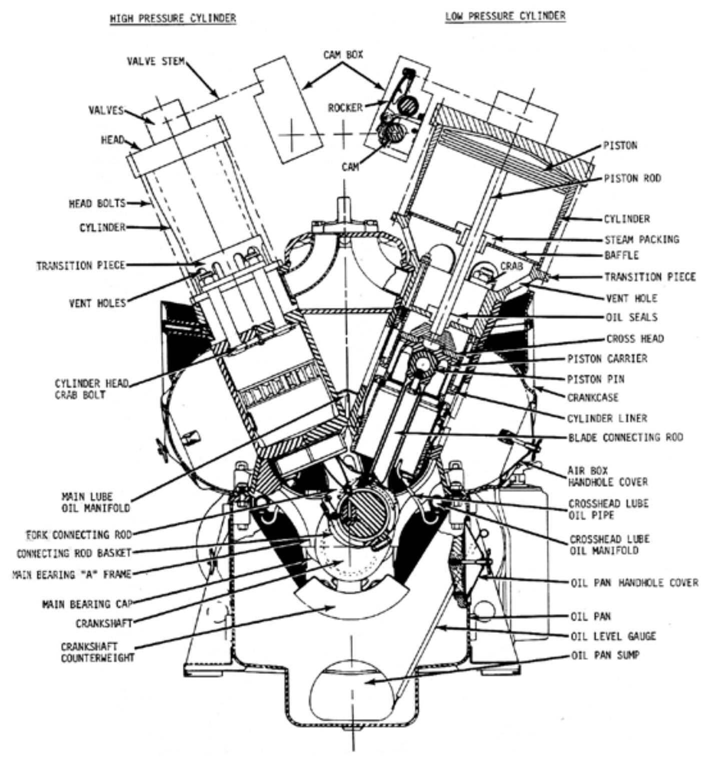


Figure 2. A cross section through the engine.

E. The Control System

The control system of the CE-635 must monitor and regulate more functions than on a diesel-electric locomotive. This is primarily due to the addition of a second major system, the boiler. On the coal-electric locomotive the analogue of controlling the amount of fuel into the diesel engine is regulating the steam throttle and the valve cutoff (the latter determines the mass of steam admitted to the cylinder during each cycle). In addition the following boiler functions must also be controlled: 1) start-up, 2) combustion bed temperature, 3) combustion air flow, 4) coal feed rate, 5) steam drum pressure, 6) limestone feed rate, and 7) limestone bed temperature. Using modern microprocessor technology, all of these power plant functions will be regulated automatically. In addition the NSPC power plant control system will be integrated with the existing diesel locomotive control system in such a way that the operator will find practically no difference either in appearance or operation between the coal-electric and the diesel-electric unit. The coal-electric will operate exactly like the existing diesel-electric with respect to MU control, braking (both dynamic and air), and wheel slip control.

V. SUPPORT REQUIREMENTS

Because the NSPC engine components are of the same scale as diesel components, engine maintenance procedures will change very little. Since the crankcase oil is cool and uncontaminated by operation, major engine overhauls are expected to be far less frequent than diesels. Periodic maintenance (crankcase oil changes) will also be reduced. Shops will have to add some equipment for boiler maintenance. Boiler maintenance will include regularly scheduled cleanout and replacing the steam tubes. The latter is expected to take place about every five years. Shop personnel will require some training in engine maintenance proce-

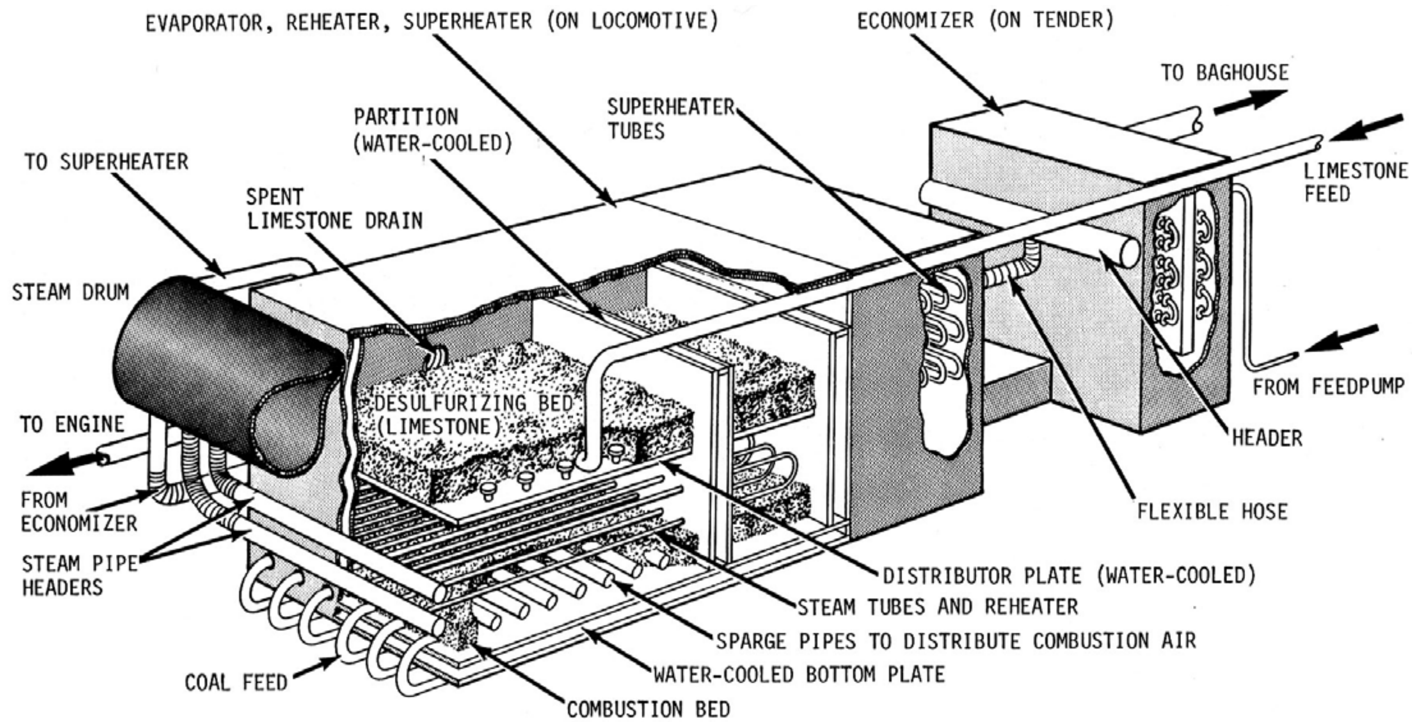


Figure 3. Wormser Grate Fluidized Bed Coal Combustion System

dures, as well as instruction in boiler maintenance.

Some retraining of operating personnel will be required, but this is expected to be minimal. Engine crews should be made aware of the operating principle of the NSPC power plant, but aside from this, limited retraining will be needed since the overall operation of the locomotive will differ little from the existing diesel.

Wayside service depots will have bunkers for the storage of both coal and limestone. The bunkers will be weatherproof to prevent freezing in the winter. The tender bunkers will be filled using a conventional pneumatic transport system. Coal will be crushed to 1/4 x 0 at a central preparation plant and transported to the depots via hopper cars or trucks. The wayside service depots will include equipment for handling spent limestone as well as facilities for treating and storing makeup water.

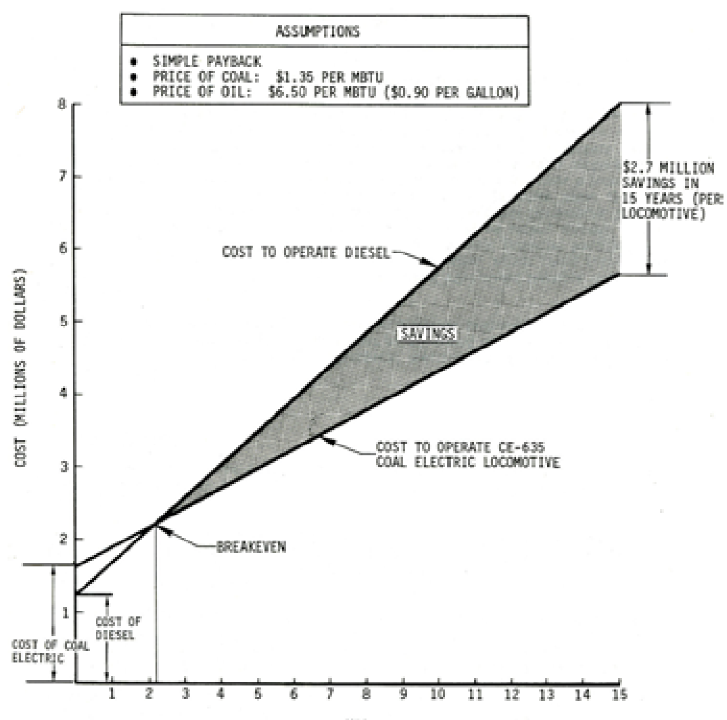
VI. THE BOTTOM LINE

The CE-635 offers the railroads a significant economic advantage over the conventional diesel-electric as well as over the competing coal powered options. The reason for this is threefold: 1) the CE-635 can burn the very cheapest grades of coal - roughly half the cost of low sulfur, double screened, and washed coal, 2) the large overlap in parts between the NSPC unit and the existing diesel means minimal increase in maintenance costs and personnel retraining and 3) the purchase price is kept to reasonable levels through minimized development costs and extensive use of existing tooled components.

Figure 4 presents a 15 year cost profile of the current diesel vs the CE-635. The costs shown are for one 3500 horsepower 6 axle, and are based on simple payback i.e., the time value of money is not considered, nor are any tax implications. The price of coal used was $1.35 per million Btu and oil was assumed to be $0.90 per gallon or about $6.50 per million Btu. With these prices the payback on the CE-635 unit is about 2 1/2 years. The annual savings per locomotive is $182,000. To get some idea of the impact this could have on a railroad, consider the following example. The Norfolk Southern Corporation owns about 2300 road haul diesels. Assume that due to depressed merchandise traffic in 1982, that 1300 locomotives were mothballed and that the remaining 1000 units were CE-635's rather than diesels. This would have saved NS approximately $182 million in 1982, increasing their total income before taxes by some 27 percent.

What's the bottom line? The CE-635 means increased earnings for the U.S. railroad industry as well as reliance on a native American resource. <|>

Figure 4. - Fifteen-Year Cost Profile: Diesel versus CE-635 Locomotive (Costs for One 3500- horsepower, six-axle locomotive)



Feed Water Management

Jerry Peoples

The following hypothetical conversation was overheard during break time at a recent Berrien Springs meet. One guy was having over heating issues with his generator and the other was trying to convince the first about a little know feed water acceleration law.

C'mon man, you got-ta get more water in your generator! It doesn't make sense — I am pumping to that cube of the speed rule. Hey, is that speed steady state or instantaneous? — Well, is not any speed by another name still speed? No, the only way to get to a steady state, is to accelerate. How does the generator known the vehicle is accelerating? Look— generators know nothing, it's up to us to take care of them. It shouldn't matter — I have a normalizer. Yea — Doble also had a normalizer and those generators were always too hot. Not correct — you forget about the compensator. Does your Honda Civic have a compensator? Hmmm — I get your point. C'mon man get with the acceleration and rid your generator of those scorched tubes. I'm confused — what about that cube rule. C'mon man — yes, the feed water acceleration law trumps the cube rule. What is this accelerating law? Well — it's about torque — see, torque gives you acceleration and acceleration is not feed water free — .

Discussion -At this junction. The most graceful and capable meet host Tom Kimmel declares an end to break time and called the meet back to order. Steady state speeds are not spontaneous! The vehicle system must be subjected to an acceleration scenario to get there. One scenario is to throttle up creating a force at the wheels commensurate with road and aerodynamics resistance at a desired steady state speed. For example, to sustain a steady state speed of 60 mph, only about 65 foot-pounds are required at the the engine. The vehicle will execute a smooth ride to 60 mph. Under this scenario, the feed water requirements obey the cubic speed law noted by Equation 1. At 60 mph the feed water

$$\dot{m} = \left(\frac{S}{40}\right)^3 = \left(\frac{60}{40}\right)^3 = 3.38 \text{ lb/min} \qquad 1$$

required by the generator is only 3.38 lb/min. While this example is technically correct, it does not represent reality because an operator will not tolerate the time to reach 60 mph with only 65 foot pounds of engine torque. Rather, the operator will throttle up near system pressure. As 60 mph is achieved the operator will throttle down to sustain 60 mph. Under this scenario, Equation 1 is not applicable because the accelerating torque will be much greater than that just to sustain 60 mph. This greater torque comes at the cost of more steam. Under this scenario the net feed water required may be calculated per Equation 2.

$$\frac{\dot{m}}{\dot{m}_o} = \left[.70\frac{T_E}{T_o} + .30\right]\frac{S}{S_o} \qquad 2$$

This equation is normalized on the basis of the maximum steam generating capacity $\dot{m}_o$ of the generator which corresponds to a steady state speed S_o. Any speed at large is, S. The engine torque at large is T_E and T_o is the engine torque commensurate with S_o. A torque ratio in combination with an instantaneous speed ratio will yield a *frozen* value of the required feed water rate. Keep in mind that a constant torque does not imply constant acceleration. For purposes of illustration, the following values have been calculated by other devices. They are compatible with a typical family style vehicle.

$$\dot{m}_o = 12 \text{ lb/min}$$
$$S_o = 100 \text{ mph}$$
$$T_o = 155 \text{ ft-lb}$$

If the operator throttles up to 80 percent of T_o, the feed water needs of the generator at 60 mph under accelerating conditions becomes 6.19 lb/min. This is 83 percent greater than the steady state requirement. The water starvation rate is initiated at about 30 mph and grows to the 83 percent deficit rate at 60 mph. If the operator throttled up to 100 percent, the increase would be 113 percent. These numbers give clearly to the root cause of the difficulties that have been associated with pressure and temperature control of the monotube generator. The same applies to power. Only 20 horsepower is required to sustain a steady state speed

$$\dot{m} = 12\left[(.7)(.8)+.3\right].6 = 6.19 \text{ lb/min}$$

of 60 mph. However, to get to 60 mph in 6 seconds, requires 150 horsepower. Thus, the impact of acceleration on feed water needs of the generator cannot be ignored.

Burnout does not occur as a single time event. It is an accumulative effect occurring over time after many acceleration cycles. Scorching and burnout may be completely eliminated by defining a base line feed water management strategy per Equation 2. First, notice that all steady state conditions are within the scope of Equation 2. Therefore, any strategy based on the cube law may be abandoned. Second, it is recognized that normalizers are band-aid type fixes that do not address the core problem. Thus, their application should be abandoned and emphasis placed on the base line strategy.

Author's comments - This article is a summary of feed water needs of the generator discussed in a larger document. This is therefore limited in scope.

For an example, it is possible to superimpose steady state feed water needs of the generator upon those demanded by conditions at acceleration. Such a chart provides a surreal picture of these two feed water states. The larger document also considers the ontological nature of steam power on other issues which reveals the complexities associated with steam engines performance and its analysis.

Finally, the author revisits a previously suggested feed water management strategy based on a combination of the Spillover and Lamont cycles. Simplicity is not necessarily synonymous with technical adequacy.

C'mon man, get with the program and avoid those scorched tubes! <|>

Doble-Sentinel Railcars and the French National Railways

Anthony R. Thomas

Excerpts from "Abner Doble and His Work at The Sentinel" by Anthony R. Thomas in The Sentinel Driver.

Readers are to be forgiven for believing that Abner's sole reason for coming to the Sentinel was to design and build a new generation steam lorry. In fact, I believe that the railway applications for his new designs were probably more important to managing director Stephen Alley than the road vehicles.

The Railbus

The first rail application was a railbus for the Southern Railway Co This was not a true Doble as it used what was to be the new 'S' type waggon boiler with auto-stoker operating at 375 psi and therefore required none of the complex Doble controls.

Fig 30- This view of the Southern Railway railbus was taken on the Dyke Branch in May 1933 where it was thought it would be ideal for the tight curves and steep gradients, Photo: A.R. Thomas collection

The engine drawing is dated February 1932, just two months before the first Doble lorry appeared on the road, and the drawing quotes a horsepower of 110.

Full details of performance were quoted in the March 1932 Sentinel rail catalogue although this first railbus was not built until a year later and delivered to the Southern Railway in May 1933.

Fig 31 - This is a view of the railbus chassis before the Metropolitain-Cammel body was fitted. The test driver here was George Woodvine, then Works Manager at Sentinel. Photo: A.R. Thomas collection

After only two years service on the Dyke branch the railbus was moved to the Dunton Green - Westerham branch where it was finally withdrawn around 1943.

Four other railbuses to the same design were produced for the Peruvian Railways in June 1934 and that was all.

The L.M.S. Shunting Loco.

It is almost certain that Stephen Alley intended to develop a range of true Doble railcars and locos using the high pressure boilers and controls as used in the lorry. As it turned out only one loco was built, this a shunting loco for the L.M.S.

The L.M.S. had ordered a total of two locos and three railcars, the first of these, loco No 8805, was delivered in May 1933. This had two of the railbus type engines, but operating at 1500 psi they gave 150 hp each. A special oil-fired lorry type flash-steam boiler was used to produce some 2100 lbs of steam per hour and large condensers were located each side with a large fan in the roof.

The L.M.S. had some difficulty in finding competent staff to maintain the loco as the skills needed were very different from the conventional locos of the day. In the event the order for the other loco and railcars was cancelled although No 8805 continued in use up to 1943.

German Developments

Warren Doble had gone to Henschel's in Germany in 1932. Here he managed to produce ten railcars between 1934 and 1936 using a similar design to the L.M.S. loco.

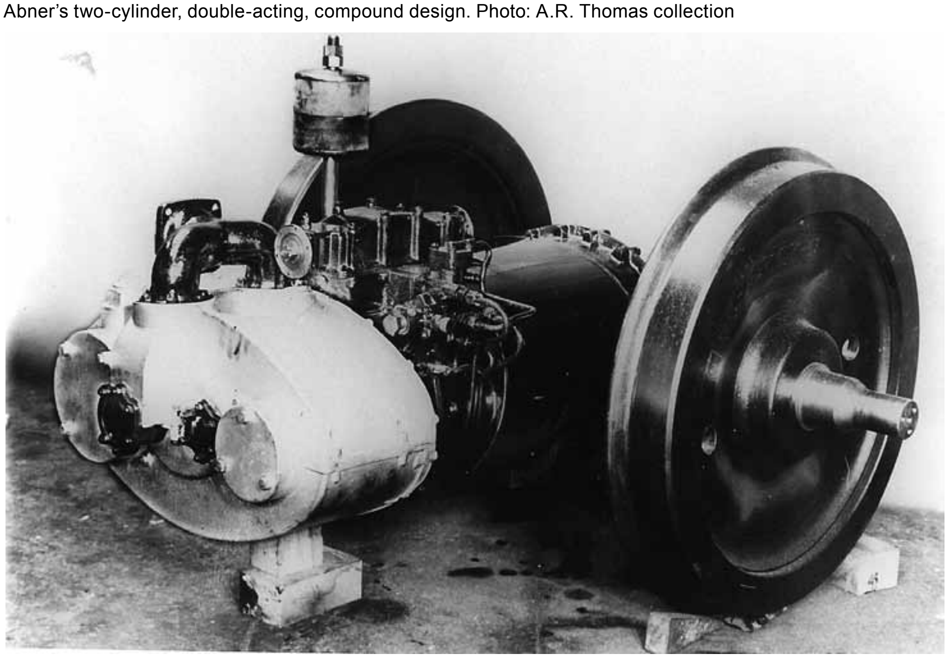
More Engine Developments and Tests

In March 1935 Abner built a 6" x 6" x 6" two-cylinder, double-acting Simple engine and tested it on his test bed in comparison with his compound engine. He later carried out similar tests on the Sentinel six-cylinder single-acting engine used in the L.N.E.R. railcars from 1929. No doubt he also had access to test data on the new four-cylinder single-acting engine used in the 'S' type waggon although I have no evidence he tested this himself.

The results therefore were most interesting :

When compared with his compound as

Fig 32 - Here is an outside view of the complete railbus engine showing the compact, totally enclosed, nature of Abner's two-cylinder, double-acting, compound design. Photo: A.R. Thomas collection



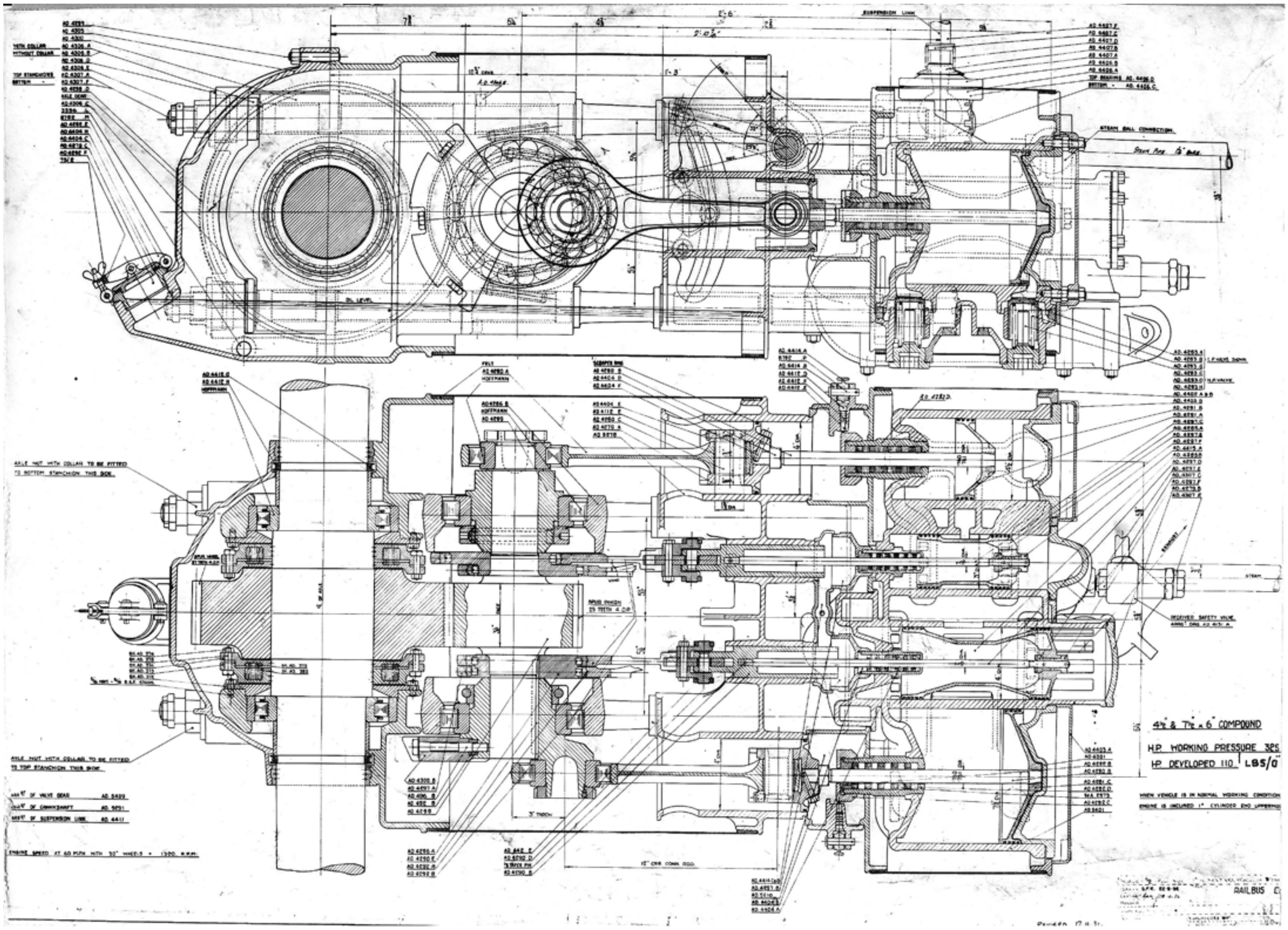


Fig 39 - This drawing of the 6'' x 6" x 6'' Doble simple engine shows the similarity to the compound version and it is thought Abner was looking for more power without too much loss of steam usage efficiency. The drawing is dated March 1935. A.R. Thomas collection

expected the simple engine produced a little more power, i.e. 164 bhp at 800 rpm with the inlet pressure around 300 psi compared with 153 bhp at 900 rpm and 460 psi for the compound.

However, as would be expected it used more steam per bhp per hour, i.e. 15.5 lbs compared with a minimum of 13.2 lbs for the compound.

More interesting was when these results were compared with the six-cylinder Sentinel engine; this gave the highest bhp at 187 with a steam consumption of 14.3 lb per bhp per hour at an inlet pressure of 300 psi.

For economy therefore the compound engine seemed satisfactory but where speed and acceleration was needed the Sentinel railcar engine was better than the Doble. Not surprisingly there are no records of any loco or railcar fitted with the Doble simple engine.

I believe these results were to have a profound effect on Abner's thinking and on the course of his later developments.

Fig 34 - This is the only true Doble loco built in Britain and was delivered in May 1933 to the LMS. Although very compact, this two engined loco could deliver some 300 hp. Photo: A.R. Thomas collection

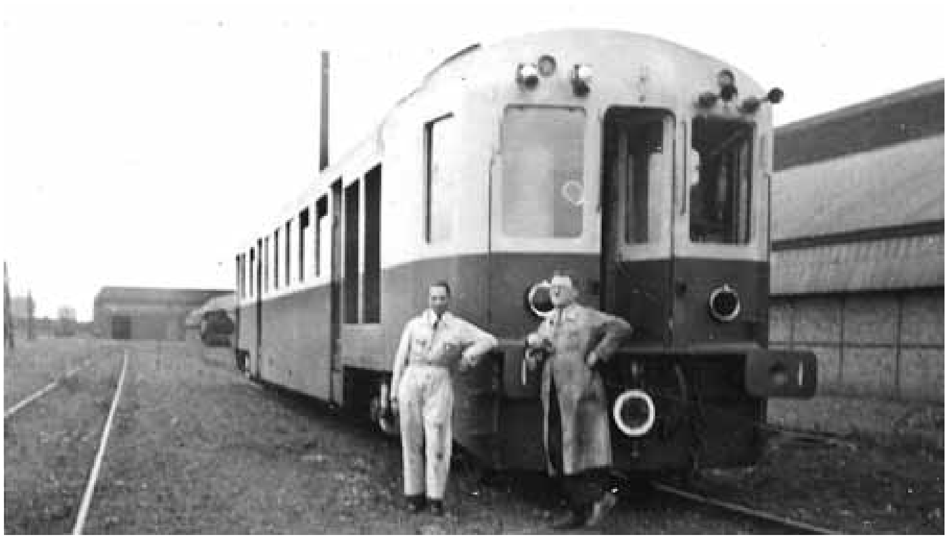


Fig 49 – Above is the first railcar built by Les Ateliers de Construction du Nord de la France in December 1935 using Doble engines and boilers supplied by Sentinel's. Photo: A.R. Thomas collection

The French Railcars

In December 1935 Sentinels entered into an agreement with the French National Railways for them to produce railcars using Sentinel-Doble engines and special 335 psi oil-fired boilers Sentinel supplied the first two sets, works Nos 9173 and 9174, but it is not known how many were built in France.

Bulletin readers can have the complete, detailed 60 page booklet, Abner Doble & His Work at the Sentinel, by the author. Send a cheque for £10.00 and your home address to A. R. Thomas, Woodpecker Lodge, Barneshall Avenue, Worcester, WR5 3EU <|>

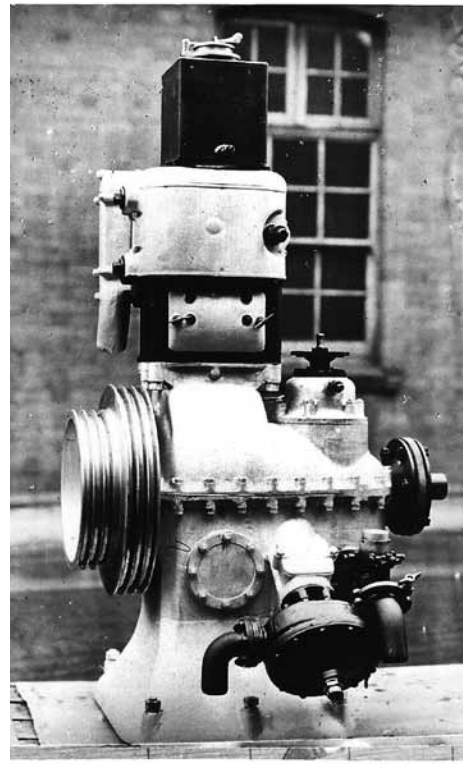
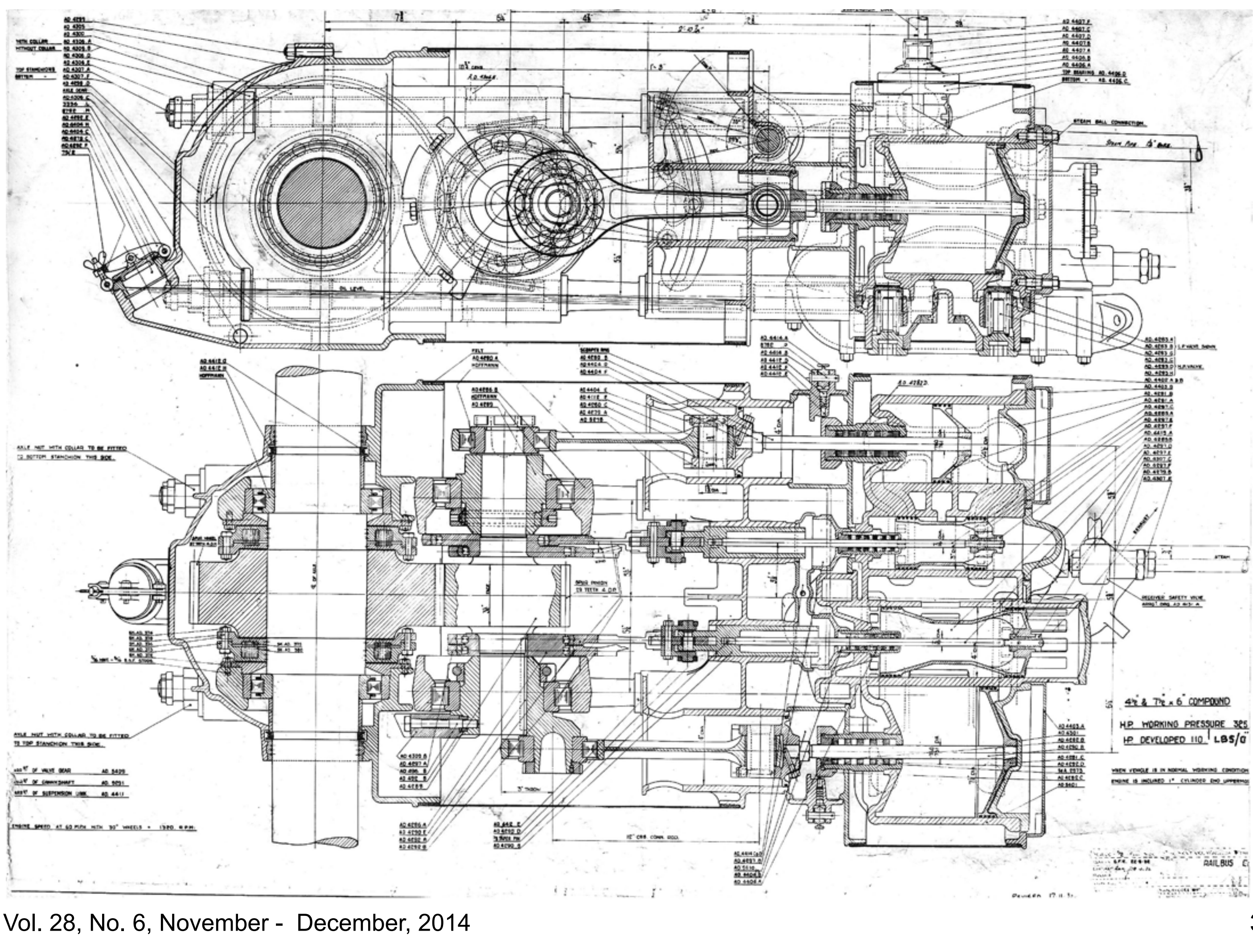


Fig 50 - This is the special Sentinel two-cylinder auxiliary engine developed for the French railcars. A.R. Thomas collection

Fig 39 - This drawing of the 6'' x 6" x 6'' Doble simple engine shows the similarity to the compound version and it is thought Abner was looking for more power without too much loss of steam usage efficiency. The drawing is dated March 1935. A.R. Thomas collection



2014 Island Navigator Tour - First Pictures

Pat Farrell

John Gurney's 1906 White model F Touring

John Kieper's 1918 Stanley model 735B

Gleason's 1918 Stanley model 735, Schroeder's 1922 Stanley model 735 B, Findlay's 1911 Stanley model 62 Roadster

Rob William's 1910 Model OO White model touring

Farrell's 1911 Stanley model 85 touring parked next to Gil Klecan's 1913 Pierce Arrow Race about

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