McCullogh

Joan S-B

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# STEAM CARS - PAST, PRESENT AND FUTURE

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STEAM POWER CLUB

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When Cal Tinkham invited me to speak to a group during the course of the Swop Meet I did not fully understand that he was talking about a meeting of steam car buffs and it was only last night that I realised that this meeting tonight would be in fact a meeting of the Steam Power Club. ~~I feel flattered and honored to speak before such a distinguished group.~~ I have spoken about steam cars before to many people at various meetings, but never before has it occurred that all of the experts would be in the audience and I would be a relative amateur standing before them. I feel it a privilege and an honor to speak to such a distinguished group.

Tonight I will talk briefly about the McCulloch steam car program and reminisce a little about those long gone happy days: and from there I want to move quickly through what is happening today toward what I feel is likely to happen to the real prospects for the steam car of tomorrow. I must incidentally point out that when I refer to the steam car the term includes all Rankine cycle automotive systems, pistons, turbines, organic fluid and water based systems. It is quicker and easier to say steam car than Rankine cycle automotive power plant.

Abner Doble said...."Any dam'fool can build an engine and a boiler. It is only when you add the condenser and the accessories, and try to drive it along the road that you begin to learn about the problems of building a steam car." As one of those dam'fools who has

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actually done just that - designed, built and driven a steam car along the highway, helped very considerably by Abner himself of course - I am going to tell you some of the dam'fool things we did on the McCulloch program seventeen years ago. That was a long time ago. Most of what I have to say is likely to be of only academic interest to the space age engineers of today who know so very much more than we did about the economics of thermodynamic machinery. During those seventeen years a lot of other dam'fools have been trying their hands at building steam cars. Only a bare handful of these have reached the stage that we did, of actually driving their car along the highway under its own power and beginning to learn about the more serious problems of steam car design.

To that extent at least the McCulloch car was successful: it was a going machine with acceptable performance and the promise of being developable into a marketable piece of hardware. A great deal of valuable information was learned from it. Within the last three years, almost up to the present time, General Motors has accomplished much the same as the McCulloch program, but they have actually built and driven TWO steam cars,...and they are the only experimenters since Doble to have completely designed and built more than one steam vehicle that would actually move by itself. This deliberately excludes a number of dedicated types who have insufficient facilities to make soundly based experimental observations on their product.

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General Motors has reached some quite negative feelings about the potential of the steam car from these experiments. There is no doubt that their stockholders and directors have thoroughly rational reasons behind their conclusions no matter what the dedicated fanatic like myself would like to believe. A General Motors engineer at Montreal recently said that they had spent real money and believed their tests to be objective: that their door was always open; if there was anything new to be learned please come and tell them. Otherwise, as far as they were concerned the steam car was on the back burner.

Let's get to the McCulloch steam car. My principal activity was concerned with boiler design and development, and there were days when one really felt that engineering was a perilous profession. Early in the program we were getting to the stage of preliminary tests of the boiler. Our boiler - Abner's and mine - was set up in the test cell, a fire-proof room next to the dynamometer room, equipped with fire extinguishers, first-aid kits, armored doors, no windows, all the power, water, fuel and fiendish accessories that a Machiavelli could dream of. The feed pump and weigh tank were connected, the fuel and ignition systems had been wired and plumbed and checked out, air blower and ducting installed, steam lines installed, gages, switches and controls mounted on a control panel. One Friday afternoon we were almost ready to make the very first attempt to fire the new Doble boiler design.

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Now you will all understand without explanation that when you run air ducts and gasoline lines and wiring and ignition systems all together in the same room, about fifteen by ten with about a ten foot ceiling, it generally pays to be a little careful; and in particular it pays not to have any more people standing around than is absolutely necessary. Certainly not until there has been a little checking and exercising to find out what is reasonably safe and what is unwise. Abner was away for the weekend and there I was, ready to press the switch for the very first time. I spoke to Jim Dooley, my boss; told him my plan was to send everyone home as soon as everything had been made ready, and come in early on Saturday morning with the absolute minimum of people needed to go through the schedule of operations that I had planned out for the first attempts at ignition, to fire up the boiler and find out if our creation would actually percolate without killing anybody. Dooley agreed with this plan. (What he actually said was "It's about time you were ready with that thing..."). Again I emphasised my feelings that there should be the smallest possible number of people present. He asked about himself, and I asked in return whether he could handle any first-aid problems that might arise..... and in that way he qualified to be present at the very first firing of the McCulloch/Doble boiler.

Unknown to me he immediately called Bob McCulloch and transmitted my report of "Boiler ready". There is no way to tell the man who signs the checks that he may not visit any part of his facility at any time

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with as many visitors as he cares to bring. Bob McCulloch shared none of my inhibitions about crowded conditions in the presence of new and untried machinery. About 8.30 the next morning I shouldered my way through the dense crowd hanging around the test cell door - the kind of people who administer production facilities, and sign payroll checks, and make annual audits, and review capital distribution figures, and look for oil wells, and manage inventories, and drive sports cars; each one well endowed with a very human inquisitiveness. The crew was all ready to go and everything had been double checked. The whole crew was there, even those who would not draw any time for the Saturday work. Jim Dooley was at one doorpost, Bob McCulloch was at the other. In between and beyond them was a first-class opportunity for a very slender pick-pocket with dreams of affluence. The boiler and its equipment filled only about half the room: the other half was full of test personnel and engineers at least partly connected with the project. No one but myself had ever seen a brand new high pressure steam boiler fired for the first time.

The test schedule called for the boiler tube to be full of water with the outlet valve wide open and for the blower, ignition and fuel switches to be turned on one at a time in close succession. When the fuel reaches the igniter plug the fire is supposed to start with a smooth rumble and everything begins to get warm. With a brand new design, newly assembled for the first time, from parts made in an experimental shop, where each man is trusted to do his best, the odds against a

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successful first shot are just plain unbelievable. A large probability is that the fuel will not be properly distributed, or will be too rich or too lean to fire as it goes by the spark, and will quietly accumulate in the combustor until some odd part of it finally sees that hot little spark. The test schedule includes provision for this sort of eventuality. In this case, as in practically all of the Doble boilers, there was a large removable access plug in the boiler top which in these first trials was to be left unbolted, and restrained only by a short flexible steel cable so that it could not be inadvertently removed. By this means any sudden increase in combustor pressure could harmlessly be released without damage to the boiler or anything else. The test crew had read the instructions but had figured that nobody would be likely to steal the plug and had simply left it loose without the restraining cable. The test operator was given the nod and he switched on the blower. He switched on the ignition. He switched on the fuel. Nothing happened. We checked the spark plug.....dry and in good working order: there was no evidence of fuel vapors but the float chamber was full. Quickly the venturi system was unbolted and, sure enough, the drilled hole for the primary mixture had been omitted. It took only a few minutes to go to a drill press and put in the missing hole and reassemble for another try. Confidence had been destroyed: where else could there be some minor but disastrous error? Bob McCulloch was pacing the floor talking with one of his accountants. I gave the nod to the test operator for a second attempt.....Blower on.....Ignition on..... Fuel on.....and after a slight pause the boiler furnace lit up

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smoothly and sweetly with a low rumble just the way Abner had said it would. We switched it off.....we switched it on.....things began to warm up.....steam and water began to gurgle from the wide open outlet pipe.....everyone watched in goggle-eyed fascination and confidence was restored. We did, after all, have a boiler that made real steam.

The test cell was jammed with people; late arrivals stood on tiptoe at the door. Rapidly we went through the check-out procedures, varying draft levels and mixture strengths, making occasional puffs and bangs, and sooty smoke from time to time. We reached the stage where it became necessary to find out what happened when the timing of the starting switches was changed. Starting the boiler by operating three switches in a carefully timed sequence would not always be acceptable; what happens when they are all closed together, or when the spark-plug malfunctions, just how much safe tolerance is available? The test operator was asked to start up on a count of four with the spark switch last.....one blower....two fuel.....three.....four ignition. Many of you steam car buffs will appreciate how much our confidence had improved: we really wanted to find out, didn't we? Vaguely we tried to clear some of the crowd from the test cell but were quite confident and not really concerned. On the count of four the boiler made an extremely loud noise and the unrestrained firebox plug smartly extinguished the four flourescent tubes in the ceiling, plunging the cell into inky blackness, and showering the room with glassy fragments.

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The opening in the armored doorway was about five feet wide and everybody except the operator and myself made it through the door before the shattered glass reached the floor. Not one person was cut by flying glass.....they all made it through the door. We cleaned up the glass fragments, put the plug back in the boiler, and at long last achieved the conditions under which we could dontinue testing the new boiler in peace and quiet. That is what I mean by the perils of being in the engineering profession.....people are our most important problem.

It turned out that this number one boiler had a lifelong tendency to make pops and bangs with little provocation. During its more than one hundred hours of later operation we learned a great deal about keeping them under control. From the number two boiler onward our later designs were very much better. A month or so later number one boiler was installed in the 1953 business coupe that Ken Rudolph had been so busily preparing for it, and my boiler test cell went on to number two and later developments. Number one boiler retained its embarrassing habit of occasionally banging its way into trouble.
It was not short of power, however, and was in fact derated from 1200 F to 1000 F for most of the time that it was in the vehicle, because of certain engine problems which do not matter at this time. On one occasion the number one boiler decided to overheat while standing with Ken Rudolph and some of the others poised around the open hood.
Last I knew, Ken still had the aluminum-coated shoes that he earned that day, and he still refuses to talk with me rationally on that subject.

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Another time Jim Dooley expressed a desire to find out what happened if he simply pushed his foot to the floor from a standing start. What happened was that one of the wheel drive shafts was wrung off like a carrot, while the engine overspeeded like a banshee. A moment later Jim and three pale-faced engineers stepped out of the disabled car and started to push it back into the shop.

One of the things that the McCulloch car did not have was a transmission, and the most interesting thing about recent developments is that in 1971 all of the steam cars that have been publicised to any extent are using one or another kind of variable ratio transmission between the engine and the driving wheels. At the recent Montreal SAE meeting many papers on automotive topics were presented including some on pollution problems and one or two on the so-called unconventional power plant systems. I was interested in one question about why an engine with the torque characteristics of the Rankine cycle would find it necessary to use a variable ratio transmission and slipping clutch in the main power train in 1971, when all the old-time steamers had been able to manage without. It seems that today's automotive engineer feels that he needs the main engine to idle when parked in order to drive the air-conditioning, the power steering and other vital components. The old-time steamers had things like feed pumps and blowers which also had to operate while the vehicle was parked, and it appears that according to the latest trade-off studies and analyses it is more economic to accept the inefficiency of the transmission, and operate the engine at low efficiency

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while stationary to drive the accessories, than to save the cost of the transmission and use it to pay for an auxiliary which could be working with reasonable efficiency to drive the accessory load. The use of a variable ratio transmission and torque converter slip system in order to allow a steam engine to idle while driving an air conditioner is rather like what Abner Doble would have described as using a rubber glove to cure a leaky fountain pen.

Let us look now at what might happen in the future, and try to find some of the facts of life, even though they may not be too encouraging. Let's try to find where the steam car is going to fit in the overall scheme of things to come during the next few decades. It is extremely expensive to put an entirely novel vehicle power system into production on the Detroit scale. Prototype cars built one at a time cost hundreds of thousands of dollars today. The tooling and plant investment to build one car every ninety seconds as they do in Detroit can easily run to hundreds of millions of dollars; and this is in addition to the development money required to ensure that the prototype is in fact good enough to be producable....to make a salable,economic and competitive product.....one that you could be proud to sell to a customer. It takes many years to develop a product to this level. Present day automobiles with all their faults have many decades of development behind them. Model changes in Detroit are planned as much as five years before the hardware reaches the showroom. It's a market where sudden changes are simply unknown because of the astronomical cost of

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changing the course of flow of capital and facilities involved in such undertakings. The present internal combustion engines can be modified and improved: gadgets and other hardware can be added which move somewhat in the right direction without involving such major tooling and equipment changes, even though these changes are only a partial solution to the ultimate problem. Every effort will undoubtedly be made to keep the gas buggy in the picture: already the industry is moving this way. The steam car will take several years to reach a volume of production that will appreciably influence what is happening in Detroit, and by that time it too will be a massive and hard-to-steer industry, with such invested capital that it will not readily be able to accept change at short notice.

This hypothetical picture of steam and gasoline automobiles competing side by side in the upcoming market, aided by legislation favoring the product having the lowest pollution, may not be too fanciful.....
but just look at what happens next.....Let's go further into the future.

Breakthrough is a wonderful word. It doesn't mean much and is often used to create an impression of great things just about to happen which will alter the course of history and be a panacea for all the ills of mankind. Breakthroughs are not made by city councils or state legislatures; they are not made by federal governments or massive corporations; rarely are they made by presidents and vice-presidents; sometimes they are made by department managers and shop foremen, The nearest approach to a real-life breakthrough occurs when two guys working on different

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problems sit in the cafeteria and talk shop. Within the next twenty years, and for all I know it may already have happened, one or two or three such guys are going to be talking about microwave ovens, or generating stations, or nuclear plasmas, or satellite relay stations... and one of them is going to say, "Hey....what if we had this wave-guide, see?....and we did thus and so, and....." and he will have laid the first stone in a structure which will overwhelm both the present Auto industry and the embryonic steam car industry which no-one has yet begun to get off the ground, but which has many of us full of wild hope.

As soon as the electrically powered vehicle becomes a reasonable practicality the present system of heat engines based on Carnot derived cycles will start to become obsolete. During the decades which follow production levels will diminish and the new system will overwhelm not only the present Detroit industry but any other competitive heat engine industry, whether it has made any return on invested capital or not. What I have described is as intangible as the nuclear submarine was twenty years ago. The problem we face is how to handle the present pollution reasonably and economically, while looking objectively at this shadow of the shape of things to come.

The steam car is feasible and practical from a hardware point of view. (If anyone doubts this I am ready to show them how.) It can certainly reduce the present levels of pollution; but it seems highly unrealistic to expect a competent industrial investor to believe that there is a real prospect of a fair return for an investment of hundreds of millions of

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dollars in an industry with a prospective life of only two or three decades.

So what are the real prospects? What is going to happen in the auto industry to meet the pollution challenge right now? Can we afford to develop the steam vehicle, or any other new and radical Carnot based power plant.....or should we do the best we can to gimmick up the present internal combustion engine by adding gadgets and fiddling about, mostly at the customers expense; adding rubber gloves for each leak in the fountain of pollution, and thus get by with a minimum cost solution for maybe ten to thirty years, while we wait for the inevitable breakthrough to other power systems and a new world of clean air?

It will always be fun to build experimental automobiles, and it is always exciting to dream of production lines of steam cars..... but the open cycle steam locomotive lived and died in a little more than a hundred years: the gasoline buggy is barely seventy years old now: the four-engine propeller-driven airliner died ten years ago: the SST triplets - one is stillborn and the other two are sick babies. There may be no page in the history book with room for more than a line about names like Stanley, White and Doble. Abner Doble may already have built the very last production steam automobile..

Think about it.

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