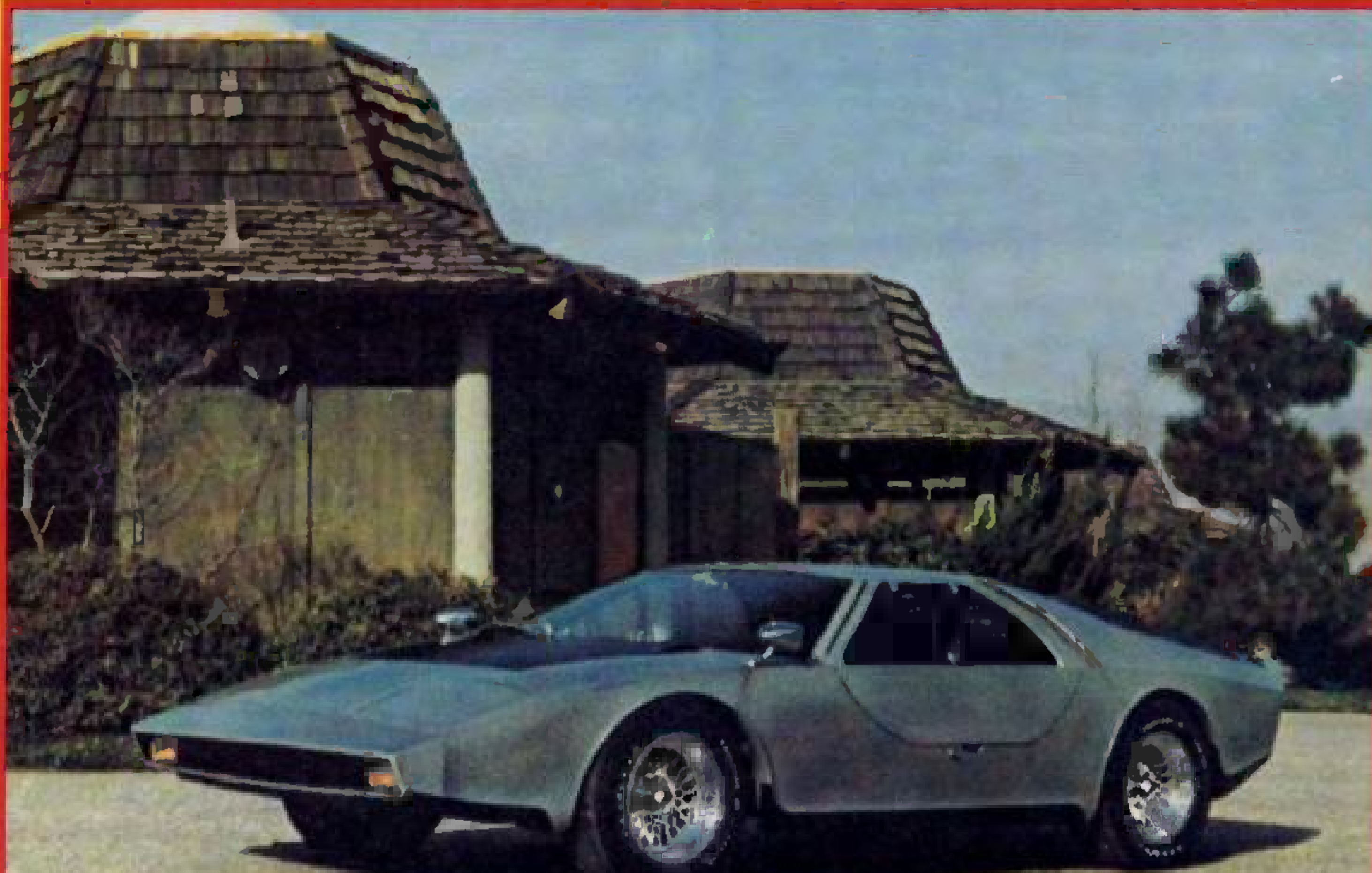
The STEAM AUTOMOBILE

Vol. 19, No. 1 1977



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COVER PICTURE: The Fiberfab Racer.
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The STEAM AUTOMOBILE is published by and for the Steam Automobile Club of America, Inc., a non-profit organization dedicated to the preservation of steam car history, the restoration of antique steam cars, aiding the development of a modern steam car, and interesting the manufacturers in producing a modern steam car. The STEAM AUTOMOBILE will accept for publication suitable material dealing with subjects which fall within the above areas. Address all communications regarding editorial matter or advertisements to: Editor, The STEAM AUTOMOBILE, P.O. Box 529, Pleasant Garden, N.C. 27313. Include zip code number with all return addresses.

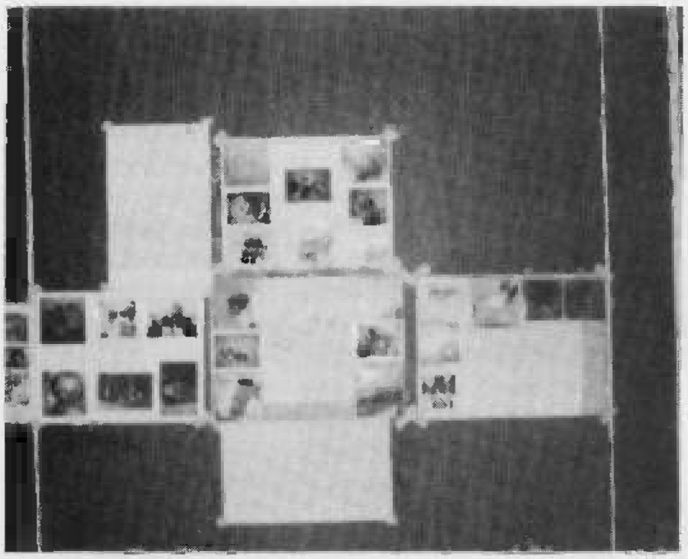
CHICAGO STEAM AUTO SEMINAR

Sept. 9, 10, 11, 1976

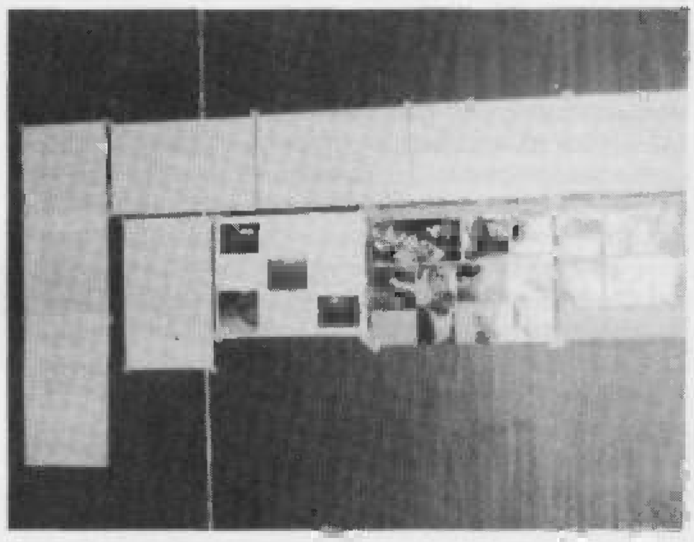
By C. A. Cummings

Photos by Roy Kruggel, James Langford and Lucy Lyon.

Steam enthusiasts who braved Chicago's Thursday morning drizzle were rewarded when sunshine and temperatures in the 60's and 70's came in the afternoon to brighten our outlook and stay with us for the rest of the seminar. Indoors at the Exel Inn O'Hare, they could hear speeches and see and fondle small display items, while outdoors they could see and ride some larger displays. From Thursday morning until the closing Saturday evening, the type of informative talk that could not be found in textbooks flowed among both the attendees interested in hints and kinks in restoring antique steam automobiles and those interested in newest developments on modern steamers.



One of the wall displays of Graeme J. Vagg of Australia.



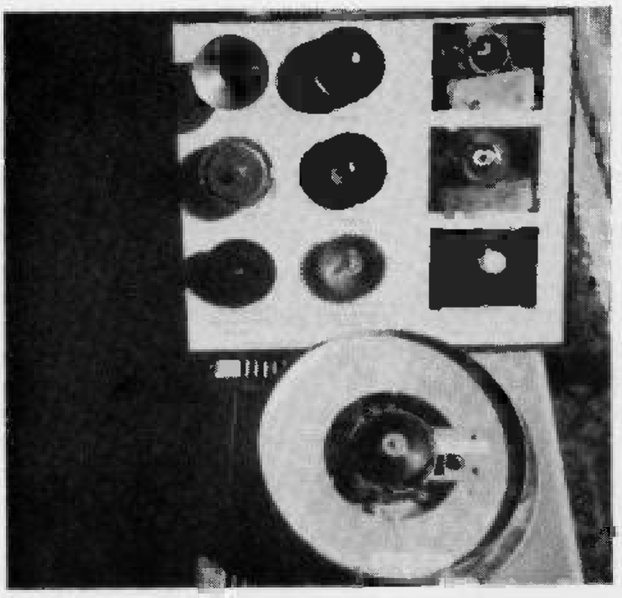
Another of Vagg's wall displays.

During the hospitality and registration period on Thursday morning, we could see the inside displays and talk with those who furnished the items. From Lt. Comdr. Graeme J. Vagg of Australia were pictures and drawings depicting "Features of Reciprocating Expander Development", including 1976 Barrett Steam Car components, a VW conversion engine, and a steam tricycle. Mrs. Robert L. Lyon had newspaper articles regarding taxis of the future and steam cars of the past, and a table display of Stanley steam car components. Doug Garner displayed stages in the development of the spinning cup burner. William J. Ryan displayed a small model of a Stanley engine, a winder for pancake boiler coils and a simple, single-cylinder engine. A large aluminum casting was displayed by Quality Castings, Inc. with the machine work on the casting performed by Gibbs Machine, Inc. T. A. Gibbs and A. R. Gibbs (sons of Mr. & Mrs. R. A. Gibbs are president and manager of these concerns).

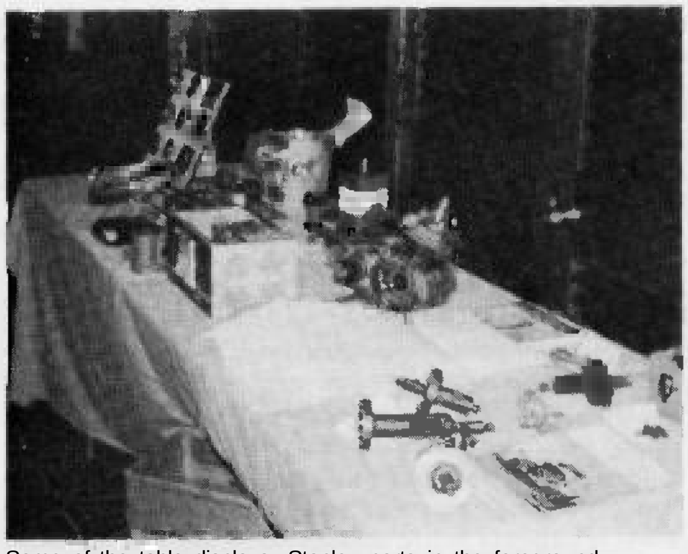
In his opening address, President R. A. Gibbs welcomed all to this third annual seminar in Chicago and urged that contributions of time, thinking and money are much needed to keep the club ongoing. The loss of our founder and longtime president, Robert L. Lyon, has made these needs much more pronounced than before as he unhesitatingly devoted much of all three needs to the club for many years. Fondly recalled and notably missed was the whistle he would blow to summon order at this and many other meets and seminars.

President Gibbs then introduced the first speaker, George D. Greene of Clayton, Missouri, who took us "Behind the Wheel of a Stanley Steamer." Mr. Greene related the restoration and operation of his Model 735 Stanley from purchase in 1953 in badly deteriorated condition to his drive to the Glidden Tour at French Lick, Indiana, with much help during the restoration years from Messrs. Lyon, Eckel, Ellis, Marshall, and others. Although a galled cross head laid up the car in the travel to French Lick, he received the tour emblem on the basis that he covered more miles than those on the hub tour anyway. He completed the hub tour in a Packard. Toils of his construction of a new boiler for his Model 735 in his basement were topped when after struggling to carry it up the basement steps that the completed unit was full of water.

Vice-President S. S. Miner of Niles, Michigan, delivered a paper entitled, "A Characterization of Steam Generator Performance Resulting from Analytical Procedures Accounting for Boiling Regimes and Two-Phase Flow", written by Jerry A. Peoples of Huntsville, Alabama. The author stated the objectives were to characterize steam generator behavior (what is happening inside) and to establish the sensitivity behavior to pressures and temperatures. He accounts for four regimes in



Display of Doug Garner's development of his spinning cup burner.



Some of the table displays. Stanley parts in the foreground

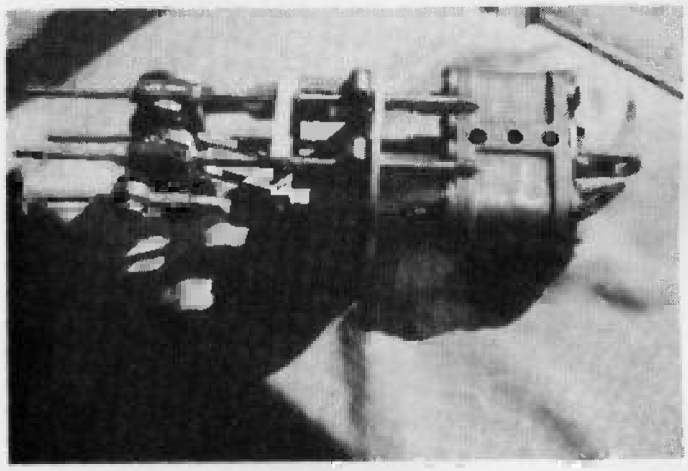
the water tube boiler in progression from water inlet to steam outlet; preheater, nucleate, film, and superheat.

The action occuring in these regimes was discussed as they affect steam generator design parameters such as tube length, and location of tube sections with respect to the combustion gas temperature profile. For example, the film and superheat regimes should not be in regions of excessively high gas temperatures (to prevent tube burnout), while the low-quality boiling regime might as well be exposed to the greatest gas temperatures (because heat transfer is best). Consideration of two-phase flow (steam/water) within the boiler was entered in the design analysis. Results of his analysis indicate that (a) a single design is valid for a wide range of fuel and air flow, (b) the insensitivity of tube length to supply pressure and (c) the weak sensitivity of tube length to temperature. The analysis provides a basis for justifying the development of a variable pressure generator concept. Gene Hise recommended that it be included in a future article in The STEAM AUTOMOBILE.

Harry G. Peterson, a consultant from Camp Point, Illinois, described the construction of a steam generator, burner, and controls for a Model 735 Stanley. His slides and blackboard diagrams showed the details of this construction effort. With the pancake-coil type of monotube generator, steam pressure sufficient to move the car can be raised in two minutes, and 45 to 50 mph can be maintained. The water rate is a high 25 lb/hp-hr, and the firing rate, 5.5 gal/hr of No. 2 fuel oil. The pancake coils are iron pipe, half inch and ¾ inch sizes, 10 inches inside diameter. A volute housing brings air to the burner which fires vertically with 3 atomizing nozzles. A Model T Ford spark plug on the second set of coils from the bottom serves as a water level sensor for an electronic control devised by Doug Garner. This controls a solenoid on the bypass water line. The burner is controlled by a thermoswitch (through an amplifying circuit) in the top of the generator. Over-the-road experience has demonstrated that these controls work in spite of buildup of deposits.

We then adjourned for dinner, after which some movies of past meets were shown. At Mr. Gibbs' Greensboro estate, moving under steam could be seen: Lyon's "Locomotive" Stanley, Chaddock's Steam Motorcycle, Gibbs' 1901 White, plus others. The "Broadway Revue", a group of two young couples, provided musical entertainment of old time medleys, assisted by their accompanist on the piano. Well done numbers included "Hot Time in the Old Town Tonight" and "Wait 'Till the Sun Shines, Nellie".

Vice President Sam Miner began Friday morning's session by soliciting our response to some questions. Our responses were to assist the Board of Directors in making plans for the future of the Club. Suggestions were requested for reducing expenses, which at present are larger than income. Measures to be taken include: the lease on the 333 N. Michigan Avenue office (the rental on which Mr. & Mrs. Lyon have been paying for the past four years) will not be renewed when it expires in February, attempts are underway to reduce the magazine cost of printing, and various methods to increase membership were urged. Methods suggested for increasing membership were



William Ryan's model of a Stanley engine.

George Greene of Clayton, Missouri, telling about his experiences in restoring Stanleys and on Glidden Tours.

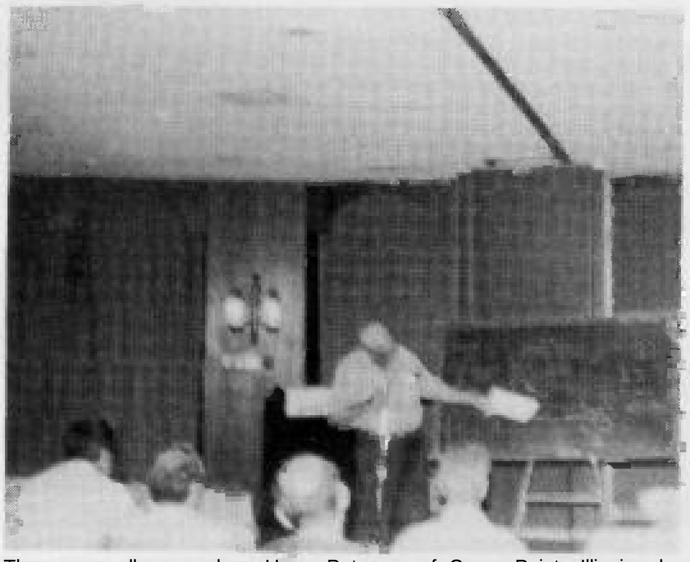
advertising and displaying some issues of The STEAM AUTOMOBILE on newsstands frequented by hobbyists, solicit aid from local automobile dealerships in providing space for steam club activities, and the offering for sale of drawings, plans, and sketches for steam conversions and construction of steam auto components. It is understood that SACA has to remain noncommittal in offering information for sale; i.e., that a guarantee is not implied that safe, efficient performance will occur if the drawings are followed conscientiously.

Gregory T. Jeffrey of Union Carbide Corporation described uses of graphite products for difficult sealing applications. He showed films pertaining to uses in nuclear power generation and petroleum refining plants. Advantages of the "grafoil" and related trade name products are that they may be used in oxydizing atmospheres up to 800°F, and they are nearly completely inert, corrosion resistant, and contain no binders. Although expensive in comparison to other seal materials, experience has shown that much lower maintenance is achieved.

Friday afternoon's sessions were begun by Lt. Comdr. Vagg with a description in detail of a low-cost modern steam system for your 1977 automobile. He favors conversion of a Volkswagen chassis because of the readily available supply of components at a generally low cost. Fabricated steam cylinders are bolted to an unmodified VW crankcase. A crankshaft from the 1500 cc engine is used, preferably with strengthening fillets welded in the corners where small radii exist. Connecting rods from the 1600 cc engine are used. Stainless steel heat-shielding plates are affixed to the tops of VW 70 mm ductile-iron pistons with three fabricated impulse valve pins. Impulse intake valves are hard 7/16 inch diameter balls, seating against a soft 3/8 inch diameter seat, three per cylinder. A ¼ inch diameter pin is arranged dimensionally to provide a 0.045- to 0.060-inch lift. Exhaust ports are 16 holes, 3/8 inch diameter, fully uncovered at the bottom of the piston stroke. This expander is believed capable of accepting steam at 1,000 psi and 1,000°F, and operating at up to 4,000 rpm. The completed conversion measures 22 inches wide and 12 inches long.

With pictures, he illustrated stages of construction of a steam generator with pancake coils of 3/8 inch O.D., 0.049-inch thick wall, seam-welded, mild steel tubing; and the lacing of 20 coils together with 1/8 inch stainless steel wire. A commercial Monarch SPS atomizing nozzle provided a firing rate from 3 gal/hr, down to 1 gal/hr. A three-cylinder water pump was home-made. It has roller eccentrics for a ½ inch stroke, moving ½ inch diameter, spring returned pistons, and it runs at ½ of engine speed.

Movies were shown of the firing-up and the over-the-road operation of Peter Barrett's car, without body. It was a bit eerie to see the road surface whistling past the exposed front tire at 35 mph. A pair of large truck radiators at the rear serve as condensers; farther forward are the expander and other steam equipment, just behind the driver.



They were all ears when Harry Peterson of Camp Point, Illinois, described his construction projects with slides and blackboard diagrams.

The "Broadway Revue" entertaining the members at the Thursday evening meal.

The development of a simple, spinning-cup burner was described by H. Douglas Garner of NASA Langley Research Center, Virginia. The need for this type of burner arose because atomizing type burners (a) require high power input to a fuel pump and (b) provide only a limited turndown ratio. In initial stages of development he had the spinning cup on the same hollow shaft with the air blower and with fuel entering through the hollow shaft. After three spark plugs failed to ignite reliably the fuel-air mixture, he received the suggestion from J. Carter, Sr. to use one plug with long electrodes located about one inch radially away from the edge of the cup. This worked. Next, Doug took Ed Blakeman's suggestion to supply fuel through a tube located above the spinning disc. This also worked satisfactorily. Doug showed slides detailing his most successful design of generator with stationary swirl vanes and folded-tab spinning cup. He brought his jig for folding the tabs on the dished spinning cup, called a "tab tweaker" and demonstrated its use. His design of burner controls was made responsive to steam pressure, which parameter controls, in turn, a fuel flow valve and the blower motor speed. The fuel valve motion moves a potentiometer in a pulse-width modulation circuit, supplying current to the blower motor. An air flow transducer supplies a feedback signal to this modulator. Doug's control for water flow to the generator in response to tube temperature was explained earlier by Mr. Peterson.

President Gibbs introduced Eugene C. Hise of Oak Ridge National Laboratory and stated that Gene would deliver a proposal for an automobile project for SACA members. Gene said that some background would come first. About eight years ago, hearing of Mr. Gibb's elliptocline steam engine brought forth a latent desire to build a steam auto. So, Gene visited Mr. Gibbs, intending to buy components. After showing Gene around the Greensboro shops and demonstrating his steamers, Mr. Gibbs stated that nothing could be bought as no designed equipment existed. He, therefore, advised Gene to build his own.

Graeme J. Vagg describing his low-cost modern steam system for your 1977 automobile, converting a Volkswagen chassis.

Gene started with the fire. His wife doubled the fire insurance on their property after Gene's first burner experiments. He talked friends into helping him, and organized the Mobile Steam Society. Much was learned from others: Peterson, monotube boiler; Carters, engine efficiency; Smith, bash valves; Reynolds, burners; Garner, spinning cup. The MSS developed its own steam auto controls. Therefore, with what Gene had seen so many people accomplish, he is convinced that through the efforts of many SACA members, the technology exists to build acceptable steam automobiles. He thus urges cars be built, and by the barter system.

Each participant would make parts for a standardized design for ten cars. Parts would be bartered on the equality of value of effort, material, etc. With such a cooperative effort, he believes costs can be brought within bounds. Graeme Vagg estimated that $1,000 to $1,500 each would be involved, con-

Gregory T. Jeffrey with some of the graphite products of Union Carbide Corporation applicable for steam cars.

Jay Carter, Jr. telling of the results of the Taxi Project and the status of their VW Dasher program. E. C. Hise, and R. A. Gibbs at the head table (left to right).

James N. Gibson telling the members about Gulf Oil Company's situation regarding the energy crisis and what they are doing about it.

sidering a VW floor pan and axles at $200 together with lots of one's own labor. Graeme offered to make available his plans and reports of effort. President Gibbs stated that this must be considered a risk venture, not officially sanctioned by SACA. A notice was to be inserted in the next issue of The STEAM AUTOMOBILE (see Vol. 18, No. 3) apprising other members of this proposal and asking if they wish to participate. Thomas C. Bayles of Elkhart, Indiana, offered to take the position of communicator and treasurer, duplicating information and mailing to all participants. Eighteen SACA members donated $10.00 each to become participants in this proposal. A "Show-and-tell" is scheduled for the 1977 Greensboro meet. The name chosen is "Project Steam 77".

Because there is so much more incentive to improve something that is operating, further development of constructed steam cars will undoubtedly take place.

Brunn W. Roysden, Jr. telling about the steam-powered bicycle and his steam roadster, promising to have it on display and running on Saturday afternoon.

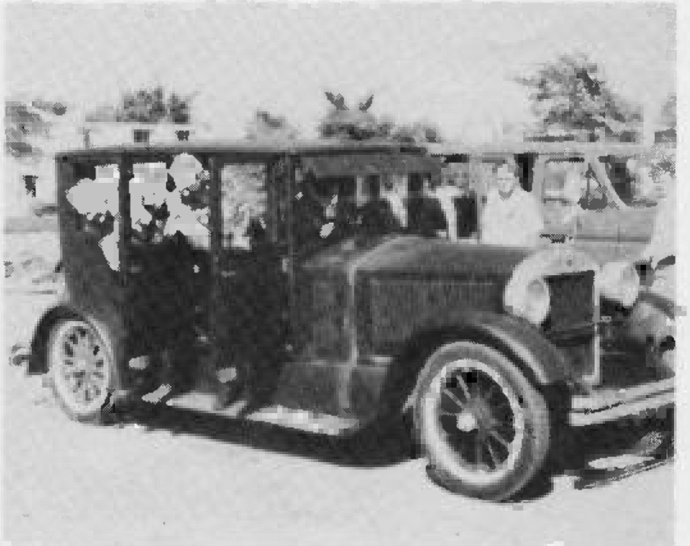
At dinner Friday evening, President Gibbs acknowledged receipt of regrets from members who could not attend, namely: Messrs. Carver, Seiple, Landry, and Langdon.

After dinner, Jay Carter, Jr., President of Jay Carter Enterprises, Inc., told of results of the Para-Transit Vehicle (Taxi Project) and the status of their VW Dasher program. Receipt of the para-transit vehicle subcontract from AMF was a result based upon the performance achievements of the Carter's VW squareback. Achievements with the squareback were impressive. It met the 1975-76 federal low-pollution standards near the end of its 6,000 mile operating life. Movies were shown of its operation at 70 mph on a Texas highway (pre-restriction era) and at the EPA test ground in Ann Arbor in May 1974.

Movies also showed the para-transit vehicle negotiating a pylon obstacle course at 45 mph. This vehicle has capacity for five passengers plus driver, weighs about 3,500 pounds, with the 359-lb steam equipment all in front, driving through an Audi transmission and front-drive axle. The expander is a 30 cubic inch, two-cylinder uniflow, 15 inches high by 12 inches long, weighs 79 lbs and develops 130 ft-lbs of torque with 2,400 psi steam. The steam generator was made from a continuous length of finned tubing, wound into 5 cycles of an hourglass helix before being compressed into a package that is only 13 inches in diameter by 18 inches high over the outside of the case, and weighing 86 lbs. Auxiliaries driven from the expander are a centrifuge for separating oil from water, a condensate pump, an oil pump, and a water pump.

Two important controls are (a) the throttle valve arranged with a safety to shut quickly if the expander speed exceeds 6,000 rpm, and (b) a solenoid-operated bypass connected into the water pump to control the boiler pressure. The expander has a somewhat large clearance volume and a fairly large steam chest volume, thus the P-V diagram is of nearly consistent shape from 2,500 to 4,500 rpm. The efficiency curve is very flat, a significant feature of this steam system and a remarkable achievement of the Carters. At 1,500 rpm, 20 per cent power, to 4,500 rpm, 100 per cent power, the BSFC is respectively, 0.76 to 0.64.

The steam system produces more Bhp/lb than most IC engines, but the peak efficiency is not as good. Jay feels that the steam system fell short of his target which was to achieve the latest emission goals. These are more stringent goals than for the 1976 production cars. He further believes that the para-transit vehicle steam system suffers from two problems. The first was that the nickel-chromium-coated copper fins on the generator tubing melted. Consequently the burner blower absorbed twice as much power as it should, and the firing rate was halved. The second problem related to the blower motor. Electronic feedback circuitry was necessary to stabilize the series-wound motor which still could not be suddenly speeded up or slowed down, even after modification. The time-frame of the project was so short that these problems could not be rectified. Even in light of these negatives, the Air Resources Board of California was impressed. Unfortunately for steam enthusiasts, the Department of Transportation will probably replace the steam system with a conventional IC engine. As for size, the condensor—4 feet wide by 2 feet high—covered the entire front of the 18-inch deep system.



Everybody was getting rides in Howard Johnson's Model 740 Stanley Sedan which he drove to the meet from Lemont, Illinois.

The VW Dasher program has incorporated design revisions based on results of the para-transit vehicle program. First, stainless steel finned tubing has been used in the generator for improved high temperature performance. Second, a shunt-wound motor requires only 0.5 seconds to speed up or slow down, and the extensive stabilization circuitry is not required. Another feature is the use of pulsed Volkswagen injector valves for fuel control. Flow is modulated by the amount of time the valves are fully opened, so that filtration to prevent plugging of tiny orifices is not necessary. Fully electronic controls are desensitized in a logarithmic fashion at low flow rates for improved "feel" of control for the driver.

Jay will close further effort at the end of this Dasher program, if no one shows interest in further development toward a production vehicle. On another subject, he revealed some ideas on a 1,250 F reheat engine which might provide better efficiency and utilize a smaller boiler. It appears so well thought out that successful operation should be positively assured. No questions from the audience could detract from the design's virtues.

On Saturday morning James N. Gibson, Engineering Advisor for Gulf Oil Company, delivered some insights regarding the energy crisis. He showed movies of refinery operations and an undersea search for oil. The dollar investment in refinery equipment is impressively high (staggering!) in millions for a 100-barrel per day refinery like that in the movie. Underwater photography below drilling platforms in the Gulf of Mexico and offshore of California not only showed the machinery, but fish swimming amid it. The presence of fish is an indication that the drilling operations are apparently not polluting the environment.

Currently, Gulf's No. 1 source of imported oil is Nigeria, second is South Arabia, and Canada is third. Generally, this imported crude requires less refining to obtain aviation and automotive gasoline than does crude from the continental 48

Brunn Roysden explaining a point to his passenger, Graeme Vagg as Sam Miner and E. C. Hise in the background discuss the car, and Harry Peterson coming up to get a closer look.

Brunn Roysden's steam roadster running in the parking lot with William Ryan of Waukegan, Illinois, ready to give assistance.

Velio Ebrok (lower right) explaining a point to Brett Everett and Graeme Vagg (left to right) at the Saturday evening banquet.

states. Mr. Gibson believes that about 15 years of proven reserves of crude oil exist. With this supply, and an increase in only 3 per cent in usage per year, he projects that gasoline will cost $2.00 per gallon in the near future. He said that most of the public appears to be living in a fool's paradise in that they do not believe facts about the shortage. In response to a question why no-lead fuel now cost more than regular, and the introduction of leaded fuel in the 1920's also resulted in a price increase, Mr. Gibson said that at present a much more sophisticated refining process is required to raise both the octane rating and keep the lead content to 0.5 per cent maximum. Mr. Gibson brought samples of crude oil from sources including: shale oil, processed coal, various states within the U.S. and many foreign countries. Notable were the yellowish Utah crude requiring steam to dislodge the solid material from the ground, and the thin Burgundy-appearing Pennsylvania crude.

Brunn W. Roysden, Jr. began description of his steam activities by showing a movie of Rex Roehl riding their steam-powered bicycle in a July 4 parade. With slides he showed progress on his steam roadster, a car which has a Model 735 Stanley engine coupled to a Model 740 rear axle, and mostly home-made parts otherwise. Brunn promised the car could be viewed in the afternoon in its present state of completion. He went on to explain the logic of the control circuitry that he developed after scrutinizing all available information from other steam enthusiasts. The control functions provide for a startup mode to fill the boiler and build up steam, a shut down mode if the fire does not appear when it should, and a normal operation mode when the car is under way. Retail surplus stores were the source of motors to operate the fuel pump, water pump (a 4-cylinder Hypro), and blower, and for componentry such as gauges, solenoids, valves and relays.

Brunn kept his promise that afternoon, because there on a trailer rested the car that few besides steam enthusiasts would admire, and all present did. Thus, it was easy to enlist helpers to get the car off the trailer and set up for steaming. The next task was to brew some of that self-lubricating working fluid, "Smithium". After a thorough checkover of the partially-complete controls, steam was generated and the car driven until a front wheel came loose. This problem, unrelated to the advances exemplified here in modern steam cars, delayed further operation for a while. Meanwhile, the steam bicycle was fired up and operated around the Exel Inn parking lot. Because it was operating in non-condensing mode, each time it was started from rest, Smithium spurted out. Oh well, good clothes and tinkering with machinery don't match each other any more than the spots on clothes from different fluids encountered during the meet.

A surprise visit from Howard Johnson, Jr. of Lemont, Illinois, was most timely and welcome during this outside display period on Saturday afternoon. He, his wife, Janis, and son, Troy, arrived in their 1924 Model 740 Stanley sedan, and they offered rides, that is, at up to 45 mph. Howard's Stanley, previously owned by Eugene Marquardt (a steam enthusiast) has been operated every year of its existence. With no-lead gasoline on both the pilot and main burner, firing into a large 23-inch boiler, the car reached 45 mph with apparent ease at 450 psi. The 4,500-lb car travels about 6 miles per gallon fuel and about 50 miles per tankfull of water. Howard said the high water consumption is due to an oil-fouled condensor. Some evidence of the consumption of water was the length of garden hose draped on the Stanley's spare tire. Howard also mentioned that he had to insulate all of the fuel lines to limit vapor-lock difficulties related to the use of no-lead gasoline. Notable was that no residue was left on the parking lot by the Stanley; e.g., no spilled oil, fuel, or condensate. Howard came to the rescue for Velio Ebrok, by supplying him not only some ¼ inch copper tubing, but a tube cutter and reamer. Velio's concern arose when his stainless steel coil of tubing was accidently broken. This stainless steel coil was to be the center feature in his after-dinner talk.

As the afternoon wore on toward dusk, we reluctantly reloaded Brunn's car on the trailer, the steam bicycle into his van, and bade the Johnsons good-bye.

At the banquet, SACA President Gibbs delivered a tribute to those who helped this seminar to be the success it was, notably to Mrs. Lyon, who has done so much in running the SACA office, answering correspondence, arranging for publication of the magazine, and making all the preparations for the speakers and the meet. Others were mentioned for their efforts in taking care of many detail factors necessary for a quality program. Vice-President Miner expressed thanks to the ladies present, who may be "steam car widows".

The results of the Board of Director's meetings were reported by President Gibbs, as follows:

1. Financially, the dues for regular members will remain at $10.00 with $25.00 for sustaining members. The

(Continued on Page 27)

The Stanley Steamer

By Revell Eckel **Photos by the Author**

Some of the legends you've heard about the great old locomotive of the highways are phony, but one did hit 197 mph before she broke up. Today a band of ardent fans still keep their Stanleys running on hot blue flame.

Utter the magic words "Stanley Steamer" in the hearing of almost anyone who is more than "?" years old, and you will very likely be treated to a little monologue which goes something like this:

"Boy, that Stanley Steamer was the greatest car ever built. Y' know the Stanley people were the greatest; they would give you a new car if you just held the throttle wide open for 3 minutes. Nobody ever did though, but those cars went so fast they couldn't be held on the road.

"Easiest car in the world to drive, though. No clutch, no shift, no nuthin'. But, even so they made you have a locomotive engineer's license to drive one. The gas car's interests put 'em out of business, propaganda and all like that."

Hogwash. I had many times heard this little recitation about the Stanley, and in my youth had actually ridden many times in my dad's 1914 Stanley Steamer, but at that time I used to look at all the valves and decided it was too complicated for me.

Then World War II came along, after which I married and began to have a family. Trying to maintain a house and a job, I lost all interest in owning a Stanley. At that time my dad had a museum with five steamers restored and about four stashed away unrestored. I wanted to own a steamer, but never thought I would have the knowledge and money to do so. So, in 1970, little to my knowledge, dad sold all the steamers to a man in Scullville, New Jersey.

They say if you heat some piping, the thing will start

I wanted to find out more about how they worked and actually how practical it was to own and run one. I decided to get all the literature and information I could and start to study about Stanley Steamers because there was one Stanley that did not go with the sale, which was a 1908 that belonged to Robert Lyon of Chicago. Since then Bob has passed on.

I joined the Steam Automobile Club of America, and this was a tremendous help. My dad was a Stanley agent in 1917 and 1924 and was known as "Mr. Steam". I suspect that this was mostly as a means of getting closer to his true love, the steam automobile, than any money he might make. In this he certainly was successful because he got to know the Stanley brothers, their racing driver, Fred Marriot, and practically every steam agent in the country. He is now up in age and can not help very much.

At first glance a steam car looks like any other automobile—it has four wheels, a hood, a dashboard, seats, and a steering wheel. But, lift the hood, and you will be shocked to see a big lump of a white drum-like affair surrounded by a lot of plumbing. That's the boiler. Under the boiler and visible by squatting in front of the car and looking at the place where the crankcase in any other car would be, is the burner. They tell you that you take a torch and heat some piping on the outside until it is red hot, then you put the tip of the torch in the little hole and turn on the pilot valve. Have you ever tried to hold the torch and reach the pilot valve? More about that later.

The dashboard is a really fearsome thing with innumerable little wheels on long stems stuck in among some very unfamiliar looking dials. Furthermore, there is no clutch pedal, no gear shift, no accelerator pedal. The pedals on the floor are a reverse pedal, a hook-up pedal, and a foot brake. On the steering column is a long throttle lever (in about the same position as a modern gear shift) which is the main speed control, which they fail to tell you to close this throttle way before coming to a corner. Do not come to the corner and then close the throttle. Nine times out of ten you will never make the corner.

On the floor, slightly aft of where an old-fashioned floor shift would be on gasoline cars, is a long handle for the hand pumps. In the old days people were braver than they are now and left the pilot light under the boiler burning all the time, so that it was always steamed up. If your wife suddenly realized that Aunt Catherine's train was due at the station in six minutes, you had to go out to the garage, release the hand brake, and without even monkeying with anything so foul as our present day self starters, you were off to the station. Nowadays, Aunt Catherine would walk or have a long wait if she had to depend on steam car transportation, because today's steam enthusiasts usually start with a stone cold boiler, and steaming up takes about half an hour. Some real steam nuts claim they can do it in fifteen minutes. Other anti-steam characters like me claim it takes all day—with luck.

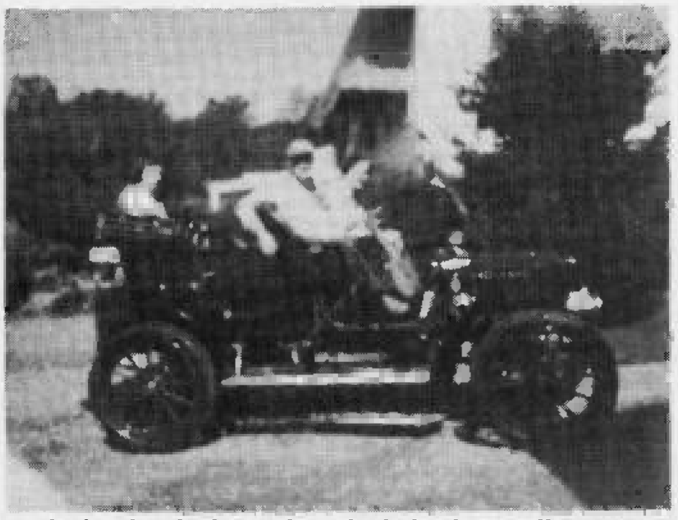
Let us go back to that big lump of white drum-like affair surrounded by a lot of plumbing. If you have ever fought a blowtorch, you will remember that you had to build up fuel pressure by pumping air into the little fuel tank, then letting a little gas in the cup below the fuel jet which you would light. This would heat the fuel jets so that the fuel coming from the tank through the jets would be vaporized, thereby giving the necessary hot blue flame.

The Stanley burner is not unlike the blowtorch, but on a gargantuan scale. It is necessary first to build up pressure in a little auxiliary tank (so that the main tank will not be under pressure). On the older models there is a little tank on the runningboard or in the car which is a pilot light tank that feeds the pilot. It also acts as a firing up for the main burner if you are using kerosene in the main burner. This small pilot tank uses white gasoline. As said before, you heat the piping going to the pilot, vaporizing the gas, and then you light the pilot. Now you can open the main burner valve slowly. If you hear a whistling noise, you know you have the valve open too far.

I would like to mention that after searching for a Stanley for the last six years, it was a little discouraging when you found one that they want anywhere from $20,000 to $40,000. It seems to me that the older generation does not realize that it will be the younger generation who will keep the old steamers going, and also in time it will be their job to keep the clubs alive. My own experience is that my father's idea was to keep the steamers in the museum to preserve them. He would not show me anything as far as steaming one up or the mechanical workings of one. I think he was afraid that I would take one out and steam it up when he was not around and perhaps ruin it. Every time I asked him to show me, he would say that it was too complicated. I am not down on my dad. I still love him, but he did not realize that it is the younger generation that has to learn all the ins and outs of these steamers in order to keep things going. Sorry to say that now he is too old and becomes confused at times when asked questions about steamers and their workings. My father sold his cars to a man who promised to keep and preserve them for generations to come, but he recently sold out, and now the cars are scattered all over. My father's desire was that his cars be kept together and not auctioned off one by one after his death.

Now I am also getting along in years and am thankful that my two sons are interested in steam cars. With God's help I know the steamers will be alive for another generation. This is what I mean when I say it is up to the younger generation to keep things going.

One day a lady said that I could use hers, and this was the greatest joy in my life. At this time my sons became interested



Look, five hundred pounds! I think the thing will go now

in steam, so we went over the car from head to foot, traced every piping and every valve, and knew the car by heart. We spent about four months on this before we decided to steam it up. This is the first time it had been steamed up since 1961. I will not go into the time we had steaming it up, but as I said before, for some of us it takes all day. Now the fuel will be heating the water in your boiler. If the water in the boiler was not up to the right level in the first place, by means of an automatic valve, it would have shut off the fuel, preventing you from burning out the boiler. Conversely, if the steam pressure gets too high, another gimmick (the steam automatic, the Stanleys call it) automatically shuts off the fuel.

After we had made enough steam, I got behind the steering wheel and pointed to the steam gauge—500 pounds per square inch. We could run on 200 if we had to, but we would have no reserve power. We released the brake and the little locking arrangement which kept the throttle from being accidentally displaced. When we moved this lever, which was long, shiny nickel-plated, and attached to the steering post, we moved off up a slight grade—just like that. We had turned no ignition key, pushed no starter button, had listened to no grinding starting motor, no sudden roar of engine, and had not stepped on

(Continued on Page 30)

Back home again with no police car following us

D-Cycle Power Systems Technical Note 7-Vapor Stirling Engine

By J. G. Davoud

This excerpt, from a letter of J. G. Davoud to S. S. Miner, is offered as introduction to this interesting article:

"As I told you briefly over the phone, and as I indicated last May in Greensboro, we cannot see a rosy future for a Rankine or indeed a D-Cycle steam engine which requires large external boiler superheaters of stainless steel or some high temperature alloy. The reason is, as I have often said, efficiency, and to get the conditions right for a valved steam engine with very high temperature and high pressure steam sets three limitations. One is the cost of the boiler-superheater, two is the problem of valving with steam in excess of 1500°, and the third is lubrication.

"For this reason, two years ago we started thinking about a steam Stirling engine of the so-called Rinia or valveless type. The cooling is done by a condenser, by removing some steam in route from the cold cylinder after it has passed through the usual heat exchanger. This means that there is only one valve, and it is a directional valve only with easy valve intervals and operating only with relatively cool steam. We think this has several advantages over the hydrogen Stirling engine. Some come to mind at once. It obviates completely the need for the complex mechanism called the roll sock to keep hydrogen in the engine, and it provides a very simple and easy way for changing pressure by changing injection rate of water into the cold cylinder. We like this especially because it makes use of the D-Cycle two-phase compression principle which we have now well and truly covered by patents. The Technical Note *1* explains this engine in some detail."

Working Substance

The working substance is steam. Steam has much lower viscosity than helium and much lower molecular weight than air. It is a suitable working fluid for a Stirling-type engine, and will probably be effectively similar to helium. See Figure 1 and Reference 1.

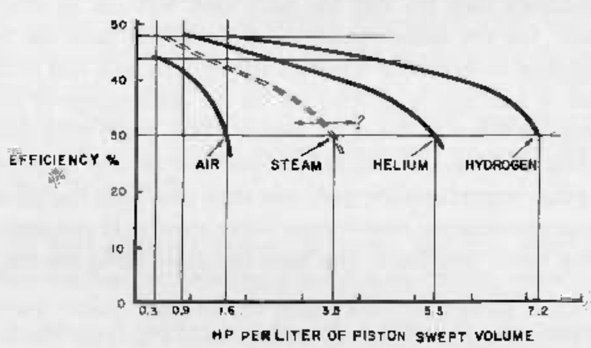
Power System

A steam-Stirling power system is shown diagrammatically in Figure 2. The engine has 3 cylinders, and the Rinia system of direct valveless connection through a heat exchanger from the hot space of each cylinder to the cold space of an adjacent cylinder. The volumetric expansion ratio of this engine is about 16: 1 (Figure 3) with a ratio of connecting rod length to stroke of 3.5: 1.

Lubrication

The engine is of the cross-head type. It is proposed to use elongated pistons and plastic (rulon) sealing rings working in the cold end of the cylinder, a technique developed successfully in various Stirling engine development programs.

OPTIMUM POSSIBLE EFFICIENCY



EFFECT OF MOLECULAR WEIGHT AND VISCOSITY OF WORKING FLUID ON POWER PER UNIT OF SWEPT VOLUME.

DATA FOR HYDROGEN, HELIUM, AIR – REFERENCE 1.

	MOLECULAR WEIGHT	VISCOSITY AT 100°C $\times 10^6$
HYDROGEN	2	104.6
HELIUM	4	234.1
STEAM	18	127
AIR	29	217.5

FIGURE 1

Heat Input

This engine can be heated by traditional techniques for Stirling engines. However, the patent will show alternative methods using a condensable heat transfer fluid. As shown, the hot space of the engine is heated by condensing vapor or possibly by circulating liquid. A boiler for a heat exchange medium is shown in Figure 2. This will greatly increase the rate of heat transfer on the outside of the cylinder and connecting tubes and eliminate the oxidizing atmosphere which is one of the factors resulting in the need for expensive alloys in current Stirling development.

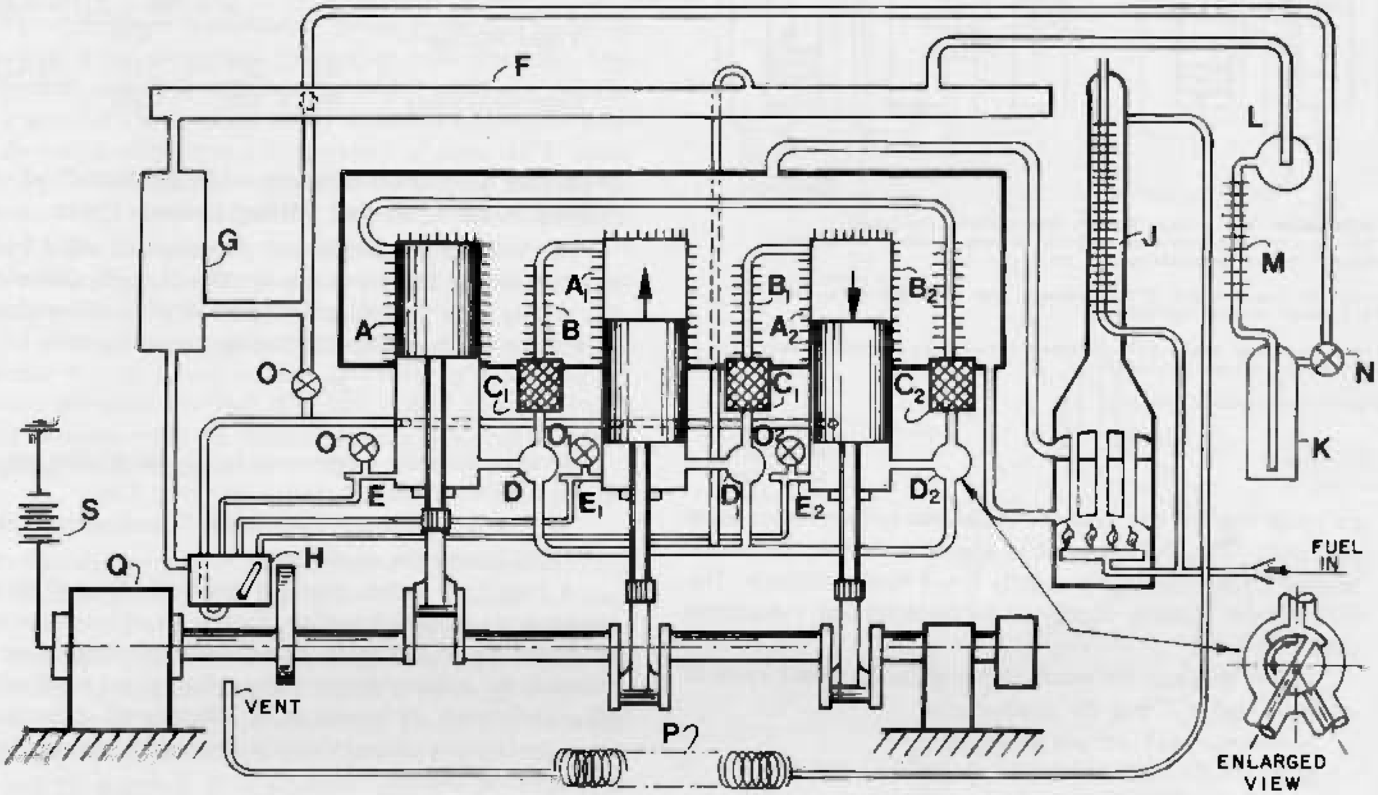
Two heat transfer media, tetra-phenyl silane (Reference 2) and elemental sulfur, appear promising. Elemental sulfur raises corrosion problems, which appear to be practically containable, and otherwise has some admirable properties, among which are light weight, low cost, low pressure at relatively high temperature, and suitable melting and boiling points, and thermal stability at all temperatures.

Cooling of Steam During Compression

The cool space is cooled internally by injection of water into steam during compression. The ideal "steam-Stirling" engine with internal cooling is shown on the T-S and P-V plane in Figure 4, together with similar diagrams for a permanent gas.

A portion of steam is removed and condensed. The point of removal is during passage from hot to cold space, after heat storage in the heat exchanger. The corresponding point is C on the phase diagrams. The most favorable time to do this between a given pair of cylinders is in the portion of the cycle depicted in Figure 5. The diagram shows that a simple oscillating or alternatively a rotary valve would have a reasonable crank interval for operation. Temperature at the valve is relatively low, and sealing is, to this extent, simplified on this account.

An important feature of this system is this: compression in the hot space is significantly decreased as the pressure during the "removal" stage is virtually constant at or close to the minimum pressure in the system. In the interval of steam removal, all compression is confined to the cold end of the cylinder pair, and the compression approaches isentropic.



A, A1, A2 — FINNED CYLINDERS
B, B1, B2 — FINNED HEATER TUBE
C, C1, C2 — HEAT EXCHANGER
D, D1, D2 — DIRECTIONAL REGULATING VALVE
E, E1, E2 — INJECTOR
F — CONDENSER
G — CONDENSATE HOT WELL
H — INJECTION PUMP
I — HEAT TRANSFER MEDIUM BOILER
J — ECONOMIZER
K — LIQUID AMMONIA CYLINDER
L — AMMONIA COMPRESSOR
M — AMMONIA CONDENSER
N — TEMPERATURE-ACTIVATED VALVE
O — CHECK VALVES ON AMMONIA LINE
P — HEATER COIL IN OIL SUMP
Q — GENERATOR
R — STARTER
S — BATTERY

FIGURE 2

Injection of Water

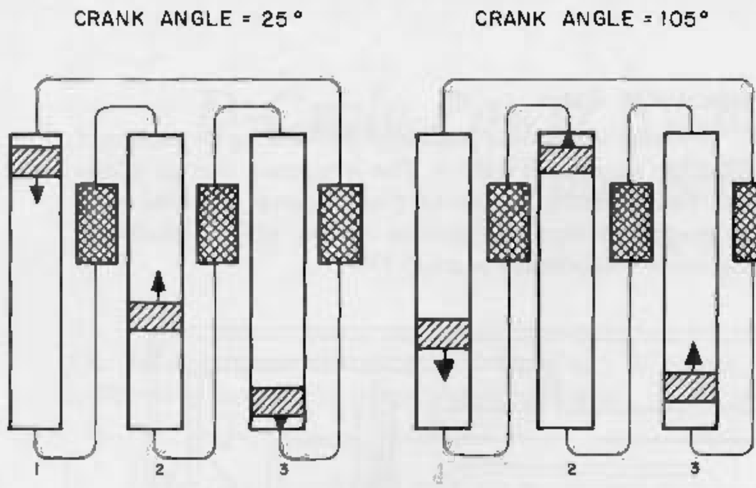
Injection should take place over 180° during the portion of the cycle shown in Figure 6. The long crank interval allows use of an eccentrically operated plunger pump. The total crank interval from start of injection in any given cylinder to maximum compression is about 270°.

Regenerative Heat Exchangers

High efficiency regenerative heat exchangers for this type of Stirling engine have already been developed and are well known. Similar regenerators can be used with steam. The proposed engine is based on compression of wet steam to a point at or close to the saturated vapor line; the cold end of the regenerator will see saturated or very nearly saturated vapor. "Blinding" of the exchanger will not be a problem.

Ideal Efficiency-Steam-Stirling Cycle vs. Stirling with Permanent Gas Working Fluid

The Stirling engine has " Carnot" or maximum theoretical efficiency between given temperature limits. Any other practi-



In 3-Cylinder Rinia Type Engine approximate position of pistons for minimum and maximum volume between adjacent pistons. Ratio connecting rod to throw 3.5: 1

Minimum at crank angle 25° between 1 and 3 is approximately 0.12 x swept volume/cylinder

Maximum at crank angle 105° between 2 and 3 is approximately 1.86 x swept volume/cylinder

Volumetric expansion ratio ≈ 16: 1

FIGURE 3

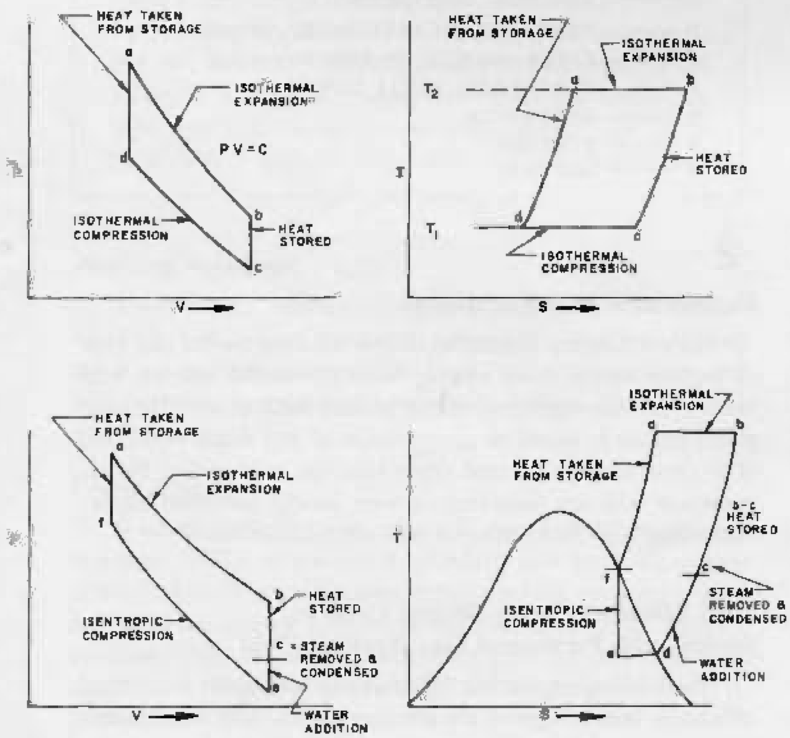
cal cycle (except, the Ericsson cycle) has to have lower ideal efficiency. The T-S diagrams in Figure 4 indicate the Vapor Stirling Cycle would have slightly lower ideal efficiency. The difference is scarcely significant as the following calculation shows.

A P-H diagram for steam showing the proposed cycle is given in Figure 7. For the steam cycle:

Isothermal work out per pound at

$$800° = \frac{86 \times 1260}{778} \times 2.3 \log \frac{640}{40} = 386 \text{ BTU}$$

FIGURE 4



"Stirling" Cycle with steam using D-Cycle principle for internal cooling

Isentropic Work of Compression from e to f is 205 BTU.

Heat required:

For isothermal expansion	386	BTU
To increase enthalpy between f and b	+228.9	
	614.9	
Taken from storage (b-c)	−157	
Total heat in per pound	457.9	BTU

Vapor Stirling $\quad n = \frac{386 - 205}{458} = 0.40$

Gaseous Stirling $\quad n = \frac{800 - 267}{800 + 460} = \frac{533}{1260} = 0.423$

Departure from Ideal Behavior—"Work Ratio" of Stirling Steam Cycle and Stirling Gaseous Cycle

The work of compression of the proposed vapor cycle is less than for the Stirling gas cycle. The example above shows this clearly. The "work ratio" (ratio of work of compression to work of expansion) in the Stirling Steam Cycle is

$$\frac{205}{386} = 0.53$$

Between the same temperature limits, the Stirling gas cycle has an ideal work ratio of $\frac{460 + 267}{460 + 800} = 0.576$

The difference is significant.

A family of curves showing per cent of ideal net work against work ratio is revealing. Such a set of curves is shown in Figure 8. At realizable expansion and compression efficiencies, the achievable percentage of ideal net work out falls off rapidly with increasing work ratio; small differences in the latter have a disproportionate effect on the real performance of the engine.

With respect to minimizing work ratio, the proposed cycle has a number of distinct advantages, viz:

1. Lower "ideal" work ratio
2. In-house development has repeatedly shown internal cooling to be highly effective.
3. Less compression takes place at high temperature due to removal of steam for condensing

These effects will more than off-set the slightly greater ideal efficiency of the gas Stirling system.

Change of Power

A precise calculation of the power output from an engine of this type would be difficult even with knowledge of unswept volume (interconnecting tubes and heat exchangers) between cylinders. The expansion ratio is fixed; hence, for a given engine, speed power is effectively changed by changing the quantity of steam in the system. This is very easily and rapidly done in the condensing vapor engine by changing rate of water injection.

To allow efficient operation at high ambient temperatures, a minimum condensing pressure of 10 psia at equilibrium temperature (193.2°F) is a defining parameter. A four-fold increase in mass of working fluid would increase the power about four times while raising the condensing pressure to about 40 psia. The maximum working pressure would be ideally about 40 x 16 or 640 psia (assuming true isothermal expansion and neglecting unswept volume). An approximate calculation (see Example) indicates that a three cylinder engine of the type shown could produce about 1 h.p. per cubic inch of swept volume assuming 0.9 expansion and compression efficiency and expansion at 1000°F.

Freeze Protection

Figure 2 shows a method of freeze protection based on saturating water throughout the system with ammonia. One temperature-activated valve on the liquid ammonia cylinder and a series of check valves on the ammonia distribution lines are shown. Activation at a temperature of about 38°F would supply gaseous ammonia at a pressure of 70 psia. At 32°F the pressure is 62.5 psia and at this temperature the solubility is about 0.9 lbs. of ammonia per pound of water. Absorption rate is extremely high. Saturated solution gives freeze protection far below any ambient temperature anywhere.

On start-up the temperature-activated valve on the liquid ammonia storage would be shut, manually or automatically. Gaseous ammonia and any air which leaked into the system would be separated in the water condenser. Gaseous ammonia is liquified in the usual way.

Other Mechanical Features of Proposed System

In the valveless engine, the only significant loss of working fluid is around the piston rod seal. With gaseous working fluids, this has always been a problem, especially with hydrogen. A solution lies in the so-called roll-sock and the elaborate mechanism to equalize pressure across it by an oil-hydraulic system. The negligible cost and ready availability of water eliminate the need for the roll-sock. Loss of steam to the crank case can be accepted. It is proposed to use one of the new water-acceptable oils such as Mobil's specially developed for steam engines. In service, the oil will be maintained about 212° by exhaust heat from the heat transfer fluid boiler as shown in Figure 2, and the crank case will be vented to atmosphere.

Change of Mass of Working Fluid—Change of Power

As stated, use of vapor plus liquid injection provides a relatively simple means of varying the mass of working fluid in the power system. This replaces the gas storage vessel and compressor plus controls necessary to accommodate the power changes of the gaseous Stirling system. The gaseous compressor system like the roll-sock pressure equalizer is not only complex, but is a continuous parasitic loss.

Heat Transfer to Engine Working Fluid

With the objective of approaching isothermal expansion of working fluid in hot cylinder, it is proposed to:

Maximize heat transfer rate to heater and cylinder head by heating with condensing vapor, and further, to increase surface area by finning heater and cylinder and to use tapered pistons in the hot cylinders to increase heat transfer period and heat transfer surface through cylinder walls. (See Figure 9).

Figure 9 shows this would have two effects. The total heated surface of the cylinder is increased almost three-fold,

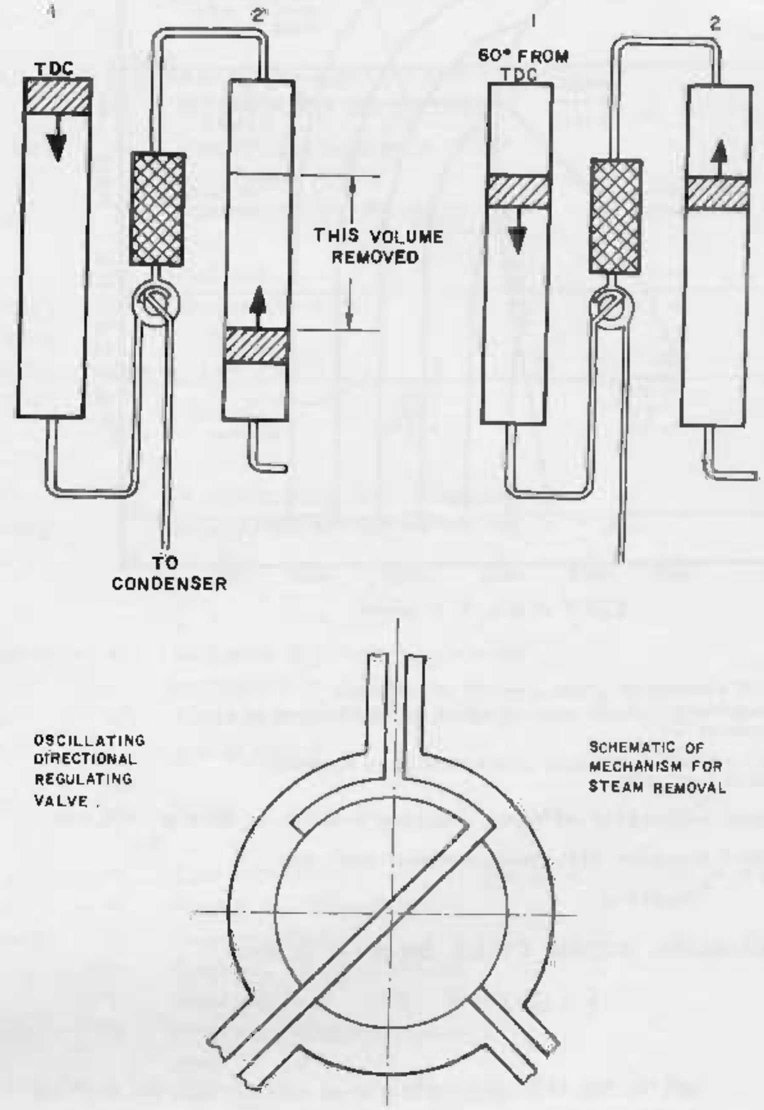
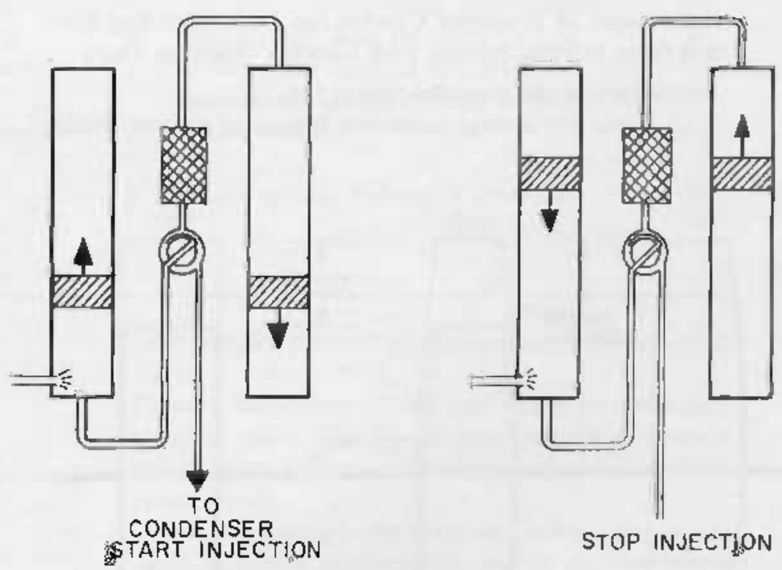
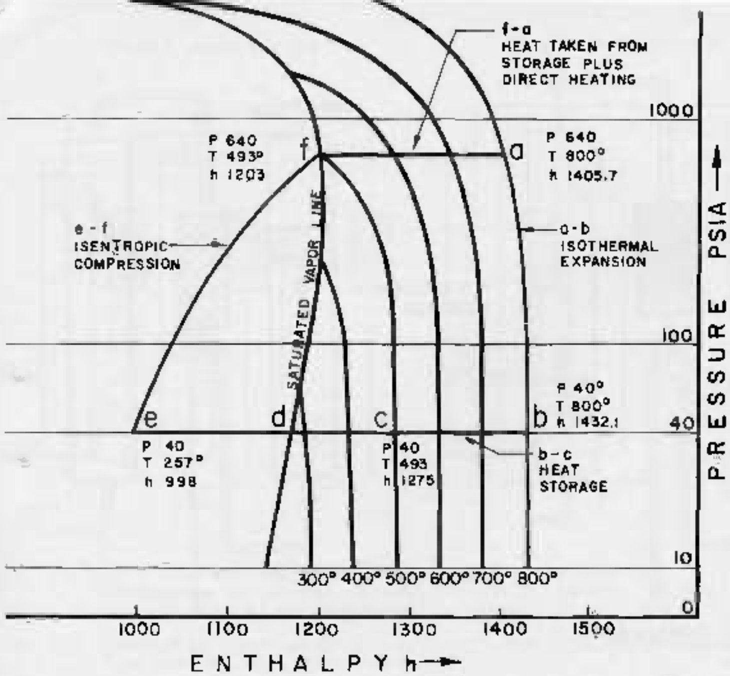


FIGURE 5



INJECTION OF WATER. CRANK INTERVAL. 180% INJECTION PHASE ALLOWS USE OF ECCENTRICALLY OPERATED PLUNGER PUMP. SEE ALSO FIGURE 5. NOTE THAT SOME INJECTION TAKES PLACE WHEN DIRECTIONAL VALVE IS OPEN TO CONDENSER.

FIGURE 6



AT "C" A PORTION OF STEAM IS PASSED TO CONDENSER.
CONDENSATE INJECTED INTO REMAINDER AT "C" PRODUCING WET STEAM AT "e".

WET STEAM "e" COMPRESSED ISENTROPICALLY TO SATURATED VAPER LINE AT "f".

Ideal efficiency of Vapor Stirling D-Cycle as show η_D = 0.408.

Ideal Stirling efficiency between 800° and 267° $\eta_{Stirling}$ = 0.423.

STIRLING STEAM CYCLE ON P-h PLANE

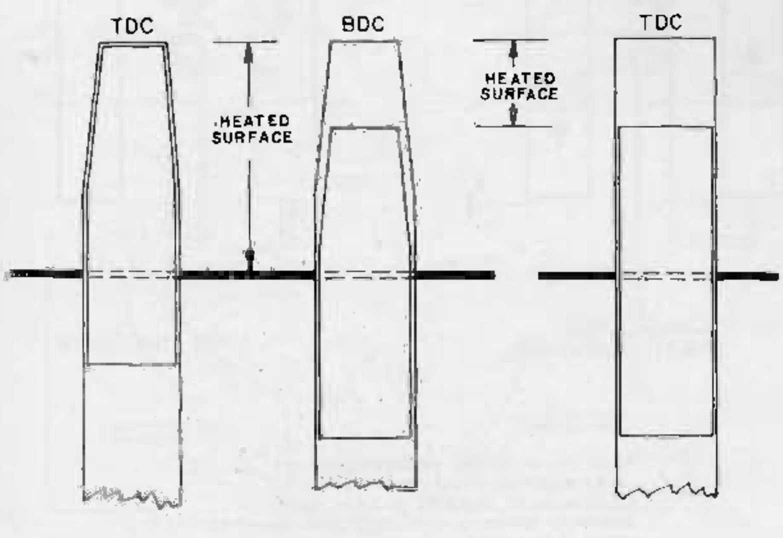
FIGURE 7

and the whole heated surface is in contact with the working fluid throughout the whole stroke. The latter is especially important because of the slow initial movement of the piston.

Advantages of Proposed Condensing Vapor Stirling System Over Stirling System with Gaseous Working Fluid

Advantages of the proposed system are:

1. Heat loss through condenser instead of radiator results



EFFECT OF TAPERED PISTON ON
HEAT TRANSFER PERIOD AND EXPOSED SURFACES
FIGURE 5

EXAMPLE

Method of Calculation of Approximate Engine Swept Volume per H. P.-Work Ration, Realizable and Ideal Efficiency Assumptions

1. Maximum temperature in working fluid during expansion is 1000°F.
2. Maximum steam pressure 640.
3. Expansion to 40 psia
4. Compression—from 40 to 640 psia within vapor dome. Isentropic compression: entropy of compression 1.44, steam at end of compression is dry saturated at 640 psia. (See Figure 6).

   Ideal work of expansion is

   $$\frac{86 \times 1460}{778} \times 2.302 \log \frac{640}{40} = 452 \text{ BTU/lb.}$$

   Ideal work of compression (Figure 6) is 205 BTU/lb.
   Ideal net work is 452 − 205 = 247 BTU/lb.
   Ideal work ratio is $\frac{205}{452} = 0.453$

   At 90% expansion and compression efficiency, the fraction of ideal net work realizable is 0.73 (Figure 7).

Realizable net work is 0.73 × 247 = 180 BTU/lb.
At maximum volume, of a cubic foot—1 lb. of steam will be divided approximately by volume as

Volume at 1000° $\frac{a \times 0.8 \text{ c.f.}}{1.8}$ See Figure 3

Volume at 267° $\frac{a \times 1.0 \text{ c.f.}}{1.8}$

Specific volume at 100° & 40 psia is 22.84 cf/lb.
Specific volume of wet steam of quality 0.82 at 40 psia is 0.82 × 10.501 cf/lb.
Then: for 1 lb. of steam

$$\frac{a \times \frac{1}{1.8}}{10.501 \times .82} + \frac{\frac{a \times 0.8}{1.8}}{22.84} = 1$$

Solving for a:
a = 11.93 c.f. per pound of steam
At 100° actual realizable workout per pound of steam is 180 BTU.
Wt. steam required to produce 1 h.p. is $\frac{42.42}{180}$ = 0.236 lbs/min.
Total maximum volume is then 11.93 × .236 cf/minute.

If b cubic inches is engine swept volume at 3600 rpm

$$\frac{3600\,b}{1728} = \frac{11.93 \times .236}{1.8} \text{ cubic inches}$$

b = 0.75 cubic inches per horse power
At engine speed of 2700 rpm the system would produce 1 h.p. per cubic inch.
"Heat in" per pound of steam is:

Heat for isothermal expansion	452 BTU
From Figure [+ (Enthalpy at b − enthalpy at f)]	+ 72 BTU
[enthalpy at C)]	524 BTU

Assume 90% boiler efficiency
Heat required 1 lb. of steam is $\frac{524}{.90} = 582$
Realizable net work is 180 BTU/lb.
Efficiency = $\frac{180}{582}$ = .309
Ideal efficiency = $\frac{247}{524}$ = 0.472

SUMMARY COMPARISON OF STEAM-D-CYCLE VS HYDROGEN IN RINIA-TYPE ENGINES

	STEAM	+ or -	HYDROGEN OR HELIUM	+ or -
1. Heat in or by direct heating by hot combustion	By condensing vapor from heat transfer fluid	+	Past designs have used direct heating	–
2. Cooling	Internal cooling by liquid injection	+	External cooling by circulating fluid	–
3. Heat loss to atmosphere	Condenser	+	Radiator	–
4. Ideal efficiency	About 95% of Carnot efficiency between given temperature limits	–	Carnot efficiency	+
5. Realizable efficiency	Higher than gaseous Stirling between same temperature limits	+		
6. Work ratio: compressor work, expansion work	Lower for Steam-Stirling	+		–
7. To change mass of working fluid	Simple variable stroke injection pump integral with cooling system	+	A pressure tank and compressor is required	–
Complexity				
8. To prevent loss of working fluid	Loss acceptable. No mechanism required	+	Roll sock & pressure equalizing mechanism	–
9. To remove working fluid	Directional valve operating continuously. Integral with cooling system	0	Valve system to introduce & remove gas to engine	0
10. Freeze protection	Ammonia absorption and liquefaction system	–	None	+
11. Working fluid cost	Negligible cost	+	Cost significant	–
12. Availability	Freely available everywhere	+	Special inventory item	–
13. Other chemicals	Ammonia for freeze protection	–	None required	+
14. And freeze	None	+	Required for liquid coolant	–
15. Heat transfer fluid	Sulfur	–	None required	+
16. Materials of construction	Carbon steel or possibly some copper	+	High temperature alloys for heater tubes	–
17. Burner blower	None	+	Fan required for direct heating	–
Parasitic Losses				
18. Radiator fan	Condenser requires no fan	+	Fan required for cooling liquid coolant	–
19. Cooling system	Continuous injection pump	0	Circulating pump for liquid coolant	0
20. To change working pressure	Integral with cooling system	+	Compressor required operating periodically during running of system	–
21. Freeze protection	Ammonia compressor operation only on start up	–	None required	+
22. Valve Mechanism to remove working fluid	Continuous by operating rotary or oscillating directional valve	0	Valve system operates at intervals	0

in less bulky equipment and better automotive packaging.

2. Simple, cheap, and effective means of changing working pressure by changing water injection rate, replaces complex compressor and gaseous storage system and reduces parasitic power losses required by operation of compressor.

3. Working substance (water) is cheap, abundant, and universally available. No elaborate or costly means of preventing loss is required. Losses of steam through piston rod gland into engine crank case are accepted and made up in water injection stage. Hence entire roll-sock and complex pressure-equalizing mechanism are eliminated.

4. Cylinder lubrication—Water (and steam) are good lubricants for rulon. The life of rulon rings with a water-steam system will be enhanced, not reduced, by the proposed system.

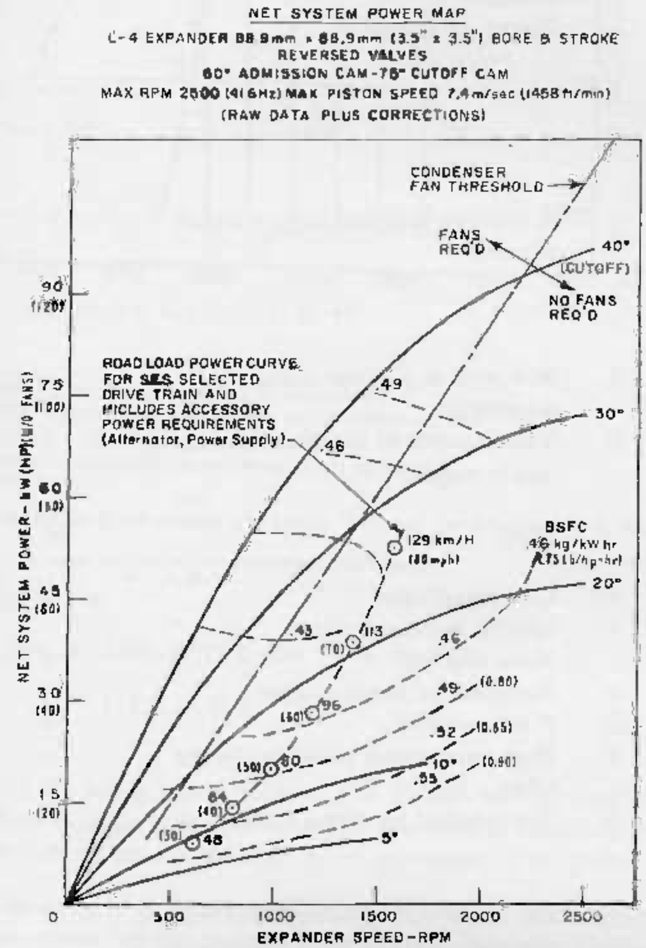
5. Cooling is internal—by injection, shown repeatedly by both in-house development and in air compressor technology to be simple and effective.

6. Heating the hot space by a condensing vapor heat transfer fluid eliminates the oxidizing atmosphere which, together with high temperatures, result in such costly

(Continued on Page 30)

SCIENTIFIC ENERGY SYSTEMS PROPOSAL FOR A 6-CYLINDER COMPOUND AUTOMOTIVE STEAM ENGINE, AS PRESENTED TO THE DIVISION OF TRANSPORTATION ENERGY CONSERVATION, ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, NOVEMBER 1975.

Part II (Continued from Vol. 18, No. 4)



L-4 Preprototype Expander Characteristics

150 BHP output; maximum expander speed 2500 RPM
4-Cylinder in-line trunk piston with uniflow exhaust
Total displacement 135 cu. in. (3.5" bore, 3.5" stroke)
Inlet steam conditions; 1000°F, 1000 PSIG
Exhaust pressure nominal 20 PSIA
Cruciform crankshaft (1-3-4-2 firing order)
Counter-rotating balance shaft (complete balance of primaries and secondaries)
Series unbalanced poppet admission valving with variable cut-off
Sliding bucket tappets and 3 arc cam form
Shell bearings throughout, pressure fed 'palm' end wrist pins

Expander Lubrication

Steam expander more benign than internal combustion engine
- Oil does not oxidize
- No combustion products—acids, soot
- No blowby of gases at combustion temperatures
- No coking in ring grooves

Slight cracking of oil
- Viscosity reduction
  - In exhaust steam 3-15%
  - In crankcase nil

Evaporation rate of oil on 700°F liner appears to control ring wear. Equal wear rates obtained with direct oil injection of:
- 600 PPM natural base stock oil
- 200 PPM 17% high molecular weight hydrocarbon polymer
  (Exxon ECA-4543)

Non-scuffing ring/liner materials
- Chrome liner
- Boron-nitride-nichrome or chrome carbide rings

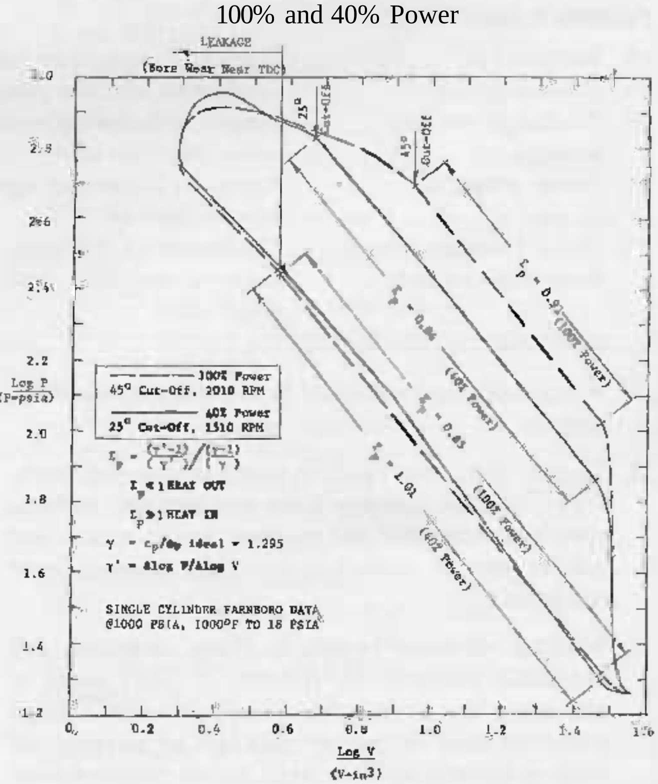
Avenues open for higher steam temperatures
- Synthetic oils
- Alternative EP additives
- Alternative low evaporation rate additives
- Ceramics
- Dry lubricants

Piston Ring and Cylinder Liner Materials and Lubrication Achievements Present Achievements

Materials

The tribaloy 400 piston ring on tribaloy 400 cylinder liner

EXPANDER INDICATOR CARDS—LOG P VS. LOG V
100% and 40% Power



demonstrated zero ring and liner wear in a 150 hour endurance test.

Lubricants

The Exxon mineral oil exhibited unsatisfactory component wear.

The Exxon oil with 20% polymeric additive reduced the oil's volatility, increased its viscosity and reduced component wear. Selected for the simulator and steam ramcar engines.

The Mobil hydrocarbon synthetic 1301'H' exhibited the lowest volatility and best demulsibility characteristics in laboratory tests.

The excellent demulsibility characteristics and cam wear protection of the Mobil 1301 'H' oil was validated by engine tests. Piston ring and cylinder liner wear characteristics presently being evaluated.

SES **Prototype Feedwater Pump**

Configuration

Fixed displacement, 3 cylinder in line

Flow control by modulation of inlet valve unloading solenoids

Weight, 14 pounds

Bi-directional drive capability

Automatic drain on shutdown for freeze protection

Performance

At maximum speed of 2500 RPM

1. 40 lb/min@ 1200 PSI
2. 90% volumetric efficiency
3. 75% overall efficiency
4. 250°F inlet water temperature

Self priming—8" Hg dry lift

Improved Response Boiler

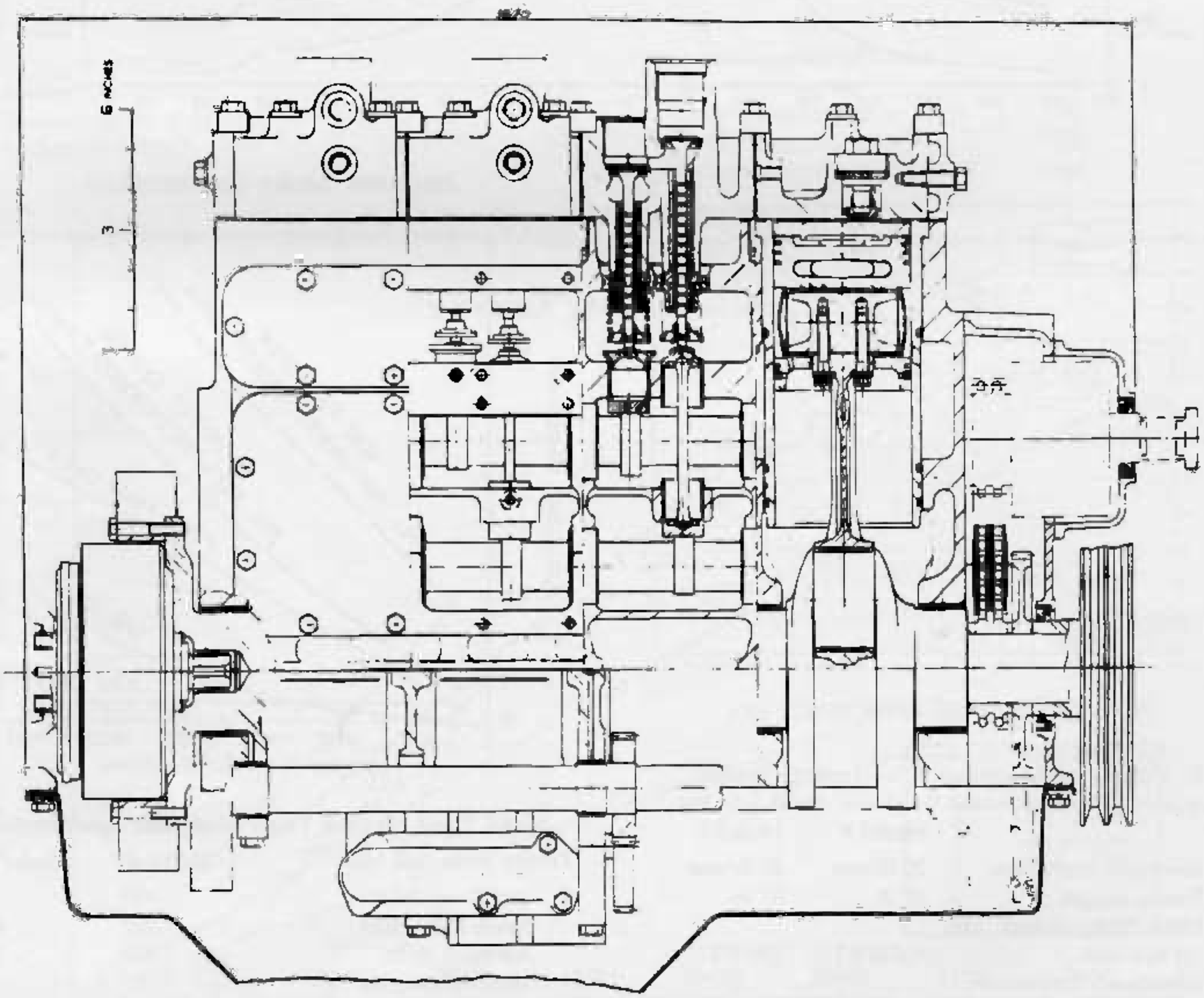
Strategy

Energy leveling

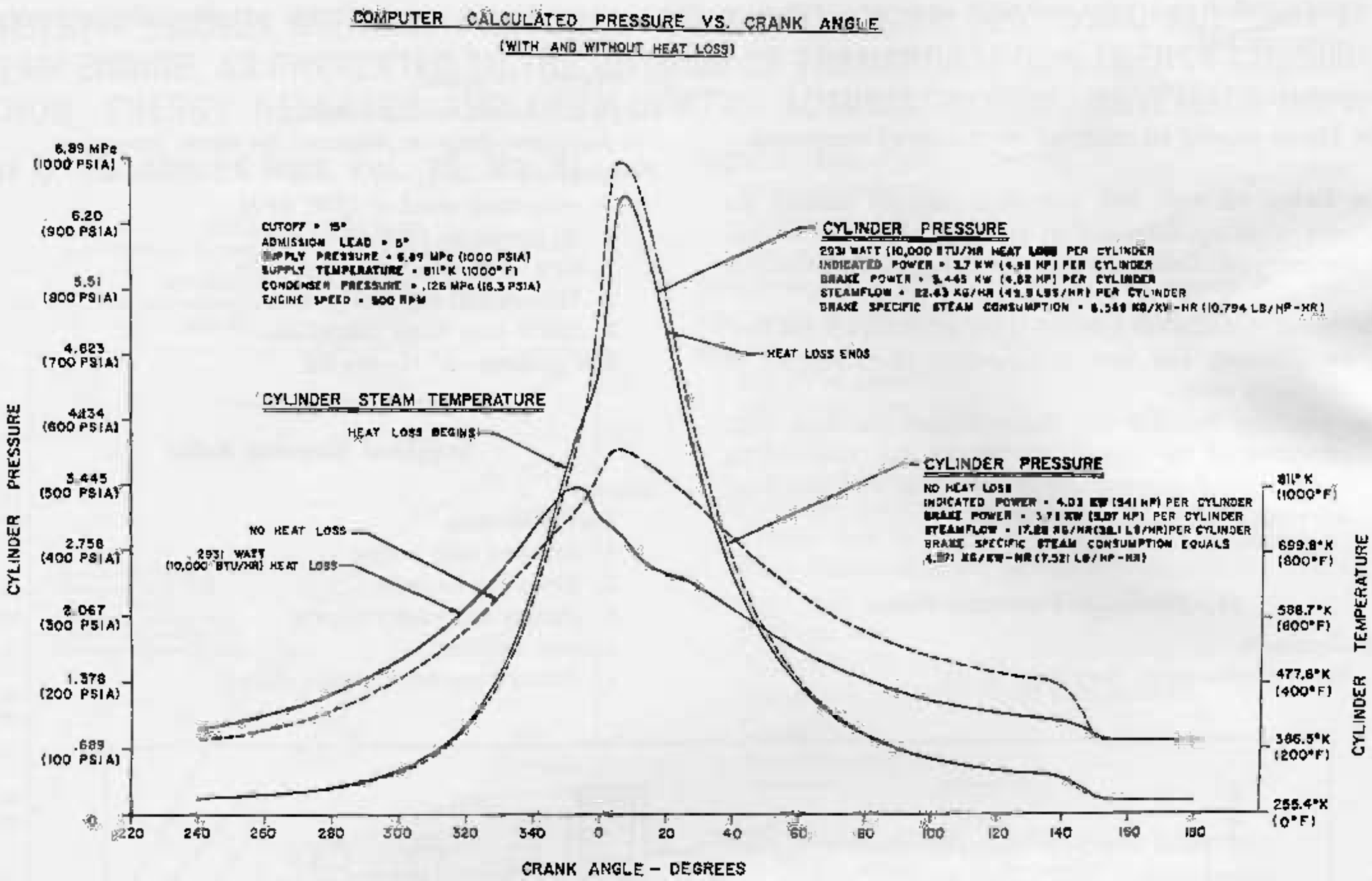
1. Reduced tube weight
2. Revised pass order
3. Passive evaporator bypass

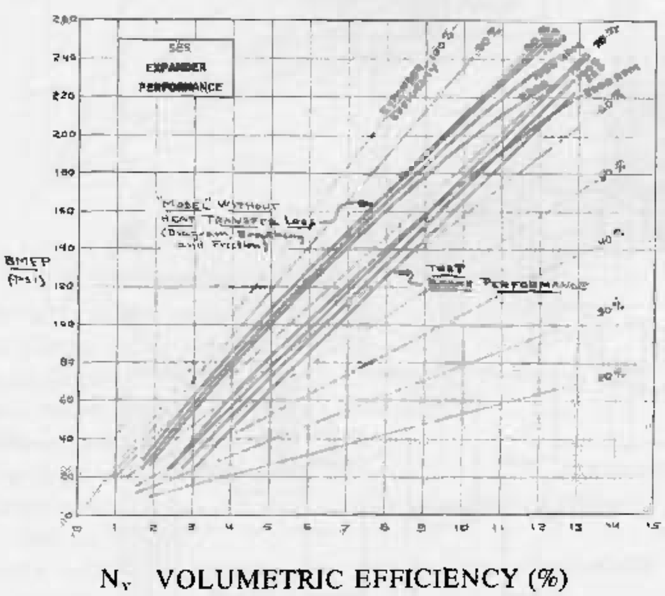
Control Options

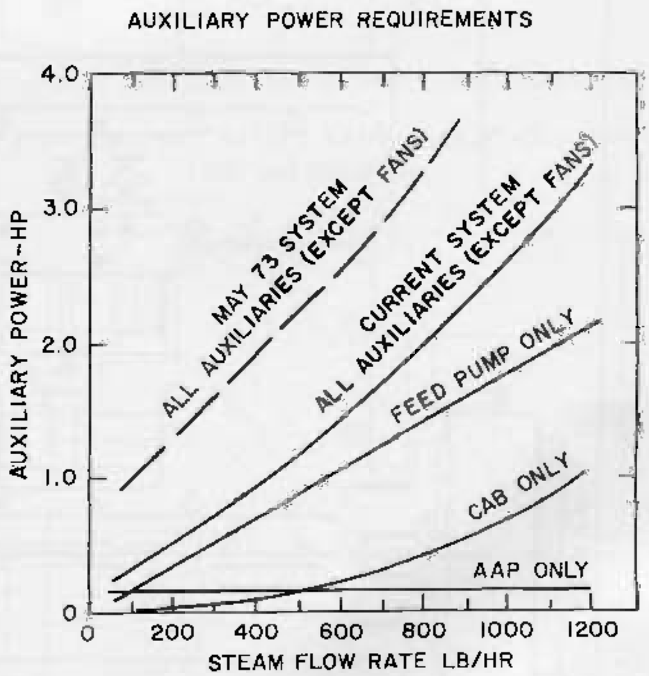
1. Active evaporator bypass control



L-4 PREPROTOTYPE EXPANDER RIGHT SIDE SECTIONS







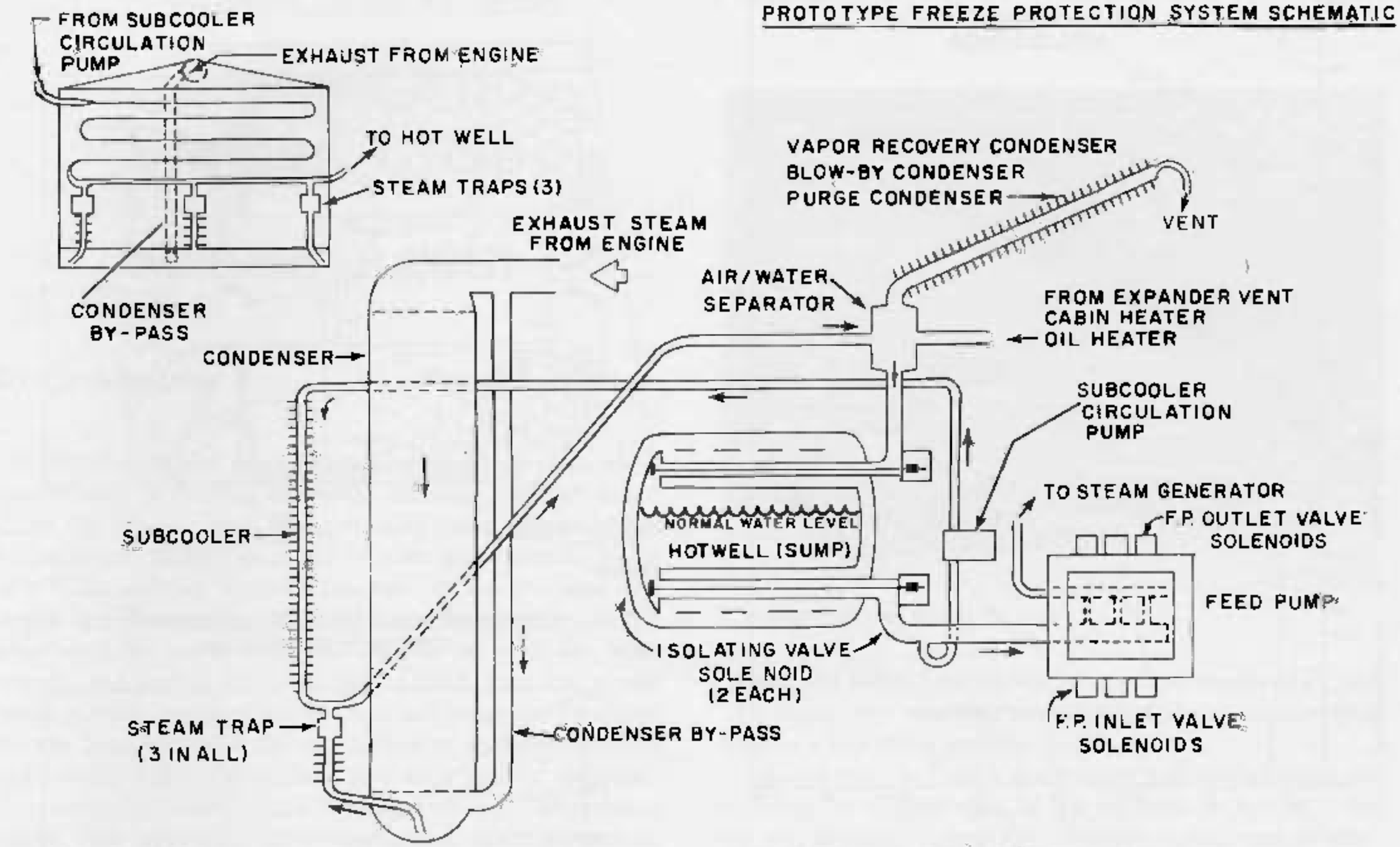
2. Variable boiler pressure to level energy change
Comparison of current model 5 and new model 7 boilers

	Model 5	**Model 7**
Maximum steam flow	20 lb/min	20 lb/min
Tubing weight	98 lb.	61 lb.
Metal energy change, idle to full load	1,430 BTU	100 BTU
Superheater temperature control point	Exit	Inlet

Model 7 and Model 8 Vapor Generator Specifications

Design point (full load)	Model #7	Model #8
Fuel flow, lb/hr	100	108
Steam flow, lb/hr	1200	1400
Air flow, lb/hr	1700	1840
Stack temperature °F	710	530
LHV efficiency, %	84	88

PROTOTYPE FREEZE PROTECTION SYSTEM SCHEMATIC



Physical characteristics		
Outside diameter, in.	19.5	16
Heat exchanger weight, lb.	57	41
Package weight, lb.	125	90

Heat exchanger specifications		
Number of passes	6	7
Total gas-side surface, sq. ft.	67	75
Total tubing length, ft.	158	120
Design point effectiveness, %	84	90

PPT PHASE II EXPANDER DATA

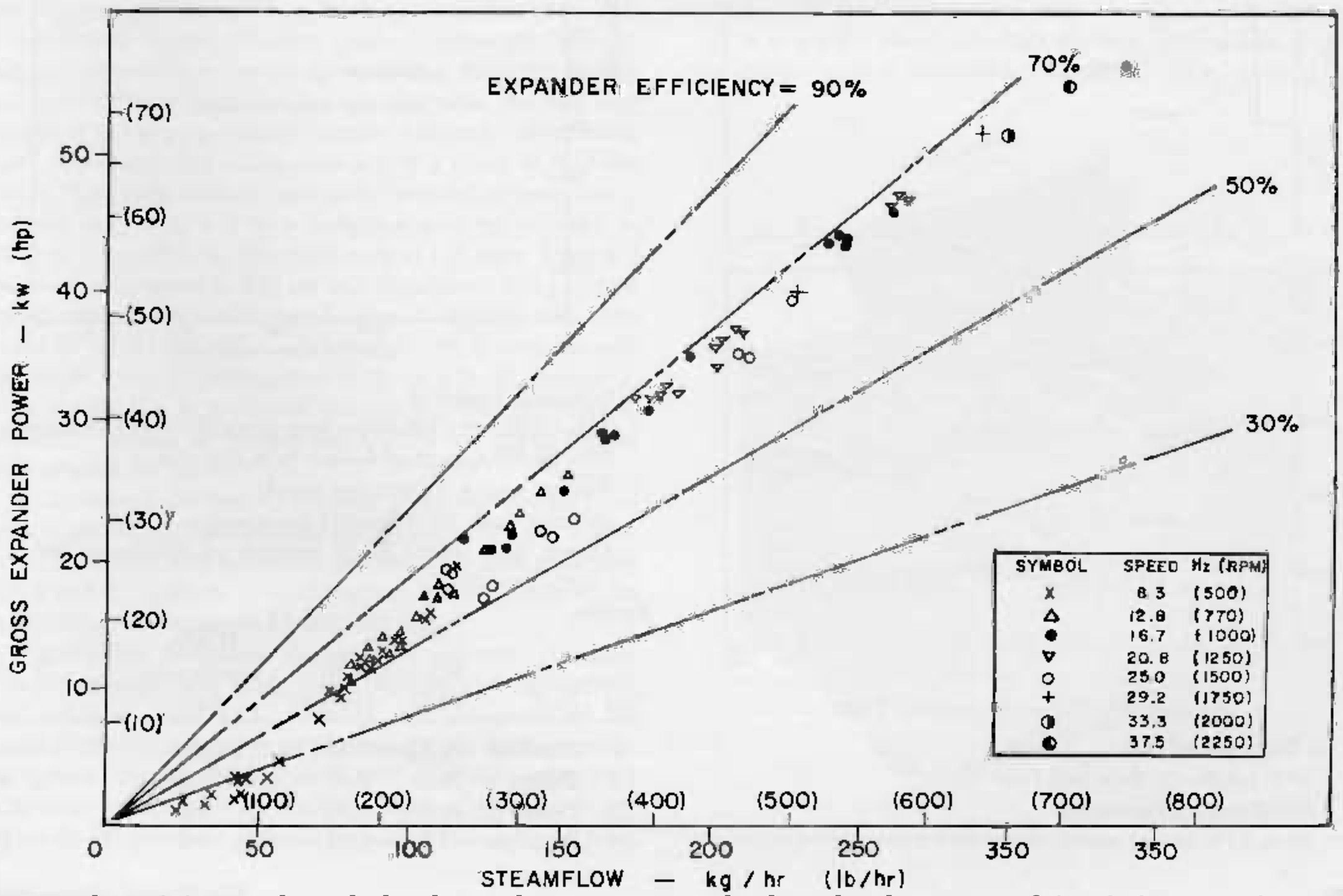
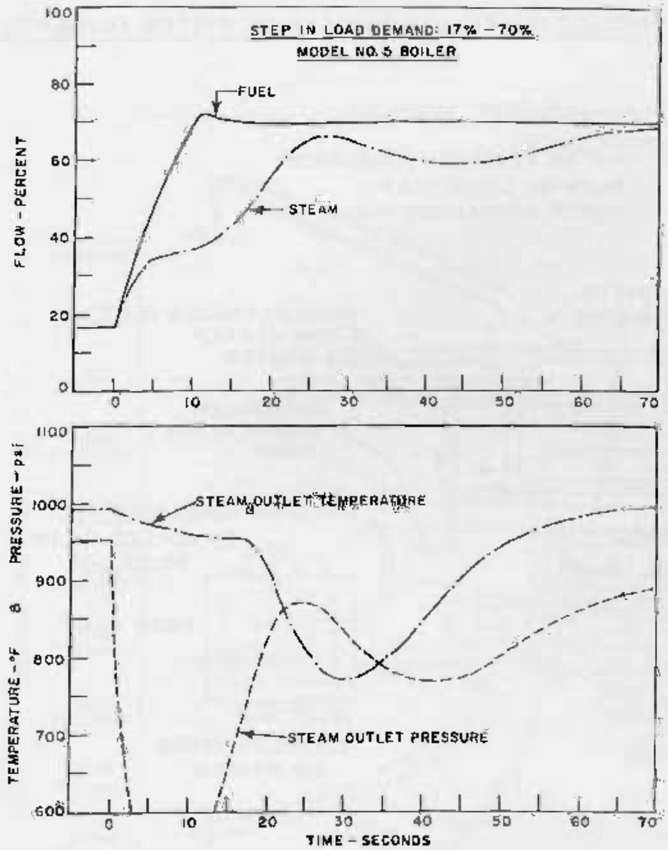
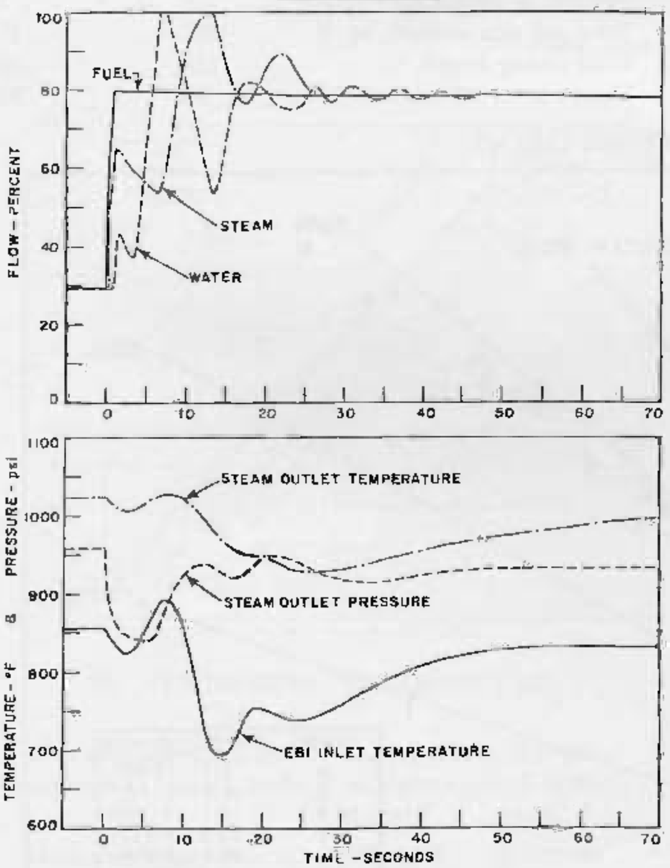


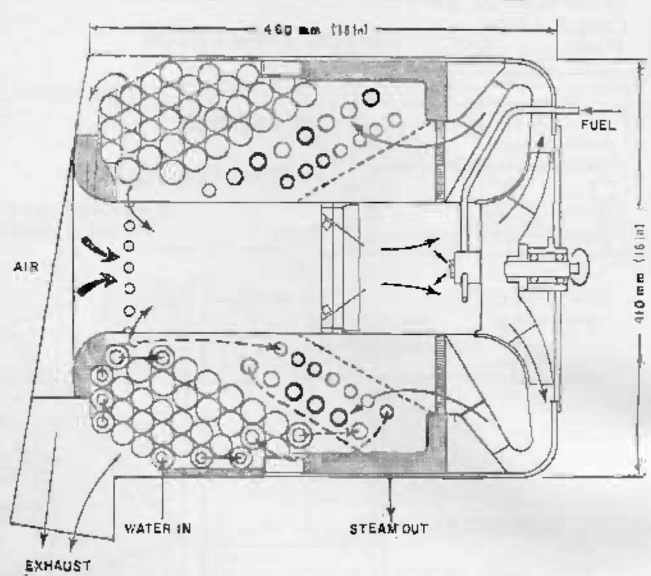
FIGURE 3800 – 7



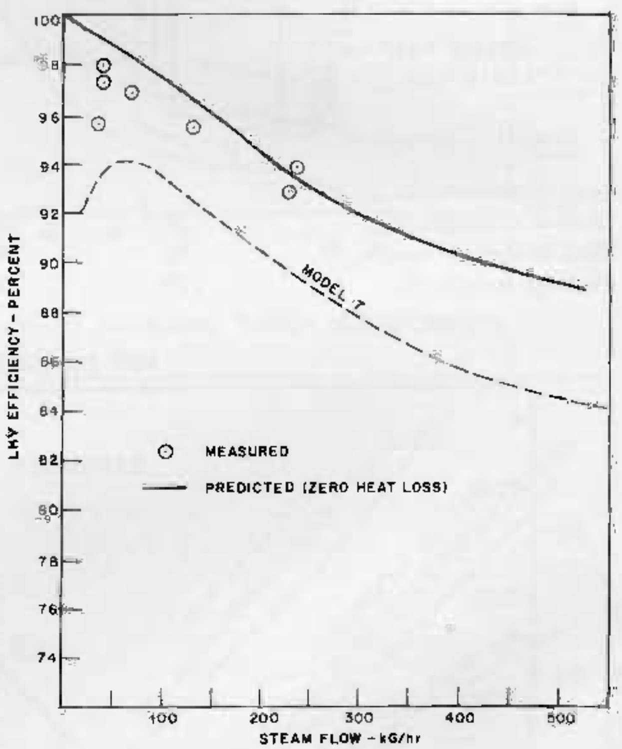
STEP IN LOAD DEMAND: 29% - 78.5%
MODEL NO. 7 BOILER



CROSS-SECTION OF MODEL NO. 8 VAPOR GENERATOR



MEASURED MODEL NO. 8 EFFICIENCY vs LOAD COMPARED TO COMPUTER MODEL PREDICTIONS



Preliminary Sulfur Emissions Tests

Test Conditions

- 30% Load—31 lb/hr fuel flow
- 350°F stack temperature
- 30 to 33% excess air
- Isokinetic sampling
- SO3 Collector: Goksoyr—Ross method—160°F condenser
- SO2 by EPA method 8—ice bath absorbers
- Sample rate: 4-5 liters per minute
- Baseline fuel: EPA straight run gasoline
- Doped fuel: added 50-50 mixture of thiophene and T-Butyldisulfide

Results

Test	Fuel	SO_2 PPM	H_2SO_4 (PPM)	H_SSO_4 Conversion Rate
1	Baseline	5.61	0.99	15%
2	Doped 1	24.2	2.58	10%
3	Doped 2	36.9	1.83	5%
4	Baseline	5.62	0.57	9%

Vintage Cycle Steams Again

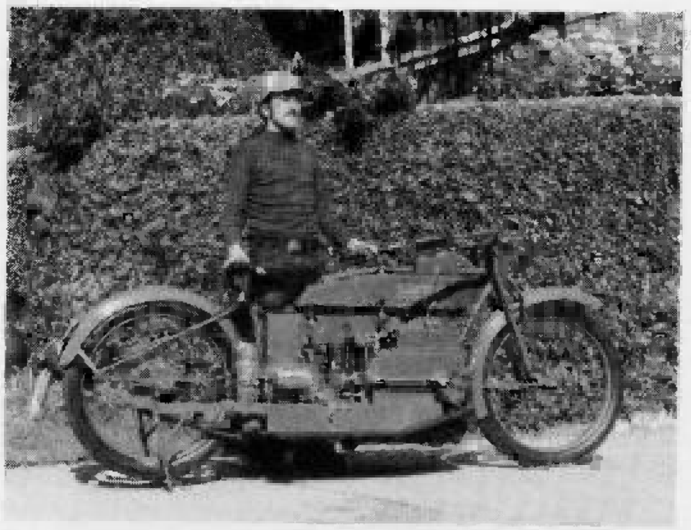
By David Sarlin **Photos by Author**

The challenge of shoehorning a steam power plant into a cycle frame, to one day mount the flaming stead and woosh down the street, these thoughts must have gripped Niles Gillenwaters. Being a machinist by trade and a onetime owner of a White and two Stanley steam cars, he was provided with ample qualifications to bring into focus the steam cycle that glimmered in his imagination. He started with the tank, wheels, and part of the frame from a 1914 Thor motorcycle which partially survived a collision with a streetcar. Thor later became associated with the manufacture of washing machines and electric drills. The fenders, with their angular cross-section, seemingly came from a Pope motorcycle. The pressure gauge, fuel automatic, automatic bypass, steam automatic, hand pump, and two needle valves are all early Stanley Steamer, while the crankshaft and flywheel are from some unknown vintage piece of machinery. The rest was made from scratch.

In 1922, after several years of construction, Gillenwaters took his 550 pound 67½" wheelbase machine for its first test ride. On many a Sunday thereafter he got together with a few of Sacramento's cycle mounted police. Gillenwaters thought that his "Steam Flyer" would do better than the police Harley Davidson's. Since the police thought otherwise, the only way to settle it was to go to a nearby country road and "stir up some dust". Invariably the police were left in a cloud of it as the Steam Flyer took the early lead and continued to pace ahead. On one run, with a 2 to 1 reduction and the pressure at 1000 psi, he pushed the Steam Flyer up to 110 mph. Typically the machine worked at 650 psi and maintained this pressure under virtually all conditions. Bud Langford (see The STEAM AUTOMOBILE, Fall/Winter 1963) once brought his steam cycle to Sacramento to show it to Gillenwaters. Niles wanted him to fire up the machine, but Bud put him off, seemingly because he thought that it might not put up a good show against the Steam Flyer.

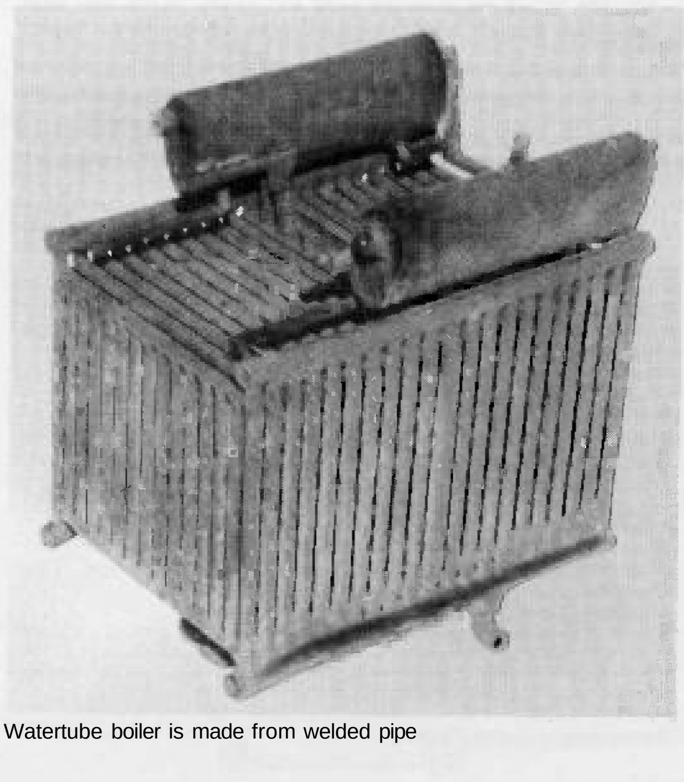
Gillenwaters claimed in his later years that the fuel and water tanks did not need refilling during a 150 mile trip that he made. However, with respective fuel and water tank capacities of 3.1 and 2.1 gallons, it would appear that the water would require replenishing every 15 miles or so.

Striving for perfection, Gillenwaters constantly tinkered with the machine and made many changes and adjustments over the years. One such alteration was conversion of the burner from a vaporizing to an atomizing type. In the atomizing system, two flat fan shaped flames were directed toward each other so that they met in the middle of the burner. An engine driven generator powered the burner blower, spark plug igniter, and lights. Control was by a pressure regulated bypass. This equipment was later removed and the cycle converted back to a vaporizing system.

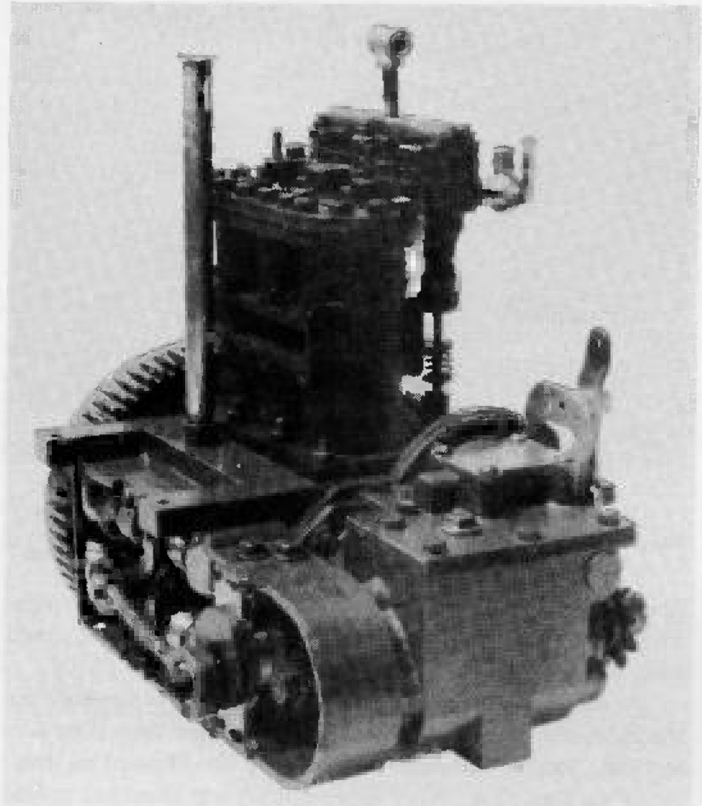


The author with the Steam Flyer

At one time the French government wanted to purchase the machine, but Gillenwaters did not sell because their offer was too low. Socony Vacuum Oil Company also showed an interest in purchasing it. After driving it several thousand miles, Gillenwaters sold the machine in the late 1930's to the Cliff House Museum in San Francisco. One story has it that the machine was fired up weekly and a reward offered to anybody who would drive it wide open for two minutes. Later the cycle was moved a few doors to a front window in the Sutro Bath's museum, where it sat for many years as a lure to draw customers in to see the museum's other marvels. During these years the cycle's original respectable dark green paint was hidden by



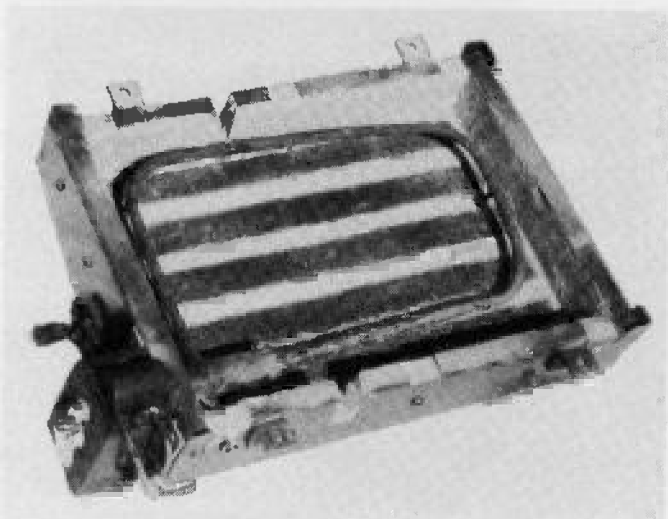
Watertube boiler is made from welded pipe



Three-cylinder uniflow engine

a coat of fire engine red and the name "Steam Flyer" inscribed on the side of the boiler. A sign sat next to the cycle and boldly (mis)informed viewers that the "Steam Flyer" was: "The first and only steam powered motorcycle made in America", and that it "may have been the fastest thing on wheels—the speed limit being unknown as no one has dared to open her up."

As she sat in the window over the years, many had their imaginations swept away wondering what it would be like to ride it. Roy Anderson recounted that once while he was admiring the cycle at the museum a gentleman came by and carefully inspected it. After a few moments his eyes became transfixed by the handsome brass pressure gauge. He evidently mistook it for a speedometer as he exclaimed, "1000 miles an hour, that's a damned lie—nothing could go that fast".



Stanley type vaporizing burner

In 1975 the author began restoration of the Steam Flyer for its present owner, Ed Zelinsky. The fuel and water tanks had both accumulated numerous cherry pits, pebbles, and cigarette butts. Being pitted with rust, they were replaced with duplicates in stainless steel. A sandblast job prior to painting was the probable source of the sand found in the burner and the half inch oil/sand layer found in the engine's crankcase. The 28 X 3 tires had to be sawed off as age had petrified the rubber. They were replaced along with the drive chain, fuel pressure tank, numerous valves, saddle, boiler casing, and many feet of sinuous tubing. The tank filler caps and whistle were missing, so new ones had to be made. The metal reinforced handlebar grips went limp with age, and new ones were machined and coated with rubber to simulate the original. Half of the grip was cantilevered from the handlebar to cushion road shocks, a feature that must have been appreciated when traveling over cobblestone roads of bygone years. Miraculously the original boiler survived through the years more or less unscathed and still works at 650 psi. It has even withstood a couple of overheatings that resulted from letting the water get too low.

For steam generation, Gillenwaters used a watertube type boiler similar to that in the 1917 Doble-Detroit. Most of its 24.3 square feet of heating surface comes from the twenty grids which are each comprised of fifteen vertical tubes. The grids are made of plain 1/8 inch welded steel pipe, and the four horizontal main headers from ¾ inch pipe. Two oval shaped steam storage drums and an enconomizer coil are mounted on top of the boiler grids while an 8 foot long superheater coil sits underneath them. Amazingly compact, the boiler fits into a casing only 12 inches wide by 16 inches long and 10½ inches high.

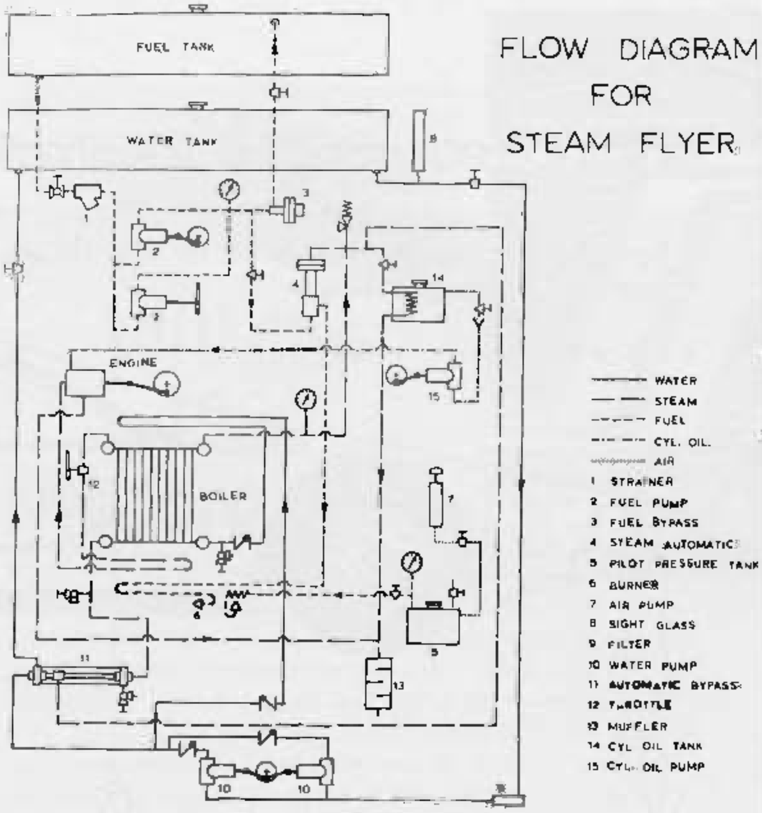
The burner is of the vaporizing type, almost identical to that used in the Stanley and White. Its grate is perforated with 840 holes produced by a No. 50 drill and from which issue a like number of intensely hot blue flames. Originally a mixture of half kerosene and half gasoline was used. A hand pump had to be worked continuously during the starting up procedure and whenever the engine was stopped as the main burner system did not include a pressure tank. A half gallon pressure tank existed for the pilot system, however, and this was tied into the main burner during restoration. The pilot burner kindles the main burner and is a miniature version of it, but the pilot more than makes up for its size in its cantankerousness. It manages best on a strict gasoline diet—therefore both burners are run on this fuel.

The procedure used in firing up the cycle is much like that used with a Stanley. After restoration of the cycle was completed, numerous "firing ups" were required to gain enough confidence to mount the inferno for a steam down the road. Little by little the cycle's idiosyncrasies were learned, and longer trips were ventured. During this period the generator seemed to have a harder and harder time maintaining adequate steam pressure. The burner was suspected, and after much tinkering around, it was realized that air was leaking into the furnace at the joint between the boiler and burner. Evidently the gasket was blown away by one of the numerous furnace explosions that occurred from re-igniting the burner before adequately purging it of all combustible vapors. Asbestos yarn was stuffed into the gap, and performance was restored. On one trip the machine burst into flames! Quickly the main fuel valve was shut, the machine put on its stand, and the fire put out with the extinguisher mounted on the right rear. Fortunately no real harm occurred to body or mechanism. Upon investigation, it was quickly determined that the vaporizer had opened up. Barney Becker provided some stainless steel, and a replacement was fabricated.

The prime mover is a 3-cylinder uniflow engine with a 1¾ inch bore by 2¼ inch stroke. Its poppet-type inlet valves are actuated by a sliding camshaft which has three profiles: ¼ and 5/8 cutoff, and reverse. Actually only the ¼ position is useful as the 5/8 position results in excessive compression, and reverse could only be used for maneuvering with a sidecar. The reverse probably stems from Gillenwater's thoughts of developing an engine for a car. Splash lubrication is used for the cams and rod bearings. Originally two open type ball bearings were fitted at each end of the crankshaft, but water that found its way into the crankcase caused pitting, and they were replaced with sealed bearings. The rod bearing journals were hard chromed for a similar reason. In accordance with good steam engine design practice, the pistons are long, have labyrinth grooves, and 4 stepped rings to minimize blowby. They and the cylinder are made of cast iron, while the crankcase is cast aluminum.

Engine power is transmitted through a pair of bevel gears via two chains and a countershaft to a two-speed Eclipse planetary transmission on the rear hub. With the transmission in gear, the total reduction is 4 to 1, while in direct, it is 2.3 to 1. In other words, the engine turns 1660 rpm to 60 mph in direct drive. The reputed top speed of the cycle with the present gearing is 85 mph, but she has not been ridden at over 50 mph since her restoration because of the affects of age and abuse of her running gear. Off of the shaft carrying the driven bevel gear is an exposed spur gear set which drives four plunger pumps at one-fourth engine speed. The plungers are all 3/8 inch diameter and have a 2¼ inch stroke. Two pumps provide the boiler with water—one pumps fuel to the pressure tank, and another pumps cylinder oil to the engine. Visual indication and control of the oil feed rate takes place at a sight feed in the oil pump suction line. A jaw clutch is fitted on the countershaft, but is of little use since raising the cycle on its stand enables the pumps to be used while standing. In order to move the machine backwards with steam up and the clutch engaged, however, the cylinder drain cocks must be opened to vent leakage past the throttle. Two hand pumps, one an original Stanley and one a copy, reside on the cycle's right side. They are used to charge the fuel and water systems as the need arises.

After the starting ritual has been satisfactorily completed, automatic controls watch over the flow of vital fluids. Fuel goes by way of the fuel automatic, which bypasses fuel back to the main tank to maintain the proper pressure, while the steam automatic shuts off the fuel flow to the burner if the steam pressure gets too high. Water flows via an automatic bypass (formerly a Stanley low water cut-off) which bypasses the flow

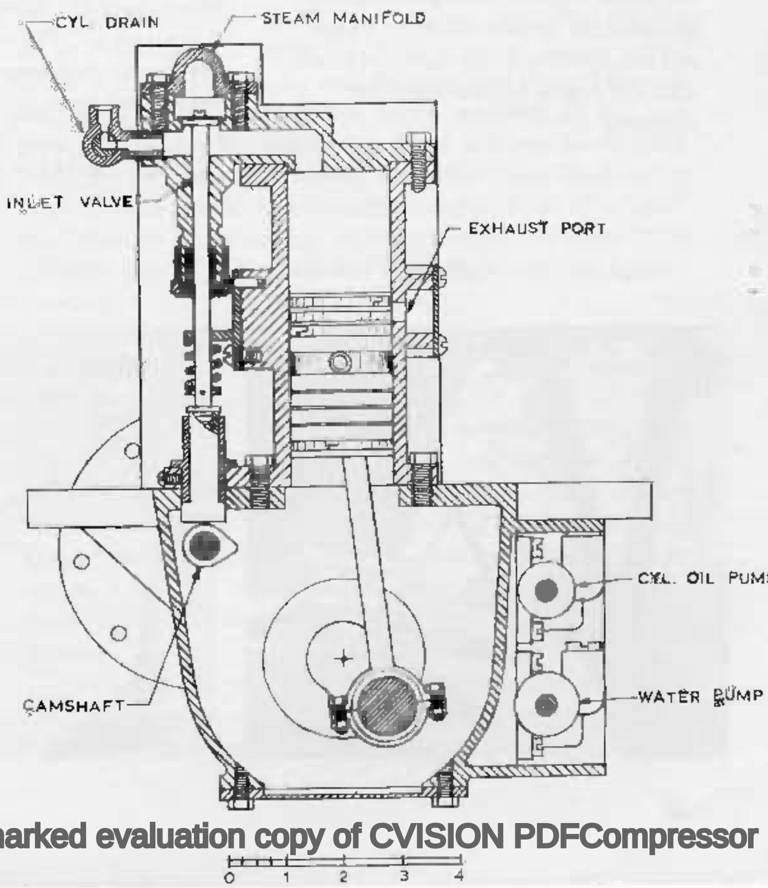


back to the tank when the water level in the boiler is adequate. A trycock was fitted to the steam automatic, but it was supplemented with a reflex water gage glass during the restoration to allow easier and more accurate assessment of water level.

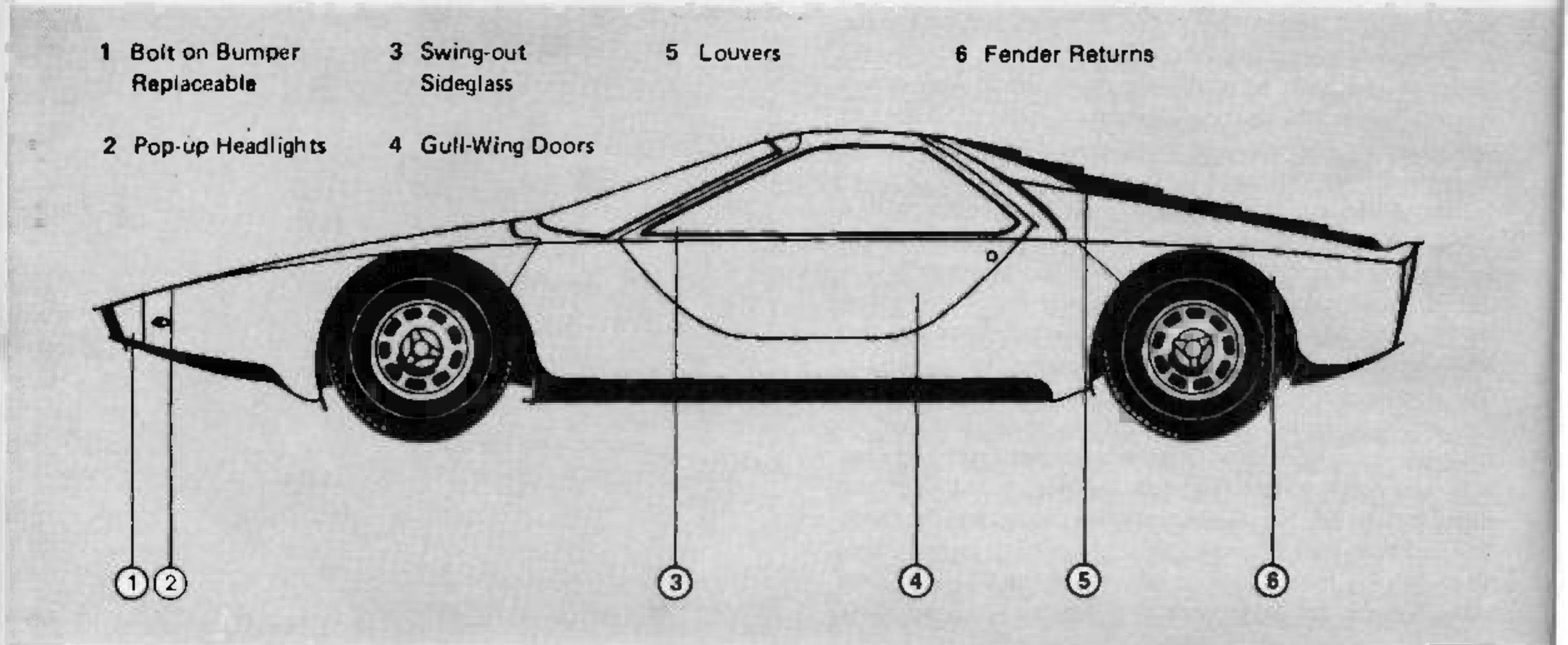
A clue to the function of the massive nickel-plated lever on the left side is its size. It is the throttle, and once under way is the sole control required, apart from the brake. It has a poppet

(Continued on Page 30)

CROSS SECTION OF ENGINE FROM STEAM FLYER



Fiberfab Features and Specifications



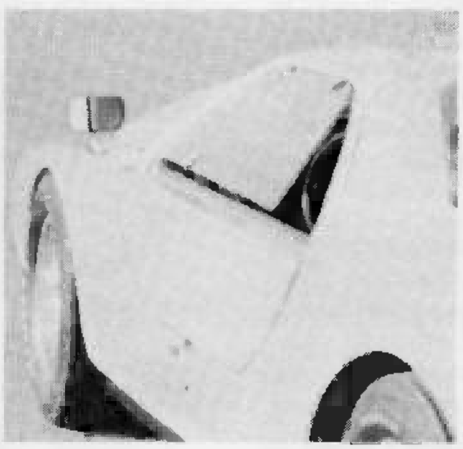
Aztec 7 body designed for full length VW chassis. 3-piece body construction for ease of assembly and replacement if necessary. The nose or hood with integral gas tank bib, bolts to the main body at the firewall. The main body inner panels are molded to fit like a glove over the VW pan, eliminating the probability of misalignment. The louvered tail section is hinged to permit accessibility to the optional trunk area and engine compartment for servicing.

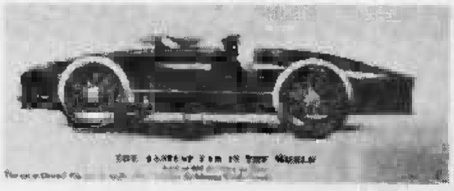
Overall Width . . . . 70"
Overall Length . . . . 192"
Hood height
(Cowl to road) . . . . 31"
Cockpit height
(Roof to road) . . . . 43"
Wheelbase . . . . 94-3/4"
Track front (7" Rims) . . . . 58"
Track rear (7" Rims) . . . . 58"
Weight: Curb average . . . . 1450#
Road Clearance . . . . 5"

STREET LEGAL -ALL STATES

AZTEC 7 BASIC KIT INCLUDES:

1. Main body complete with inner panels, firewall and rear bulkheads and mounting flanges for bolting to chassis.
2. Nose section with molded gas tank mount and hood cover.
3. Tail section complete with integral louvers.
4. Rear body hanger with hinge points.
5. Pre-hung doors that swing up Gull-Wing fashion.
6. Door latches.
7. Windshield designed especially for the Aztec 7.
8. Curved side glass (tempered) with holes drilled to accept swing-out van type hardware.
9. Rear glass (tempered).
10. Molded front bumper.
11. Headlight boxes.
12. Headlight actuators to raise and lower headlight assemblies.
13. One pair fiberglass GT seat shells.
14. Dash panel large enough to accept gauges of your choice.





Will the 1906 Record fall?

FIBERFAB

FIBERFAB attempts assault on the historic steam car speed record. Fiberfab, the pioneer kit car manufacturer, joins forces with the JDEX Co. to attempt to break the land speed record for a steam powered automobile. The record of 127.6 MPH was established on January 26, 1906 by a special built Stanley Steamer. It has remained unbroken to this date.

The auto to be used in this attempt is a modified version of Fiberfab's newest GT body kit, an Aztec 7. This sleek GT coupe features gullwing doors and ultra modern styling. The Aztec 7 is designed to fit on a VW chassis, which will be replaced with a special tube frame on the racer.

The power system utilizes components from the multi-million dollar Lear Steam Bus Program. These components were loaned to James Crank, President of JDEX Co., by LMC Corporation, successor to Lear Motors Corporation of Sparks, Nevada. The racer's power system consists of a recirculating hot gas, vaporizing burner with regenerators, producing 7.5 million BTUH. This then fires an extended surface boiler with parallel circuits and optimised control.

The boiler produces 5,000 lbs of steam per hour at 1,500 psi at 1,150°F, which drives a high speed turbine. The turbine then exhausts into the atmosphere. The turbine is designed to operate at 65,000 RPM and features sequential throttling. The 65,000 RPM of the turbine is stepped down via a 24 to 1 high-speed gear box. The gear box is coupled to a Hilbrand quick change differential via a modified Casale Marine transmission. The Casale has only forward neutral and reverse gears.

The space age technology used in the development of this system made it the most advanced mobile steam power system yet developed for automotive use. Mr. Crank says that the small steam turbine used is capable of approximately 350 HP. The racer should prove that steam is still here and an able performer. With more and more controls on the internal combustion engine and petrofuel shortages, the steamer could solve a lot of problems.

Rick Figueroa, Executive Vice President of Fiberfab, is author and director of the attempt. Mr. Figuiroa says that the modern steamer will exceed 200 MPH. The attempt is tentatively scheduled for August of this year at Bonneville. ■

(Continued From Page 9)

good news is that $2,300 in contributions has been received.

2. An effort to have more local steam activity will be made through regional meetings. Membership activities will be conducted on local levels, originating in and confined to certain groups such as the existing Mobile Steam Society in Oak Ridge, and in groups to be formed in the Chicago and St. Louis areas.
3. Antique steamer activity is to be encouraged. George Greene has suggested an antique rally, but acknowledges that some owners will be reluctant to bring antiques to a meet because of the risk of damage.
4. The Board of Directors encourages the self-build projects, such as the Project Steam 77 barter idea mentioned by Gene Hise. The SACA can be the clearing house for steam project information.
5. Members are to seek possibilities for advertising on an exchange basis. For example, The STEAM AUTOMOBILE could run advertisements free of charge if another hobbyist-related magazine would run advertisements regarding the SACA.

After the banquet meal, including charbroiled beef, Professor Velio Ebrok of Upsala College, New Jersey, mentioned that his work at the college involves some dreaming up and building steam items. He hinted that some projects may delve into sensitive information, which he could not reveal, but he could and would like to tell about some simple devices. One has an inordinately complicated name for a simple device-polytronic regenerative cycle heat engine. In reality, this can be demonstrated, as Velio did, with a coil of copper tubing about ½ inches ID with the ends brought from the coil in parallel, about 12 inches long, and nearly touching at the open ends. Mention of this device was found in a Boy Scout handbook empowered with a candle under the water-filled coil to move a model boat. It is sometimes referred to as a "putt-putt" boat or steam engine. Its low efficiency of about 1% is probably related to the fact that it operates with atmospheric pressure.

Velio immersed the tubing ends under the surface of water in a tray and lit a sterno can under the coil. He had previously filled the coil completely with water. Soon water and small quantities of steam pulsed from the ends of the tubing. This strange action immediately evoked explanations of the phenomena at each table. Fascinated, many arose from their chairs and filed past the demonstration. Velio offered explanations of the phenomena and its possible applications, but he said it is at least an intriguing demonstration that members might use elsewhere in initiating interest in steam among their friends.

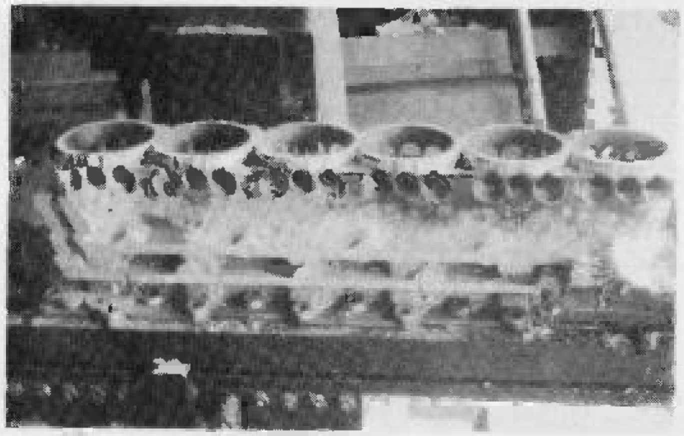
In closing the seminar, SACA President Gibbs asked if anyone had any words to add. Many expressed the thought that this was a very successful and interesting seminar. ■

A CHAIN DRIVE—STEAM DRIVEN VOLKSWAGEN

By Peter A. Barrett

Photos by Author

A



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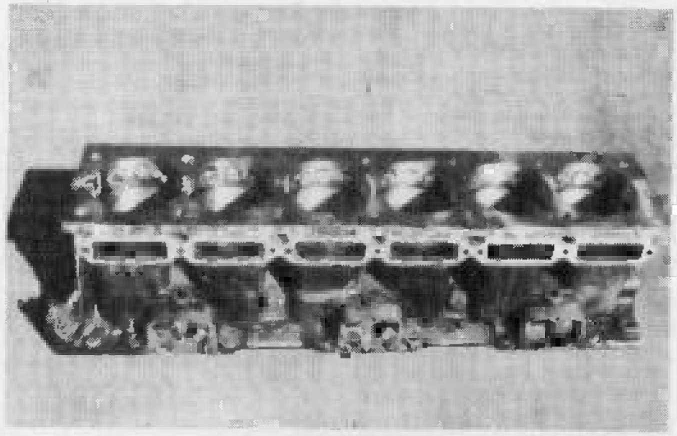


The chain drive Volkswagen was the third vehicle in a series of Barrett steam cars. The previous vehicle was a Triumph Spitfire which was equipped with various engines which were conversions of Mercury outboard engines having various configurations of rotary or "bash" valves. These converted engines had steam rates which were too high. The aluminum pistons and cylinder heads were unsatisfactory for prolonged use with high temperature steam.

Accordingly, I set the following goals for my engine design which should eliminate some of the known problems:

1. Use cast iron pistons
2. Use ductile iron cylinders
3. Reduce the steam rate on the engine

I used the crankshaft and connecting rods from a Mercury engine around which to build the engine. The crankcase was modified by welding and machining. Photographs A, B, C, and D show the steps in fabricating the crankcase. It was planned to operate this engine on an oil/steam mixture so the exhaust steam was fed into the crankcase to lubricate the lower end of the engine.

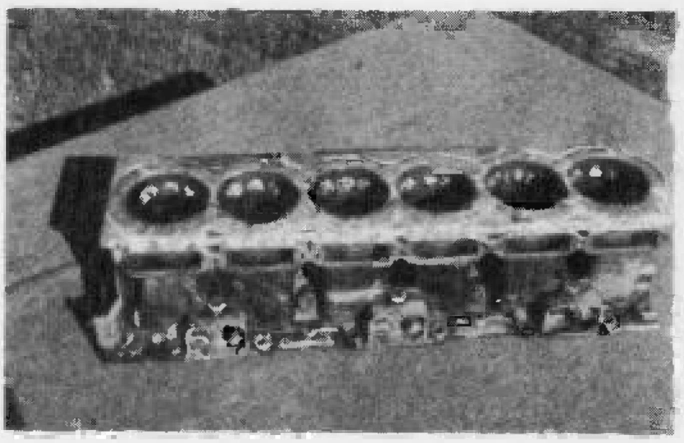
Patterns were made for the cylinders, and the cylinders were machined from ductile iron castings. The cylinder heads were equipped with three bash valves.

The piston castings were made with cores, using the shell molding technique. The inside surfaces of the pistons, which could not be machined, were consistent within .020. As a result, it was possible to produce a light piston even though it was made of cast iron. The finished piston was only 50% heavier than its aluminum counterpart. Since this steam engine was to be run at a slower rpm than the internal combustion engine Mercury, the additional weight of the piston was not a problem. The design and machining of this engine required one year. The engine was initially equipped with a starting valve in addition to the three bash valves per cylinder. The initial test results on the engine were disappointing. Although the cast iron pistons and cylinders eliminated the problems of excess piston wear and loosening of threaded fasteners that had been experienced previously with the Mercury conversion engines, the steam consumption in the engine was still excessively high.

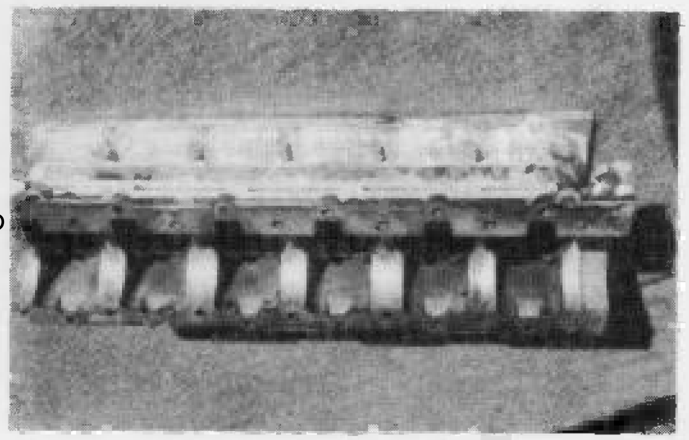
It was only after the starting valve was removed and the engine was operated with a fixed and short cutoff (5%) that the engine demonstrated the steam economy for which I had been searching. The decision to remove the starting valve was made from the following circumstances:

My son, David, had built a steam-powered bicycle that used only a bash valve. Tests on this bicycle engine indicated that steam rates of 12#/MPHR were being achieved. The bicycle engine was started by pedalling the bicycle to 7 MPH, and lowering the friction roller of the engine onto the tire. Thus the steam engine was cranked, and as soon as the steam throttle was opened, there was power available to the wheels. The bicycle power plant ran so reliably and efficiently that I wanted to try out this principle in the Spitfire steamcar.

C



D



To make a quick test of this concept, the engine in the Spitfire was modified to an all bash valve engine by removing the starting valve. The engine was warmed up by raising rear wheels off the ground and pushing on the wheel to crank the engine. After the engine had been warmed up, the car was pushed over to a test hill and push started. The initial acceleration was very jerky until fifteen miles per hour was attained. Thereafter the car accelerated up the test hill better than any of the self starting engines had ever done. The system pressure could maintain 800 psi up the test hill at 40 mph whereas the other engine would drag the system pressure down to 400 psi under the same conditions. Since the test was performed with the steam generator unchanged, I concluded that the use of a bash valve, non-self starting engine would produce a great improvement in engine efficiency.

The problem remained how to start the engine, how to accelerate the vehicle smoothly at low speed, and generally control the vehicle. The logical answer was to use the clutch, transmission, and electric starter which I had been avoiding previously because of a respect for the conventional steam car design. Accordingly I planned to transfer the power plant to a Volkswagen chassis and discard the Triumph chassis. The Volkswagen was selected because it is readily available and parts are cheaper. The VW floor pan is a self contained vehicle ideal for testing an automotive steam powerplant.

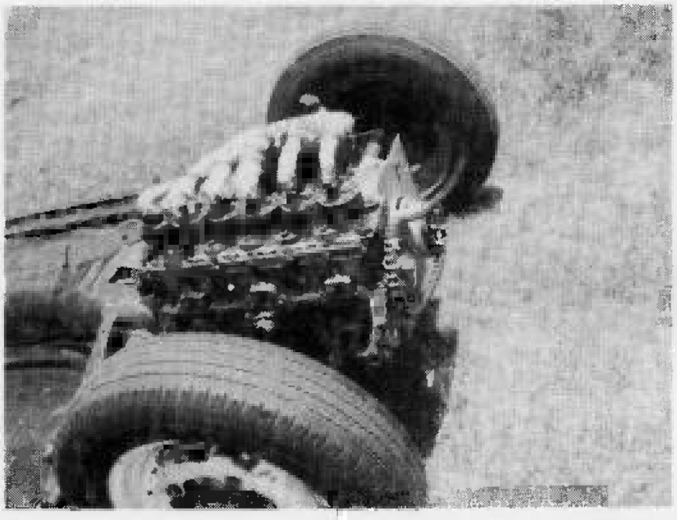
However, if one wished to couple any available steam engine into the clutch and transaxle of a Volkswagen, one is faced with the problem of providing compatible interfaces between the engine and transaxle. After studying this problem, I decided it would be easier to make an adapter plate which would mount onto the transaxle housing. This plate contained a shaft and bearings to rigidly support a shaft. The VW flywheel and clutch were attached to one end of above mentioned shaft and a #50 sprocket was attached to the other end of the shaft.

A tubular engine mount was attached to the transaxle, and the engine was installed in this mount. The engine was connected to the transaxle with a #50 chain. Photograph E shows the engine and adapter plate mounted on the VW transaxle. A 1.5 to 1 step down ratio was used between the engine and transaxle. The chain drive allowed the engine-to-wheel ratio to be changed as desired for experimental purposes. Photograph F shows the power plant installed in a test vehicle.

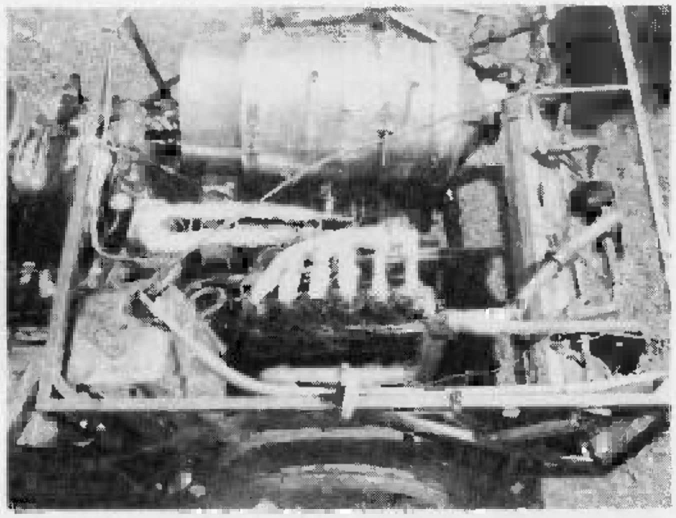
The chain drive worked very well. The engine could be cranked with the VW electric starter, and the engine would continue to run as long as steam was supplied to it. The operation of the vehicle was identical to driving a stick shift IC engine car. However, the flexibility to control the car was a big improvement over the previous steam cars that I had built.

Other improvements and simplifications resulted from the use of the electric starter and transaxle. I had previously used an electric driven pump to feed the boiler when steam pressure was raised on start up. This electric driven feedwater pump was used extensively while the engine was warming up and the car was struggling thru its first quarter mile of operation. During this period the electric power used out of the battery was extensive.

E



F



With the electric starter and transaxle, the electric driven pump could be eliminated. Steam pressure could be raised to 300 psi off of residual water that was in the steam generator. The engine could be started at this pressure. Since the transaxle could be placed in neutral, the engine could be used to drive the feedwater pump until the system operating pressure of 1000 psi was reached. Now when the vehicle is started, the engine is up to temperature, and normal performance is available. No longer is it necessary to tolerate substandard performance for the first quarter mile. During start up, the electrical load is no more than when operating on the road (20 amps at 12 volts) and the alternator will be operating for 75% of the start up period.

In conclusion, the principle of coupling a non-self starting steam engine to the rear wheels through a clutch and transmission is excellent. Photograph F shows the engine and chain drive as installed in a test vehicle. This type of drive has many economical and technical advantages. It should make it possible for more experimenters to get a steam car running on the road by utilizing automotive components which are readily available and very reliable.

The only thing negative about this 6-cylinder engine is that it requires too many manhours of machine work. Since the engine can be started by an electric starter, the same basic engine configuration could be built in 2-cylinder version. The simplification and reliability would be greatly improved.

As a result, I have been engaged in an engine project with Lt. Cdr. Graeme Vagg to convert a VW engine to steam. The first VW engine conversion was a 2-cylinder engine, and it is very successful. As a result, I now have a surplus 6-cylinder and chain drive adapter, and I hope to sell these items to a steam enthusiast who will install them in a vehicle and put them over many miles of road. ■

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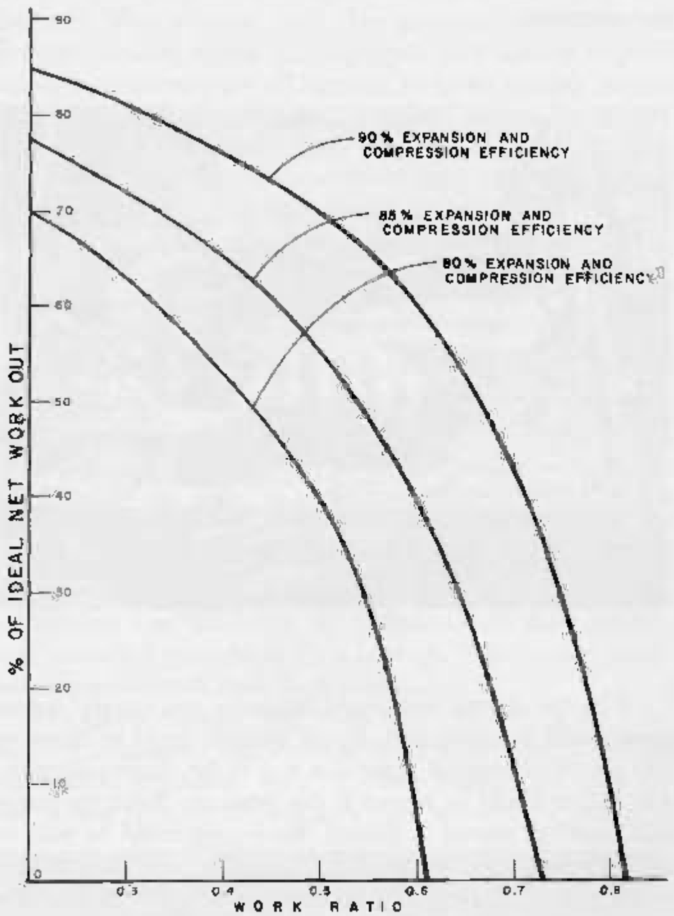

(RATIO OF IDEAL WORK OF COMPRESSION TO IDEAL WORK OF EXPANSION)

FIGURE 8

metals in the gaseous Stirling engine. The net result is that the condensing vapor Stirling engine will be easier to construct and requires cheaper materials.

References

1. Norman D. Postma, Ford Motor Company; R. Van Giessel and F. Reinink, N. V. Philips, Holland, "The Stirling Engine for Passenger Car Application".
2. U.S. Atomic Energy Commission BNL 2446 (1955) pp. 89-102. ■

(Continued From Page 11)

any clutch nor shifted any gears. But softly with a slight odd creaking from the engine behind us, we were off! It was an eerie feeling going up a hill like that with just the merest suggestion of a chuff-chuff. I still could not get over the strange effortlessness of the car's running so quietly that the creak of the leather upholstery, as we shifted our weight, was oddly magnified, like people coughing in a library. We stopped for a crossroad, the engine did not idle, it stopped dead. Your power is not made in the engine like a gas car as it is in the steam you have made and saved up in the boiler. If you think you have enough steam to get home on, you can just turn off the main fire and go home on the steam you have in reserve, which we did. As the pilot light went out on us, we decided to head for home, and we had also been driving around without license plates.

There is another thing about a Stanley that is called the hook up. When you push it part way down, it will stay there until you push it again. It limits the valve opening on the engine and saves steam when cruising. At low speeds or in traffic you can run more smoothly without it. There is a lot more to a Stanley than just the boiler, burner, and engine. There are pumps, pumps for air pressure, pumps for water, fuel, and cylinder oil. These little pumps are situated under the floor boards and are mechanically operated from the engine. Then there are gadgets like the superheater which dries and heats the steam for greater power. All these devices were interconnected with what seemed like miles of piping, valves, joints, etc.

This article may be boring to some older members, but might be some help to some new members like myself who are just starting. I have a long way to go before I can be considered an expert like my dad, "Mr. Steam". I feel like one of the old timers now with singed eyebrows and a strong left arm from using the hand pump. ■

(Continued From Page 25)

seat, but tapered passages cut into a cylindrical spool actually do the throttling. To avoid having to deal with a much higher temperature, the throttle was located before the superheater. This arrangement may be better for the throttle, but sure does not make life any easier for the rider. This was realized during an early test drive when an attempt was made to turn around on the hill in front of the author's home. The throttle was closed, and the cycle slowed to a well mannered stop on the hill, but as she started to go across the road, steam remaining in the superheater sped her forward. Quickly the foot brake was stepped on, but the same foot was also needed on the ground to keep the cycle upright. It was touch and go, but the turn was finally negotiated without harm to mechanism or body.

The Steam Flyer is remarkably quiet, making only a rhythmic "pht, pht, pht" as she contentedly steams along. Though never accurately measured, the fuel and water consumption are thought to be about 20 and 5 miles per gallon respectively. ■

Letters

Dear Sir:

Your embassy has kindly supplied your address. There are quite a few of us here who are very interested in the steam car. Now that we may have petrol (gas) rationing at any moment, we thought it a good idea to start to find out all we could about it. I do not know of anyone in South Africa who is interested in this subject, hence my letter to you.

Would you be so kind to send us any literature pamphlets, or anything which would be of some help to get us started. I do not know what it will cost, but maybe you could enclose a price list. We have read about the steam car in a few magazines, and it has quite taken our fancy.

R. E. Lindstrom, Republic of South Africa

Dear Sir:

Enclosed you will find my dues renewal. Thanks to your perseverance in the steam car communication field in the United States, we may yet see someone step forth with a better solution to the transportation problem in efficiency, conservation, and air pollution control. Sorry I can not contribute more to the club, but time and money are very limited for the present. Therefore, my solution is to contribute when I can and at the very least the dues once a year.

The thought has occurred to me that when it has been determined a sufficient membership has been attained, why that membership should not be offered the opportunity to back a steam car operation (modern development) that thorough investigation shows it lends itself best to mass production.

John B. Davis, California

Dear Sir:

I wish to build a full size replica of the 1908 Stanley Gentleman's Speedy Roadster. I would appreciate any information I can purchase or obtain on original specifications, etc. I am equipped with a machine shop and access to a foundry to do as I originally desired. Will you help me as I have had no luck on my own.

I will be very happy to send you a complete description of the project, if it can ever begin, replete with photos, etc.

Keep up the wonderful work you are doing and remember, the daily use of an antique steamer or replica thereof will draw more attention to your cause than a VW.

Dan E. Ryan, Colorado

BACK ISSUES OF The STEAM AUTOMOBILE

Back issues of The STEAM AUTOMOBILE are available for Volumes 2 through 18 (1976). The magazine is not sold separately nor on a subscription basis, but obtained only through payment of the annual dues of $10.00 which includes 4 issues. Send a check for the volume numbers you wish, and those ordering 5 or more volumes will receive Volume 1 complimentary. There was only 1 issue of Volume 1.

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Condition: A. Restored, running; B. Restored, Museum; C. As Found; D. Restoring; E. Running

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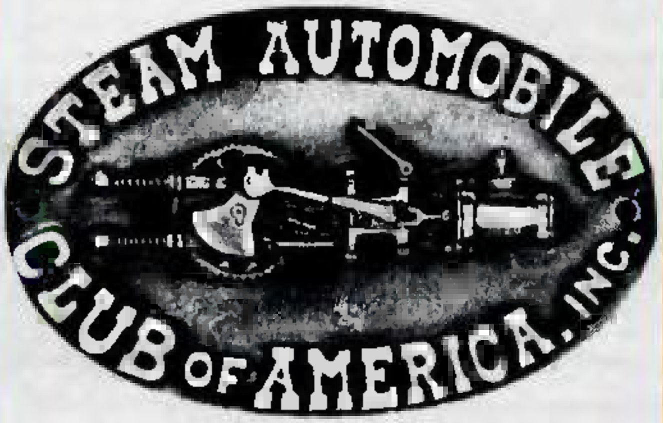

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S.A.C.A. MEETS

Santa Ana, Calif.—April 1, 2, 3, 1977

Greensboro, N.C.—May 6, 7, 1977

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