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Description of a Modern Automotive Steam Powerplant

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McCulloch Corp.

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ABSTRACT

The history of steam cars dates back to the early [illegible] century. McCulloch Corp., looking for a superior automotive propulsion system, applied modern engineering techniques and latest methods and material in furthering the Paxton steam car development. An outline of the technical features of early steam cars is included. In the study of the vapor cycles, a standard vapor-cycle with stress on high pressure and high temperature to reduce size and improve efficiency was deemed best. Though steam car virtues such as high performance, fuel economy, and low noise level are readily apparent, the development of the internal combustion engine is so far advanced that any newcomer will require a tremendous development effort.

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TO TELL YOU A LITTLE of the technical aspects of the McCulloch Corp. steam car development, we go into the steam cycle, very briefly, primarily to show what we were trying to accomplish, to show some pictures of the previous, better efforts in this field for comparison, and then to give some details of the Paxton Car development. We believe the McCulloch work in this field is the latest, concerted effort of applying modern engineering and the latest methods and materials to the modern, automatic, lightweight, high-performance, automotive steam powerplant. However, this development was discontinued in 1954 and the entire project is now in dead storage. Reasons for this will be given later.

In 1951, McCulloch Corp., looking for a superior automotive propulsion system, designed for today's driver under today's traffic requirements, decided to look into the "steamer." We were engaged in the development of the Paxton automobile at that time with another unusual powerplant, and the steam powerplant was intended as an alternate to power this same, luxury sports-type car. This automobile was styled by Brooks Stevens, and has since been shown to the Detroit stylists. Perhaps some of you have seen it in some of the automotive literature. It is shown in Fig. 28.

To facilitate this development, the late Abner Doble was engaged as a consultant, not only to make use of his lifetime of experience in the steam field, but also to avail ourselves of his creative mind. We also licensed all Doble patents, which gave us a good business position.

As many of you will remember, the Doble Steam Car was built in San Francisco up until about 1930. The latest models, known as the "Series E" were truly superlative vehicles. I believe this car was the last production effort in the steam automotive field in this country and possibly in the world.

Our specifications were merely that the powerplant would have to give the Paxton performance superior to any similar vehicle. That's a big order, but our preliminary studies indicated we could do just that; so, we launched into the development of steam generators, feedwater pumps, engines with variable cutoff, condensers, and all sorts of new and intriguing problems. I might add here that what was considered phenominal acceleration in 1951 is no longer unusual. You'll see this in some of the data presented. However, our latest testing indicated that even today's performance can be met or bettered.

Most very early steam automobiles had, literally, a boiler with a large quantity of water to be heated, and a noncondensing, single-expansion, steam engine, permanently geared to the drive wheels, with reversing accomplished in the valving. The vehicles had a large, thermal storage capacity which was fine in operation to minimize the boiler control problems, but it did take a long time to heat up--sometimes as long as half an hour! Later versions used a monotube boiler or steam generator with very little water in actual cycle operation. For example, the last Stanley Steamer built carried 6-1/2 gal of water in the boiler alone! --more than in the complete Paxton system.

The later models, such as the Doble "E" series, used almost complete condensing. These early machines all had quite low steam pressures and temperatures (about 750 psig and 600 F) and were not too efficient. Worst of all, they consumed lots of water. Some of them even had built-in pumps for sucking water from the local creek or nearby horse-watering trough! Obviously, this would not be acceptable in a modern automobile because one can hardly find horse-watering troughs these days; so, our requirements included complete condensing of the exhaust steam under all conditions--the system had to be almost sealed, and should use no more water than the current automobile requires in radiator refilling. Now, since we had to condense all exhaust steam, we have a double premium on efficiency or a low specific steam rate. A low specific steam rate not only saves fuel and reduces the steam generator size, but, more important, it reduces the condenser and cooling-fan size. As you will be able to see in the photographs, the condenser and cooling air system are the apparent limiting factors in the powerplant size in a given vehicle.

To get low specific steam rates, one must consider high pressures, high temperatures, and high expansion efficiencies. To get high efficiency, the Phoenix development (as the project came to be called) was designed for 2000 psig nominal maximum steam pressure at the throttle valve, 1200 F nominal maximum steam temperature from the steam generator, and the engine was double-acting, double-expansion, with variable cutoff of the high pressure steam entering the cylinder to provide outstanding maximum low-speed torque (long cutoff) combined with very efficient high-speed operation (short cutoff).

The steam automobile is not new. Fig. 1 shows the Gurney Coach of 1827, and Fig. 2, a Clarkson bus of 1904. The early 1900's produced a host of various steam automobiles--the more famous of which were the Stanleys and Whites. The last Stanley of about 1925 was a good looking, good performing, 80-hp (bursts), 20-hp (continuous) car.

Because the system we were considering was, in many respects, quite similar to the latest Doble cars, their designs should be studied. Fig. 3 is a photograph of one of the latest Doble Steam Cars. This unit was built around 1930. It had a 142-in. wheel base, and was powered by a 4-cyl, cross-compound, double-acting engine, using Stephenson valve gear with manual cutoff variation and reverse. It carried 17 gal of water and had a gross weight of some 5500 lb. The chassis arrangement is shown in Figs. 4 and 5.

In pursuing the McCulloch development, we searched the world-over for some of these cars, or parts thereof, to facilitate our development, and finally did purchase Abner Doble's personal car, Serial No. 24, in England, and returned it to Los Angeles. Several Doble steam generators and auxiliary sets were also found and restored to use. We found it quite a problem obtaining 2000 psig, 1200 F, small-capacity laboratory steam supply for our testing of engines, valve gear, insulation, condensers, exhaust turbines, and the like.

The Doble engine, together with reduction gear, locking-type differential, and brake shoes, is shown in Fig. 6, and the steam generator, together with its motor-driven combustion air blower and carburetor, in Fig. 7. The auxiliary unit, which includes the 4-cyl feedwater pump, lubricators, and electric generator, is shown in Fig. 8. This automobile was, clearly, one of the better pieces of automotive engineering of its day. We can say, first-hand, that Serial No. 24, after having been around the world in 25 years of use (and disuse) and, after having gone several hundred-thousand miles, still was an acceptable vehicle (Fig. 9).

In the early study phases of the development, many vapor cycles were considered, and fluids other than water were given serious study. A fairly standard water-vapor cycle, with stress on high pressure to reduce size, high temperature to improve efficiency, and good mechanical design, appeared the best. Many exotic fluids show a high theoretical effi-

Fig. 1 - Gurney's steam coach of 1827. 6 passengers were inside and 12 outside. Coke was used for firing boiler so little or no smoke was emitted

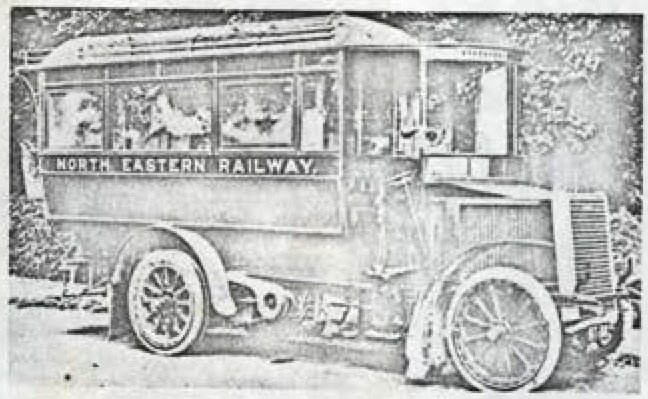

Fig. 2 - Clarkson Bus of 1904

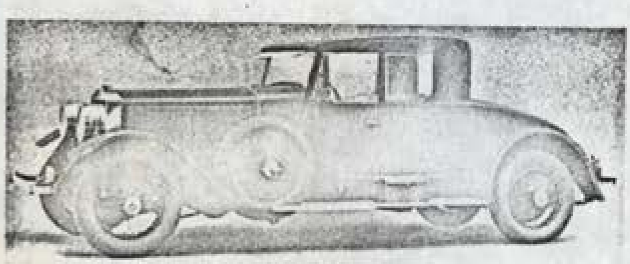

Fig. 3 - Doble deluxe runabout - disappearing seat under rear deck

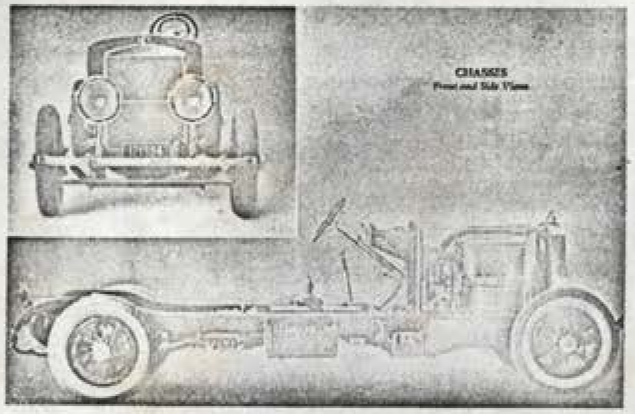

Fig. 4 - Doble steam car - chassis front and side views

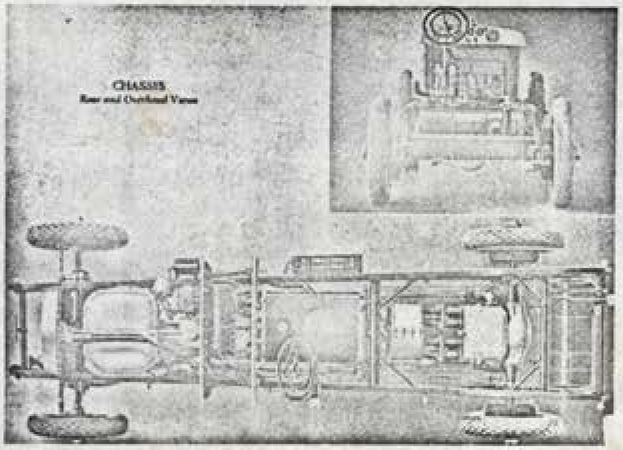

Fig. 5 - Doble steam car - chassis rear and overhead views

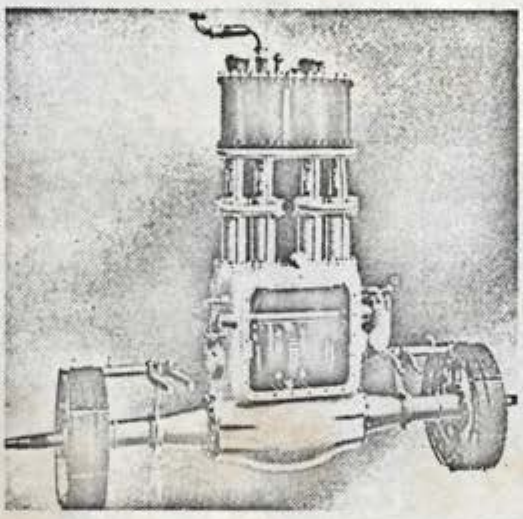

Fig. 6 - Doble engine with reduction gear, locking type differential, and brake shoes

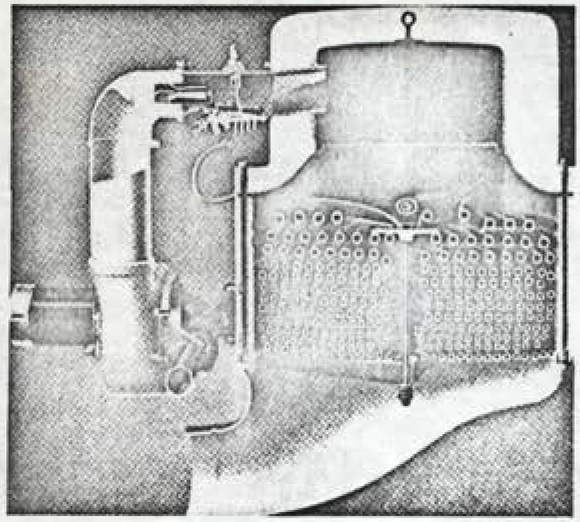

Fig. 7 - Doble steam generator with its motor-driven combustion air blower and carburetor

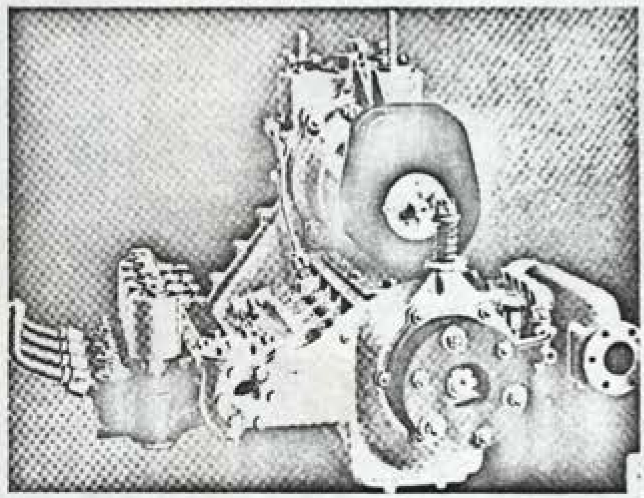

Fig. 8 - Auxiliary unit which includes 4-cyl feedwater pump, lubricators, and electric generator

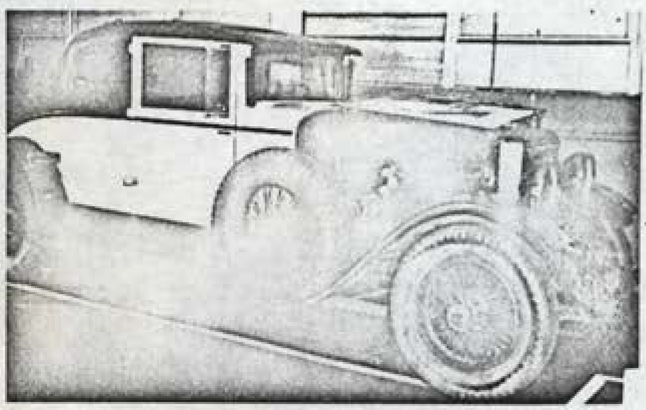

Fig. 9 - Serial No. 24 Doble after 25 years of use

ciency, but they also present some very difficult problems. When one considers that this equipment is to go into the hands of the inexperienced--and even incompetent--such things as mercury vapor lose their appeal.

By far, the most soul-searching occurred when we had to commit ourselves to the maximum operating temperature. Many limiting factors must be considered here, but lubrication of the high-pressure cylinder is certainly among the more pressing issues. At these temperatures, there is enough oxygen in the steam from dissociation and other sources to oxidize partially the conventional lubricant. Can the cylinders be lubricated at all at these temperatures? Is it possible to run the piston and rings and shaft seals of materials that require no lubrication? Unfortunately, when lubricant is used in the engine, it will find its way into the steam system where it breaks down, the hydrogen grabs the available oxygen first, leaving the carbon as deposits in the steam generator tubing. This worried us until we learned of operating experience on the Dobles where it appeared to be no major service problem. Although they did operate at lower temperatures, finally 1200 F was selected as our design objective, and, I am pleased to report, we did run our dynamometer test engines under this condition of 2000 psig and 1200 F. Initially, we backed down a little for use in the automobile because we had enough development problems without including overtemperature complexities.

The schematic steam cycle (Fig. 10) shows the complete fluid path.

I am sure you are acquainted with vapor-cycle theory, but, for completeness, we have the Mollier chart (Fig. 11). This chart illustrates vividly what the high-pressure ratio and superheat do for you in cycle efficiency. Table 1 also illustrates how this powerplant compares with the earlier steam cars and with a modern generating plant. Although these objectives were not easily attainable, our calculations indicated that this powerplant should give us a luxury sports-type car with high mileage and excellent acceleration, as well as the other inherent advantages of a vehicular vapor-cycle powerplant. These advantages are:

1. Separation of the chemical heat release process from the conversion of this energy to mechanical power. This permits a "readiness" of power unattainable in most other prime movers.

2. Separation of the compression and expansion functions of the vapor-cycle. This permits stopping the expansion process whenever no power is needed. Literally, the expansion engine can be coupled irrevocably to the vehicle's driving wheels and not related to the compression functions--the boiler feedwater pump and steam generator--whatsoever.

3. Close control of the combustion process. Combustion is performed in a most leisurely manner, compared to the high-speed internal-combustion type engine. No tetraethyl

Table 1 - Comparison of Various Steam Systems

System	Stanley Steam Car	White Steam Car	Doble Steam Car ("E" Series)	McCulloch Steam Car	Modern Steam Electric Generating Plant
Type of steam generating unit	Fire tube	Monotube	Monotube	Monotube	Complete powerplant type
Type of engine	Single expansion	Double expansion	Double expansion	Double expansion	Turbine with reheat
Condenser	None (Partial later)	Partial air cooled	Partial air cooled	Complete air cooled	Complete large natural body of water
Pressure, psi	600	600	1500	2000	2400
Temperature at superheater outlet, F	800	800	800	1200 Design	1050
Exhaust pressure (40 mph cruise for steam cars)	20 psia	Atmospheric	5 psia	1 psia design 1026°F.	0.75 psia
Specific steam rate pounds stem per bhp-hr	Over 20 (estimated)	17 (estimated)	12 claimed	6.5 dyno test of engine	5.6

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lead is required in the fuel. Excess oxygen is always present, so high-combustion efficiency is attainable, and no smog or noxious fumes are produced (no carbon monoxide is produced). The furnace can be operated indoors without danger to personnel.

4. Closely related to the control of combustion and the long burning time in the steam generator is the ability to burn almost any fuel. While our experimental work was all done on the liquid hydrocarbons, solid or pulverized fuel can readily be used with a little burner variation. Of course, there is always the hope that, eventually, a fission or fusion source of nuclear heat would become available.

5. Because the combustion process is separated from the operating fluid, no contamination occurs from sulfurous or obnoxious combustion products.

6. The reciprocating-engine type expander has a wide permissible variation in mean effective operating pressure (including negative values for braking), giving excellent torque and speed characteristics for an automobile with no transmission complications.

7. A wide range of expansion ratios are attainable because the compression and expansion portions of the cycle are not interconnected. This can improve the efficiency under some operating conditions.

8. High operating pressures and two-stroke cycle, double-acting engine functions result in high specific outputs--that is, high bhp per cubic inch of engine piston displacement. As you may have noted in the Doble chassis (Fig. 4), the engine is small enough to lie beneath the floor panels. In the 1953 Ford coupe in which we installed the first Paxton steam plant, the engine and differential mounted beneath the trunk floor without change from standard. This characteristic also results in low specific engine weight.

9. Although the steady-state, high-output efficiency offers no advantage over current gasoline and diesel powerplants, the actual variable-duty, low-average power operation demanded by modern, metropolitan traffic does give the steam plant a favorable position. The best way to explain this is to note that the steam generator burner brings the unit to full temperature a few seconds after the throttle valve admitting steam to the engine is closed, so during all coast-down and during all time at a stop-light, or during

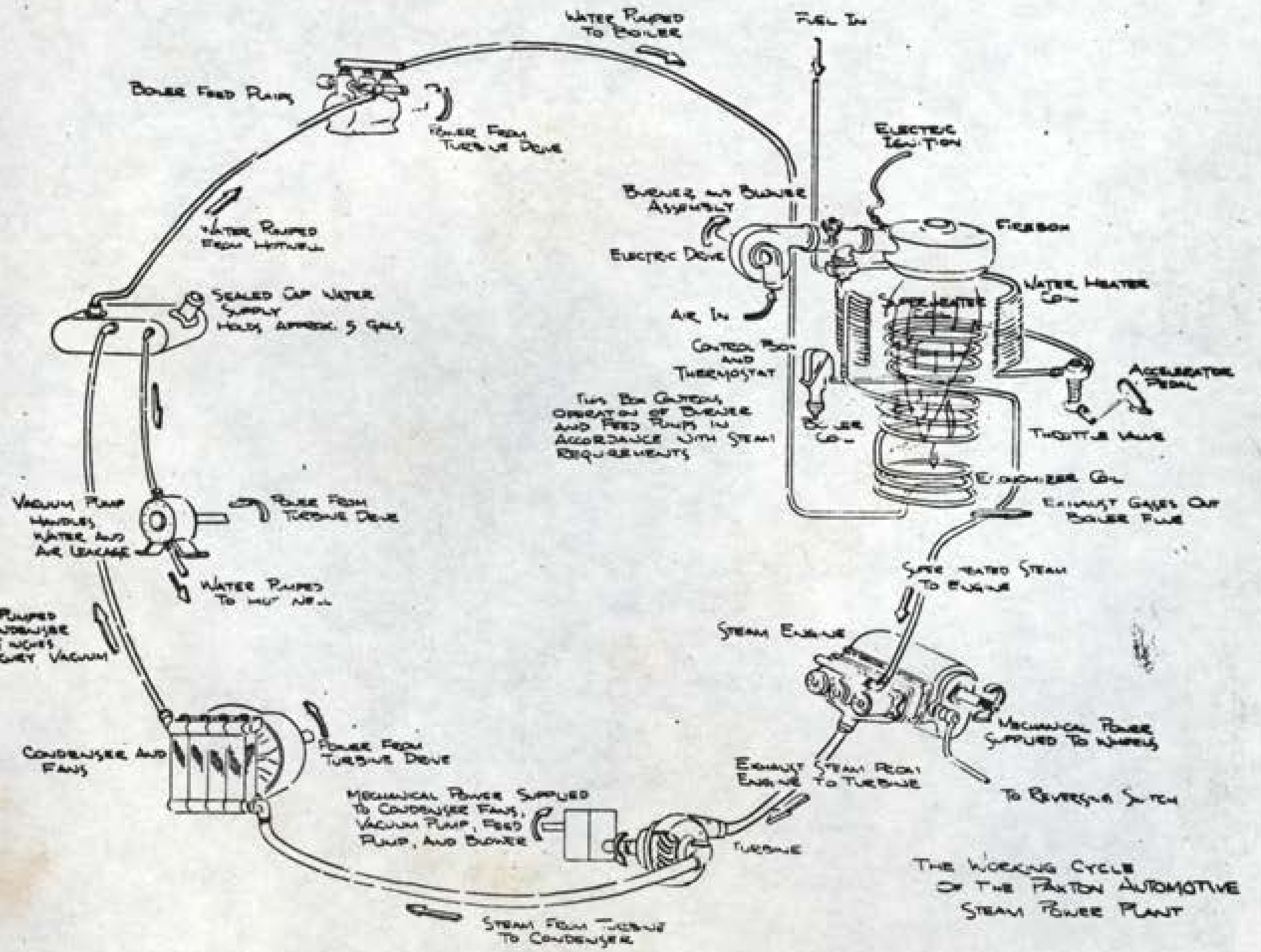

Fig. 10 - Working cycle of Paxton automotive steam powerplant

all time in a traffic jam, no fuel is being consumed. The well insulated generator only restarts the burner a few seconds every several minutes to maintain temperature. These characteristics result in the high mileages shown in subsequent figures.

10. We would be remiss if we did not list some of the secondary features of steam that were true advantages in the days of the Stanleys and Dobles, but can no longer be better than the highly-developed gasoline automobile:

a. Virtually silent operation.

b. Instantaneous high-capacity cabin heat available--or continuously available when standing, if desired.

c. Minimal vibration.

d. Smooth acceleration throughout range, from standing to full speed.

e. Infallible cold-weather starting (no high-output battery required).

f. No freezing problems.

I'm sure you can see why we believed steam could make a superlative automotive powerplant.

Needless to say, the steam-cycle powerplant also has some disadvantages that must be noted and carefully studied to be minimized:

1. The cycle efficiency is not as high as high-compression gasoline and diesel engines at high power.

2. The system must be designed to minimize the loss of fluid and it must be replaced easily.

3. Overall powerplant weight will be higher than competitive systems, unless careful design and light alloys are used. The reduced size of the high-pressure system minimizes this disadvantage. (It should be noted here that our steam system is actually lighter when the transmission and drive lines are considered.)

4. Long, cold-starting time can be serious, and this was a serious problem on old steam cars, but modern monotube steam generators with greatly reduced thermal capacity have brought the cold-starting time to under 30 sec. I might add here that, with modern, automatic, well-insulated steam generators, it might easily be left on "under steam" continuously if rapid starting is desirable. Our Paxton generators were still hot after a cold, overnight shutdown. In fact, a butterfly-type damper was installed downstream of the carburetor to preclude thermal air convection and thereby minimize thermal losses.

5. Since the automobile may draw electric power for the burner air-blower, as well as the other usual electric uses, for some periods (perhaps extended) when the generator is not in operation (the vehicle is stationary), a large capacity battery is desirable, although we did use the standard automotive unit in our test car. It should be noted that the present automotive battery, designed for the high current drains of cranking, is not the optimum type.

6. Last, we should mention that there are some legal problems about licensing in states that still have laws requiring a steam engineer's license to drive a steam-powered car. These would certainly not stand up under challenge, and were not always enforced in the last years of the older steamers.

Figs. 12-14 show the predicted performance of the Phoenix engine in the Paxton automobile. Although this particular combination was never road-tested, the powerplant was operated in a converted 1953 Ford coupe chassis, and the performance data taken there proved these curves could be equaled or bettered.

Fig. 12 shows the "flash" or short-term horsepower output, as well as the continuous output of the Paxton engine. The short-term power is limited by the steaming capacity. An approximate road load curve is also shown. The difference between the two curves is the power available for acceleration and for hill-climbing at any speed.

Fig. 13 shows the torque available at the crankshaft over the speed range. The ratio between the engine and rear-axle is 1.6:1. The torque available at the poorest crank-

Fig. 11 - Mollier chart - vapor-cycle theory

Fig. 12 - "Flash" or short term horsepower output as well as continuous output of Paxton engine

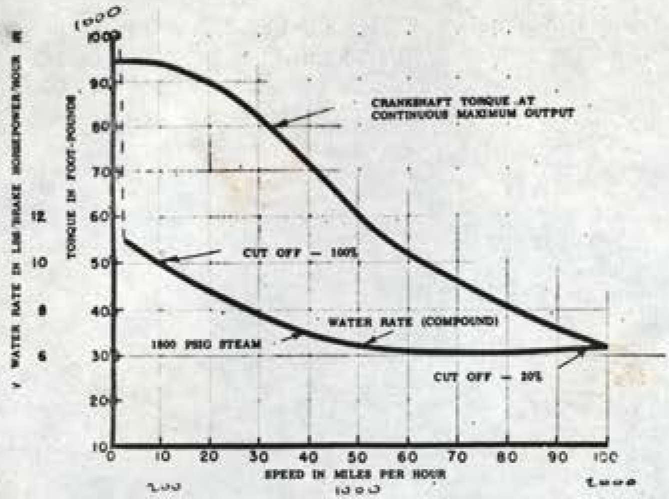

Fig. 13 - Torque available at crankshaft over speed range

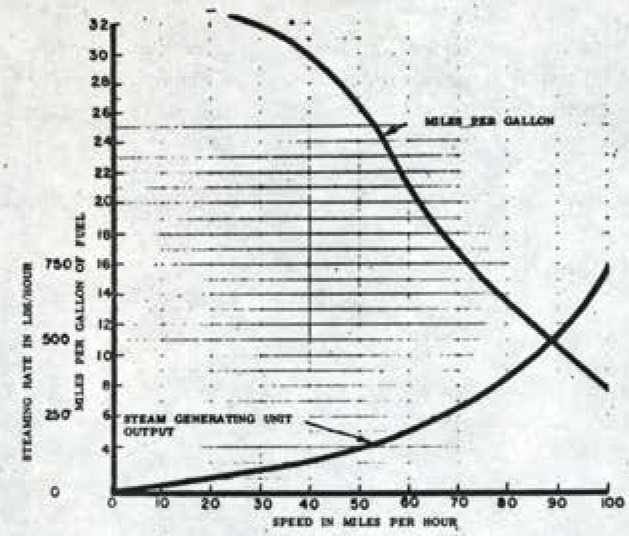

Fig. 14 - Calculated specific fuel consumption for Paxton

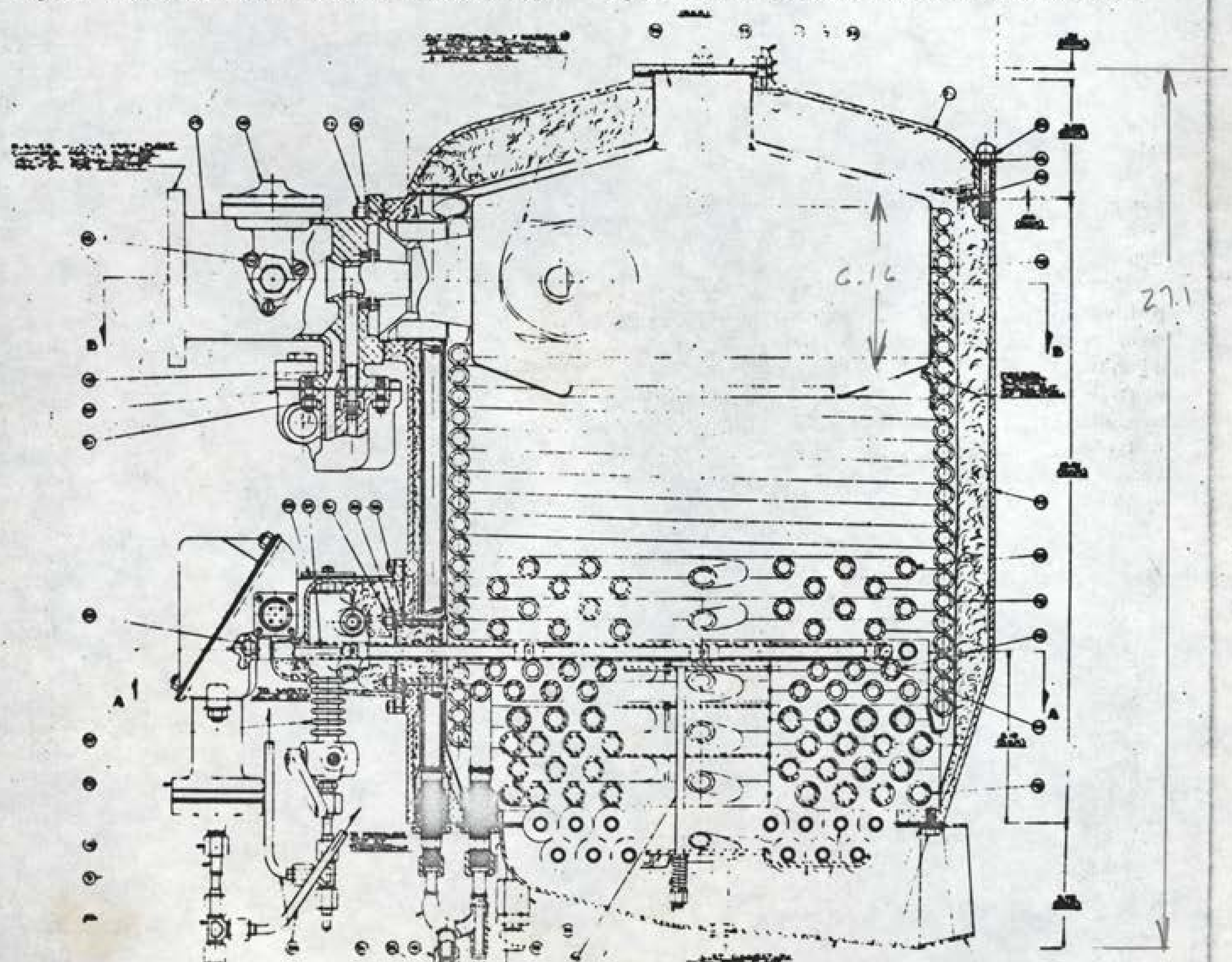

Fig. 15 - Steam generator shown in cross-section

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angle in the engine is adequate to pull a 30% grade. Also shown is the water or steam rate in pounds per shaft horse-power hour as a compound engine. At the very left of the curve, the very high water rate at very low speed indicates the starting operation as a "simple" engine. The application of full steam pressure to the large piston area of the low pressure cylinder produces the very high initial torques and, under these circumstances, has a very high water rate. The water rate expected is also shown and, as expected, it is not as good as we would like at the low speeds and light loads.

Fig. 14 illustrates the calculated specific fuel consumption for the car and, I might add here, again, that the actual test data from the converted Ford bears out the validity of these forecasts.

The steam generator is shown in cross-section in Fig. 15. This unit illustrates vividly that, within limits, the higher the pressure and temperature for a given power, the smaller the boiler will be. This unit is only 18 in. in diameter. It comprises a preheat or economizer section where transfer is largely by convection and high, internal water velocities and large external surfaces are used. Aluminum-copper bi-metal tubing was used. In the next warmer section, a greater portion of the heat is transferred by radiation and less by convection, so all-steel tubing is used, with no extended external surface. In the evaporation and superheater sections of the boiler, the tubing is exposed to full radiation from the furnace and, with low-alloy tubing, we did experience some mechanical damage to the tubing from "heat cracking" on the surface where the temperatures can rise to very high values when the throttle is closed suddenly after a heavy load. Inconel or stainless tubing with heavy walls is essential in these areas.

The gas passages are designed to narrow-down in flow area to allow for shrinkage of the hot gases passing through the boiler to maintain high velocities and good heat transfer.

The fire-box not only guides the burning air-fuel mixture to insure a very turbulent vortex, but protects the tubing in the upper part of the unit from direct flame impingement. The fire-box is hot enough to be virtually transparent to radiation. Stainless or equivalent must be used, and 310 Series was found to be satisfactory during the extent of our testing. In later steam generators, a crown coil was added to the top for more surface and lower heat losses.

Initially, "Santocel" insulation was tried, but the finely-divided powder leaked out everywhere, so subsequent steam generating units were insulated with "Fibrefrax" - a fibrous material. Its insulating characteristics are not quite so good, but it does stay in place.

I might squelch some old stories here about "the boiler blowing up." There is so little actual steam volume in our unit that we customarily ran without safety valves. We did have several tubing failures, but none were caused by excessive pressure alone. Both Mr. Bell and I, as well as others on the development, have been around these operating units when a tube has ruptured for some reason, and we consider it no hazard whatsoever in the automobile.

Figs. 16 and 17 present a cross-section of the boiler control. Needless to say, the boiler output must closely follow the operator's accelerator pedal or demands. By the same token, it cannot exceed prescribed pressure or temperature limits. In this unit, temperature is detected by the differential expansion between the steel tubing and a quartz rod that extends across the boiler, as shown in Fig. 16. Pressure is determined by the spring-loaded diaphragm shown in Fig. 17. Either of these controls can cut off the fire and the pressure unit controls feedwater also.

The feedwater admitted to the boiler is directly related to engine speed, since the engine drives the 3-cyl, positive-displacement, plunger-type feedwater pump. It is beyond the scope of this paper to go into detail regarding boiler control, but I should say that when extra feedwater (over normal) is admitted, it enters what we call the Normalizer which bypasses much of the first part of the boiler to provide a prompt temperature response. Feedwater added to the Normalizer circuit, together with normal boiler-feed coming through the economizer, exceeds the evaporative capacity of the unit, so the temperature falls.

Fig. 18 presents a cross-section of the boiler feed and vacuum pumps. The feedpumps' cylinders can be cut out (made inoperative, but still reciprocating) individually with the solenoids, which merely hold the inlet-valve open. Noncondensibles, such as air-leaks and burned lubricants, together with some water vapor, are handled by the three vacuum pump cylinders. These noncondensibles are removed to maintain good condenser heat transfer on the vapor side.

An operational schematic of the Wolfe compound Paxton engine is shown in Fig. 19, which should make the engine cross-sections clearer. The steeple-mount high-pressure and low-pressure pistons are both approaching top dead-center --cutoff has been completed so both the high-pressure inlet and low-pressure exhaust valves on the left are closed. As the crank proceeds, the transfer-valve on the right will open, permitting gas from the high-pressure cylinder (now expanded) to continue its expansion in the low-pressure cylinder. Near bottom-center, the exhaust port opens, allowing the major blow-down to flow from the cylinder to the turbine; at that time, the transfer closes. As the pistons again start upward, the high-pressure valve and small exhaust valve on the left are opened, as permitted by the amount of cutoff used. At 20% cutoff, these valves close very early. The small exhaust valve prevents excessive precompression in the low-pressure cylinder.

Fig. 20 is the same, basic engine in actual cross-section. The transfer valve is shown; the high-pressure inlet and low-pressure exhaust valves lie behind it. The ported exhaust is shown at the top of the engine. The cams are three-dimensional, and the camshaft is shifted lengthwise to alter the cutoff of the admission of high-pressure steam. This is done automatically, based on engine speed and steam chest pressure. Fig. 21 is a lengthwise section of the engine.

The automobile had a De Dion type rear-axle with the gear reduction of 1.6:1 and differential, as shown in Fig. 22. This equipment, as well as the engine, is shock-mounted to

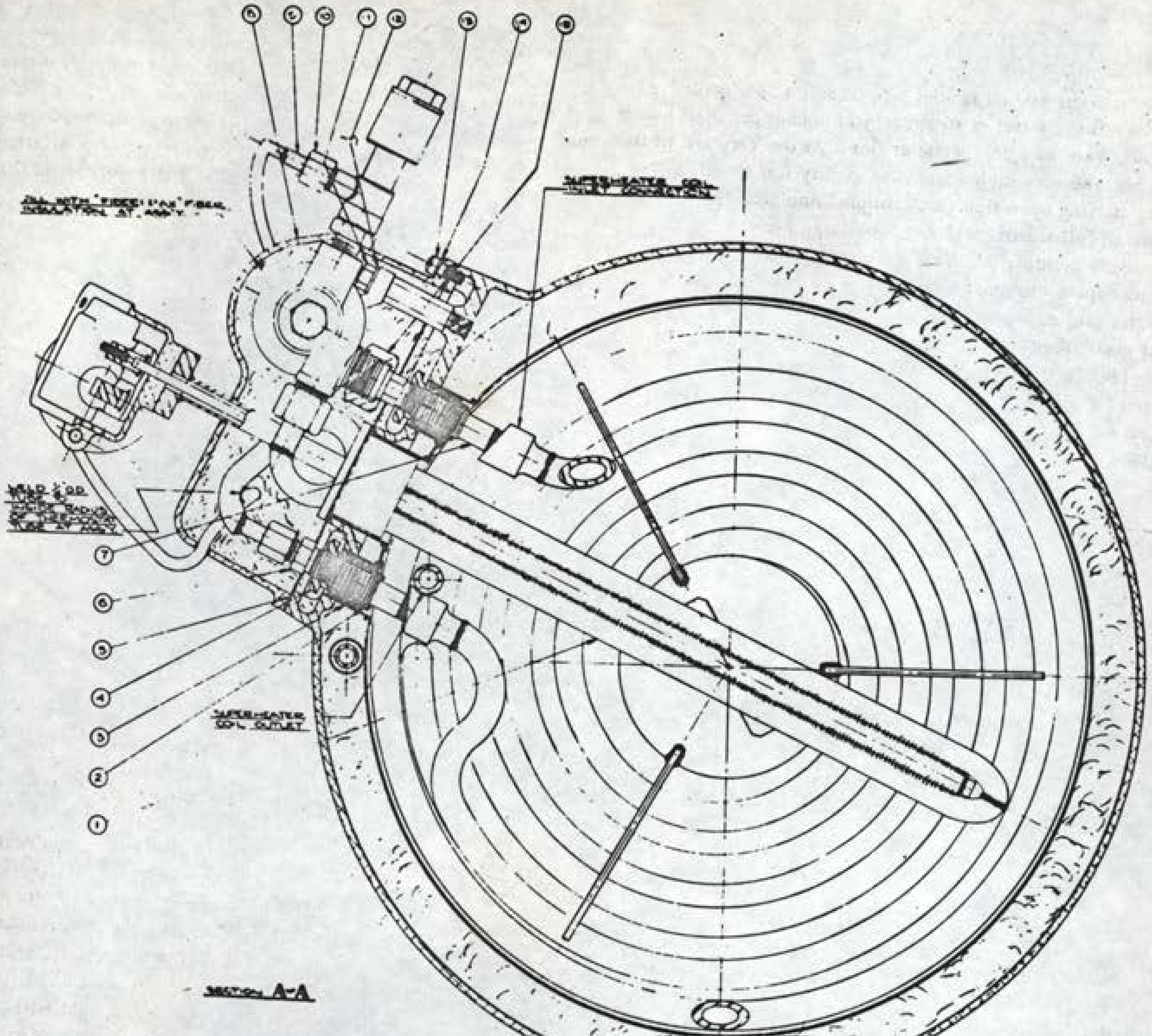

Fig. 16 - Cross-section of boiler control

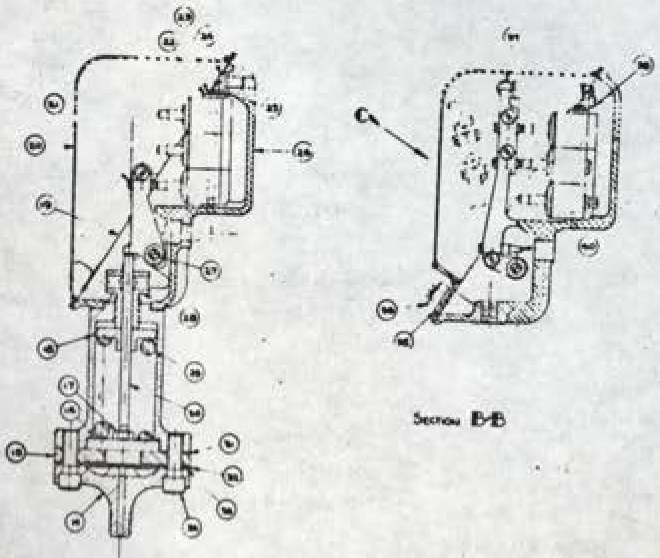

Fig. 17 - Cross-section of boiler control showing spring-loaded diaphragm

the automobile frame, and universals connect the differential to the rear wheels. This installation is better illustrated in Figs. 23 and 24 where the Paxton equipment is mounted under the floor of the trunk in a standard 1953 Ford coupe.

The Paxton steam generator is also mounted under the standard hood of this car, and the floor-board tunnel was completely removed (Fig. 25).

Table 2 is the automobile specifications; Table 3, the steam generator specifications; and Table 4, the engine specifications. Table 5 shows the weight of such an installation.

What do you put in? and where does it all go? The chart in Fig. 26 illustrates this. I might add that this is based on full-load circumstances. The 23% efficiency shown would not be seen on the road very frequently.

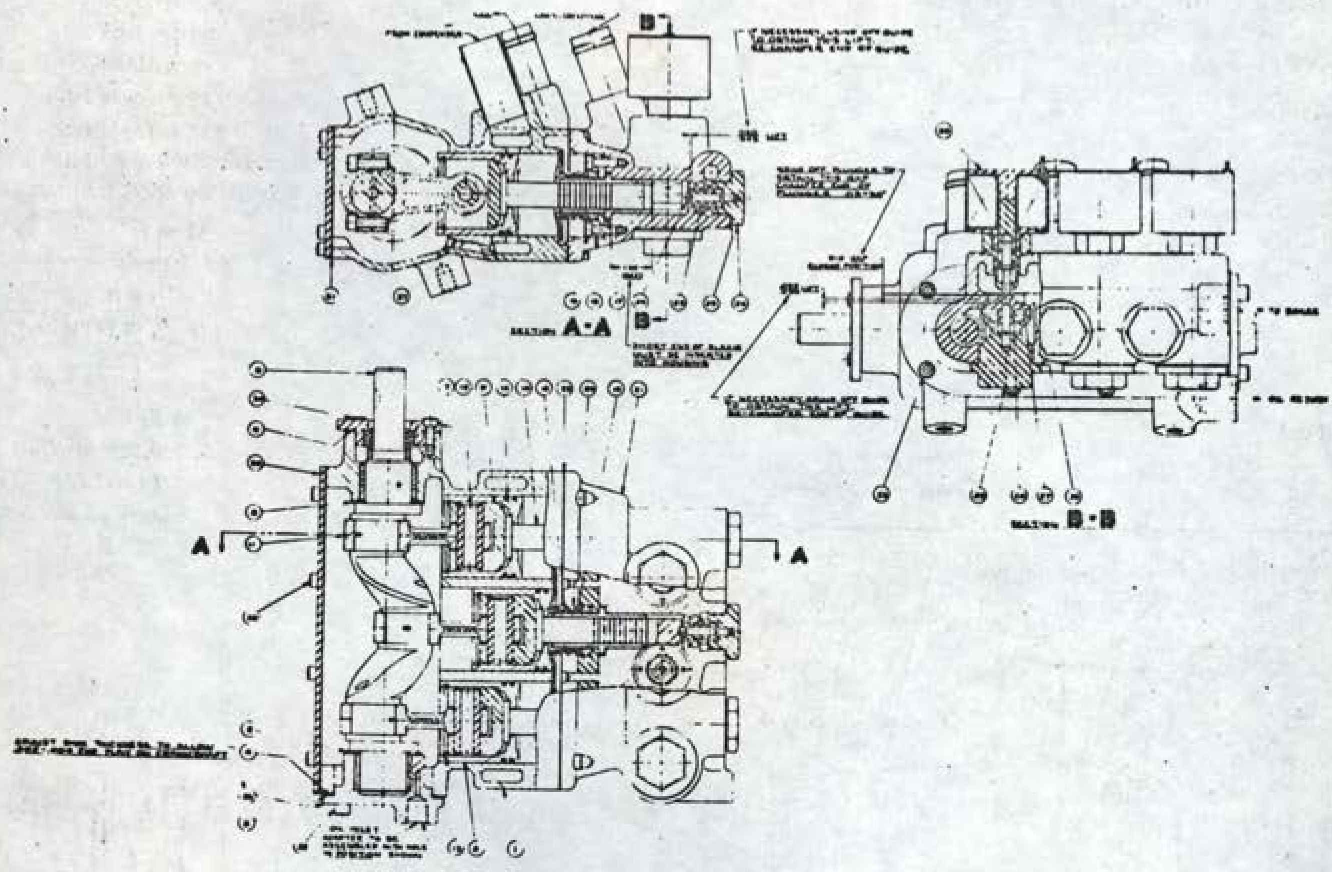

Fig. 18 - Cross-section of boiler feed and vacuum pumps

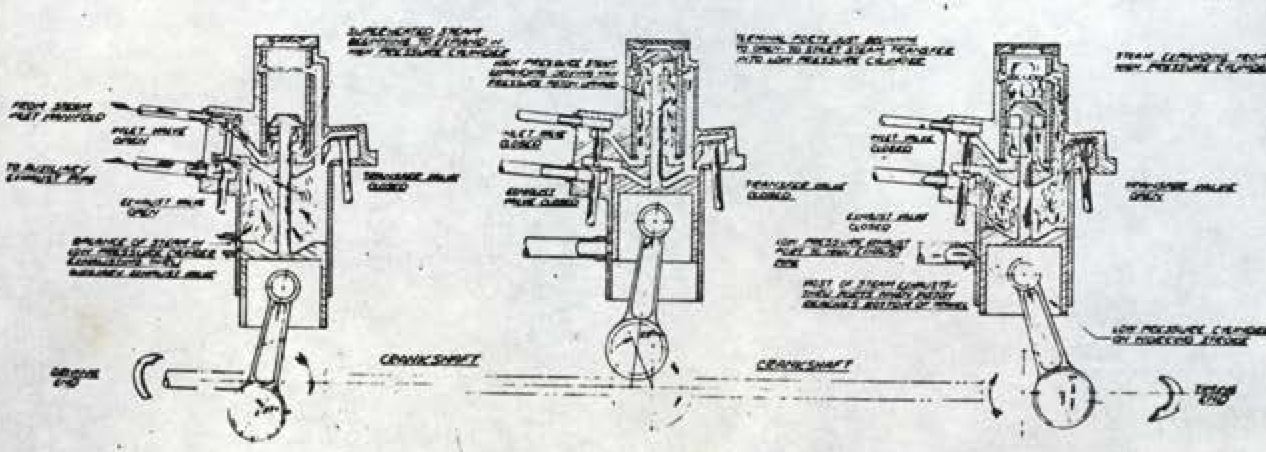

Fig. 19 - Operational schematic of Wolfe compound Paxton engine

Table 2 - General Specifications - Paxton Steam Car

Chassis:	
Wheel Base	118 in.
Tread	59 in.
Overall Length	200 in.
Overall Width	76 in.
Overall Height	56 in.
Curb Weight - Unloaded	3050 lb
Weight Distribution:	
Front	55%
Rear	45%
Powerplant:	
Engine Horsepower	150 bhp - Not sustained because of insufficient steam
Engine Torque	900 + ft - lb
Maximum Continuous Steaming Rate	900 lb/hr
Expected Actual Average Water Rate	9.0 lb per bhp-hr
Steam Pressure	2000 psi at boiler
Steam Temperature	900 F max at engine
Fuel	Any gasoline, kerosene, or diesel fuel - Will burn in any ratio, without adjustment

Table 3 - Detail Boiler Specifications - Paxton Steam Car

Case Diameter	18 in.	
Case Height	27 in.	
Tubing Lengths:		
Helical Coil		92 ft (approx.)
Crown Coil		17 ft
Super-Heater		24 ft
Thermostat		3.5 ft
Boiler Coil		21 ft
Water-Heater Coil		41 ft
Economizer Coil		19 ft
		215 ft (approx.)
External Area of Coil		57 sq ft
Combustion Chamber Volume		1.1 cu ft
Fire-Box Volume		0.51 cu ft
Fuel Consumption at Full Load		72 lb/hr (approx.)
Weight of Boiler with Thermostat, Control, Carburetor, but no blower or water		188 lb
Heat Release as Steam		1,200,000 Btu/hr
Steam Generator Efficiency		90% (approx.)

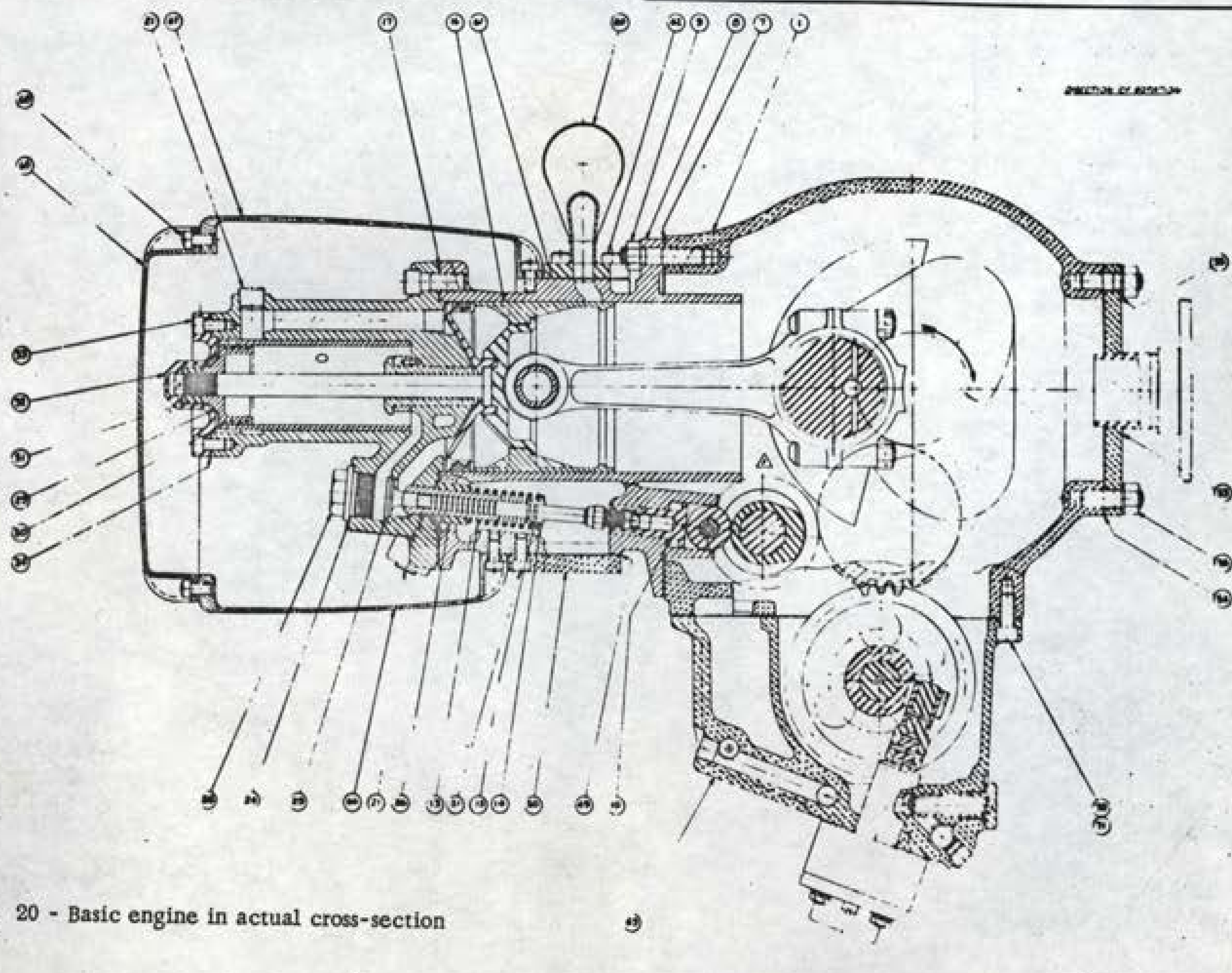

Fig. 20 - Basic engine in actual cross-section

Table 4 - Detail Engine Specifications - Paxton Steam Car

Type	3-cyl, double-acting Wolfe compound	
Bore	HP - 1-3/4 in. LP - 3-3/4 in.	
Stroke	3-1/2 in.	
Displacement (Total)		23 and 116 cu in.
Output		120 bhp
Speed Range	0 - 2000 rpm - Full power from 1200 rpm	
Steam Conditions at Engine:		
Pressure		1560 psig
Temperature		1200 F max
Quantity		750 lb/hr
Torque at Worst Crank Angle		900 ft-lb
Max Expansion (at 10% cutoff)		24:1
Clearance Volume HP Cylinder		15.5%
Terminal Ports on LB Cylinders		145 deg atc 0.8 sq in. area

Table 5 - Weight Breakdown - Paxton Powerplant

		Lb
Steam Generating Unit		
Boiler tubing	119 lb	
Casing with insulation and controls	69	
Fan and motor	25	
Carburetor	10	223
Engine		285
Transfer case and differential		65
Condenser with fans and housings		140
Exhaust turbine		15
Feed pumps, vacuum pumps, and drive		35
Steam piping and wiring		35
Valves and controls		30
Generator and control		20
Flues		25
Hotwell		20
Water and oil		60
Total powerplant weight		953
Total vehicle weight (2 passengers)		3335

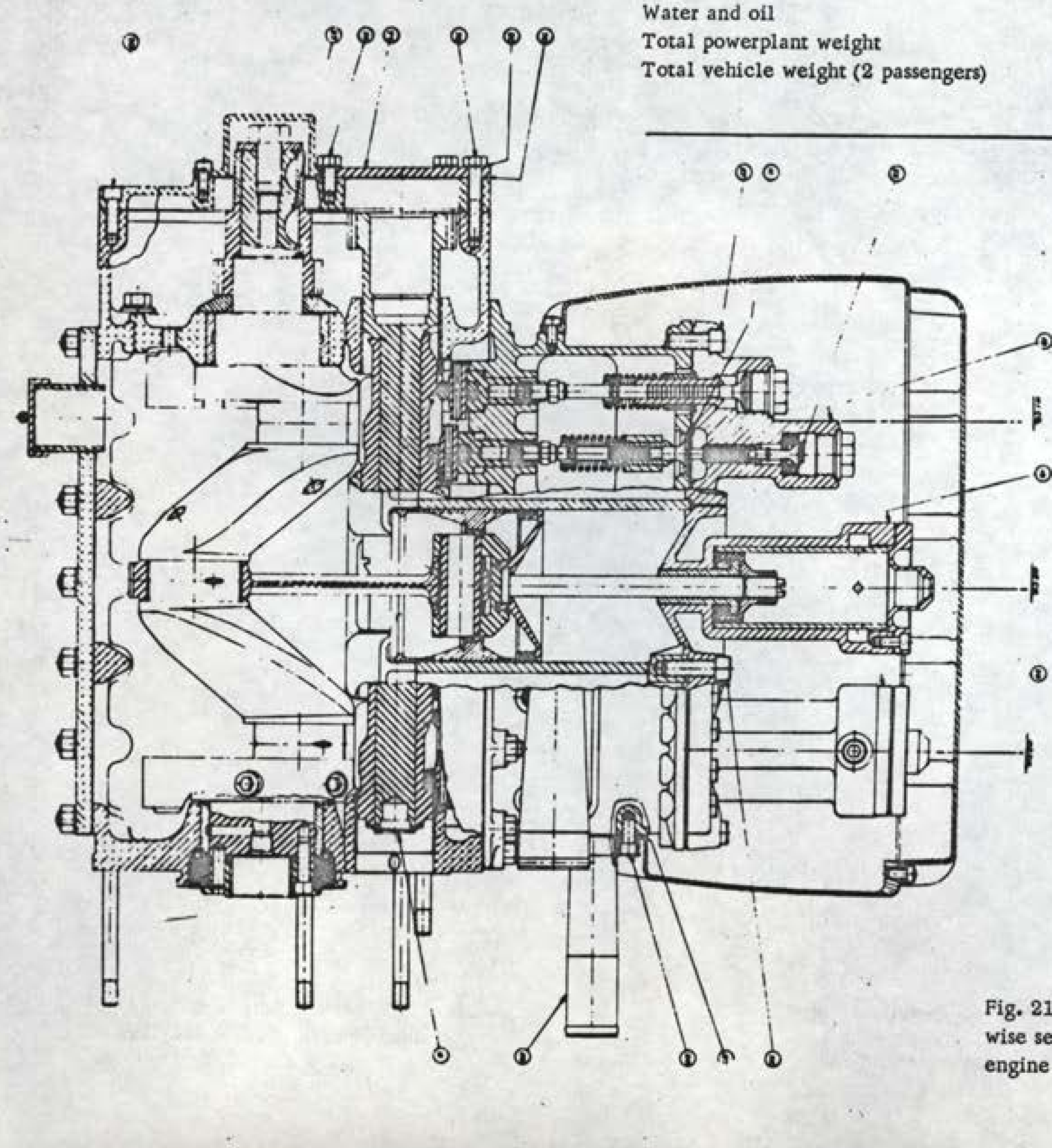

Fig. 21 - Length-wise section of engine

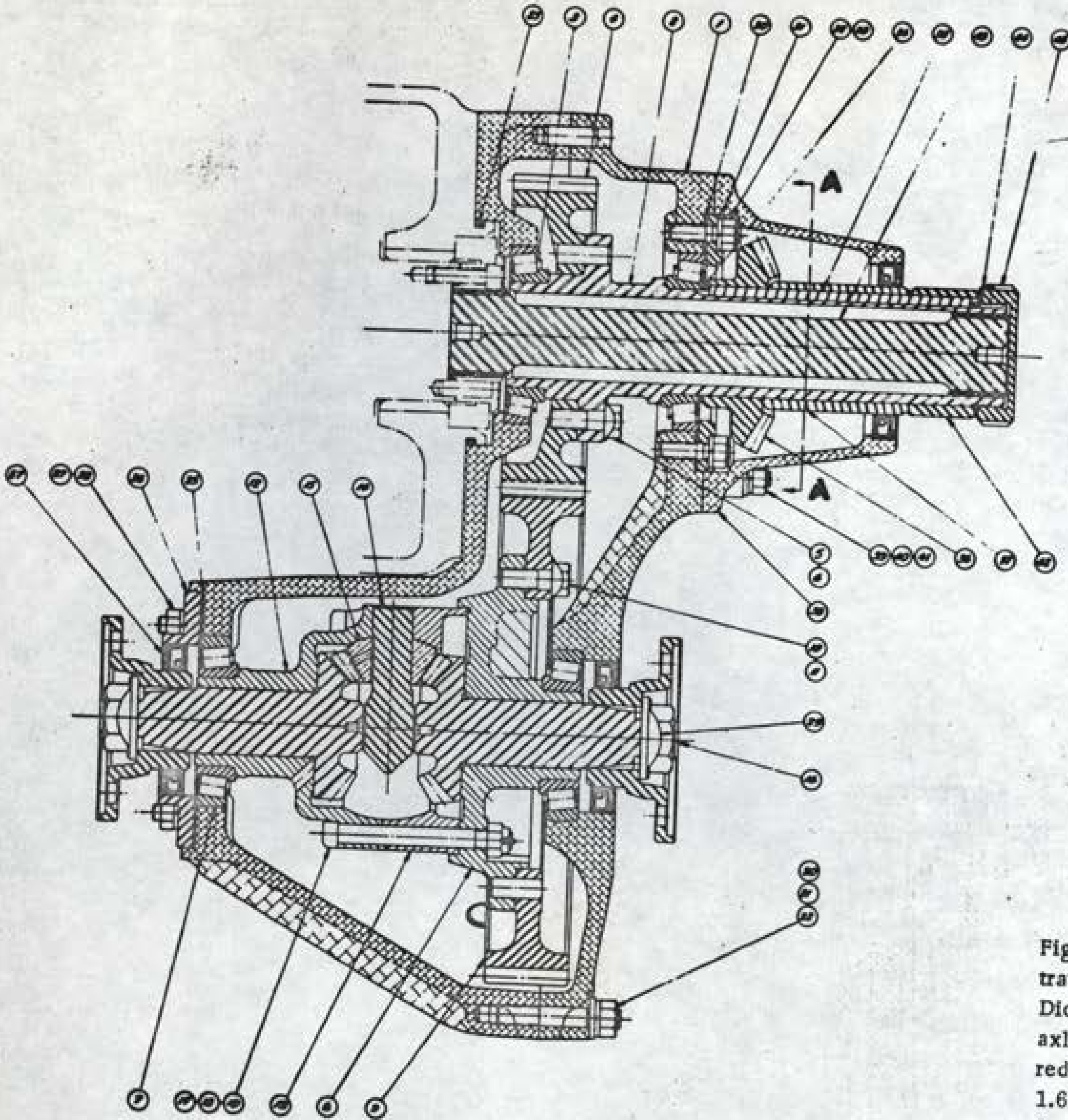

Fig. 22 - Illustration of De Dion type rear axle with gear reduction of 1.6:1 and differential

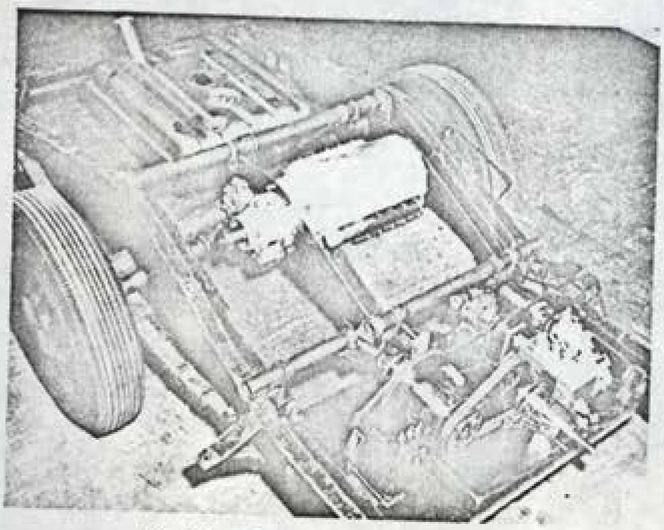

Fig. 23 - Installation of Paxton equipment mounted under floor of trunk in 1953 Ford coupe

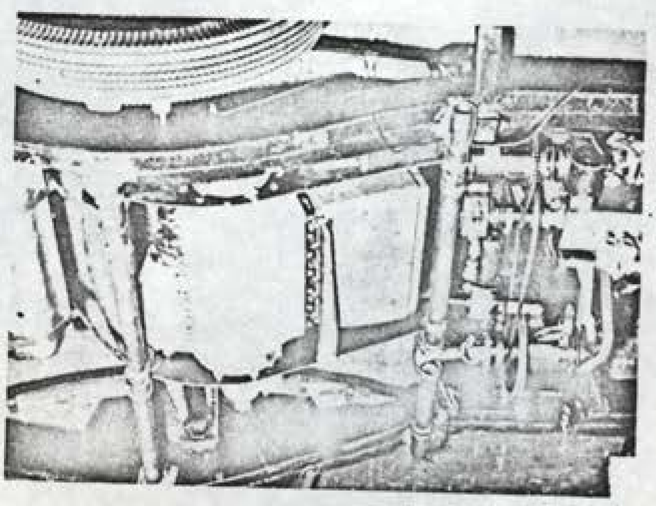

Fig. 24 - Paxton equipment mounted under floor of trunk of 1953 Ford coupe

The instrument panel of the test car had the usual speedometer, gas gage, and the like on the left, and the special instruments, as shown in Fig. 27, on the right. These were not required for normal driving and could be covered with a snap-in panel so the casual driver would not be confused. The only instrument he saw pertaining to the steam system was the pressure gage in the center--which indicated the availability of power. All other controls are standard.

Fig. 28 shows the Paxton automobile, built to accommodate this unusual powerplant. Styling is an ephemeral thing, but performance-wise, even by today's standards, it should be very interesting.

Now--when one gets through with all the technical description, you must project yourself into the position of a potential customer from Waukegan or Boise or Miami who asks, "But what does it do better for me?" Unless this question is answered in a positive, forthright manner, all is for naught--for no one will want a steam automobile, just because it's "different." In fact--many will not want it because it's different.

Briefly, here's what it can do better:

1. It gives very high performance--effortlessly.
2. Fuel economy will be markedly better in some driving patterns--but always better.
3. It will accept a wide range of fuels--burn the cheapest available.
4. There are no critical tuning adjustments, whatsoever.
5. There is no urgent sensation of engine speed when accelerating, as there is with the present engine and automatic transmission, or in the proposed new gas turbines.
6. The noise level is generally below the best automobile built today.
7. There is instantaneous and continuous passenger-compartment heating or cooling available (by steam jets).

With all these virtues, you have every right to wonder why this development was not continued. To this, I can only say that it was not stopped because of technical difficulties, although it is obvious that the current state of the art in internal combustion engines and automatic transmissions is so advanced and has had so many millions of man-hours and dollars spent on its perfection that steam, or any other newcomer, will require a tremendous development effort to better it--and any new system must be better from the beginning, or fail. Also, many business and tax factors vitally influence the course of a large, long-range development program such as this. Primarily because of these factors, the McCulloch Corp. decided to hold the development in abeyance in 1954, and no work has been done on it since.

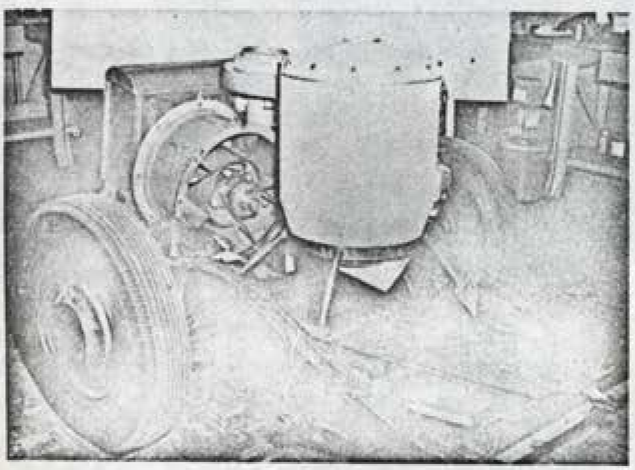

Fig. 25 - Paxton steam generator mounted under hood of 1953 Ford coupe

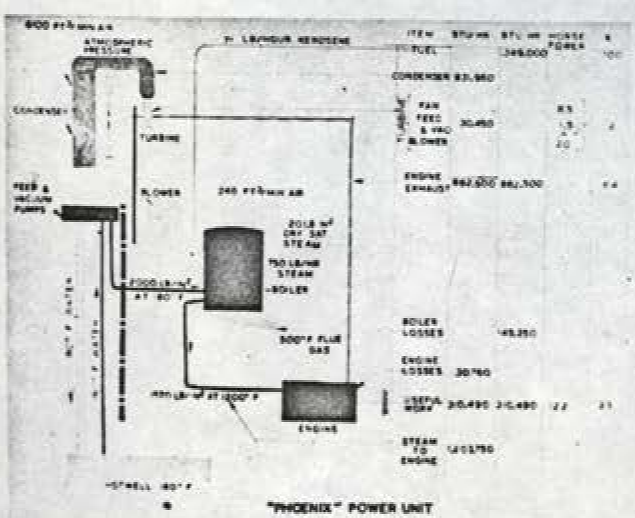

Fig. 26 - Quantities and heat balance at maximum output (1500 rpm)

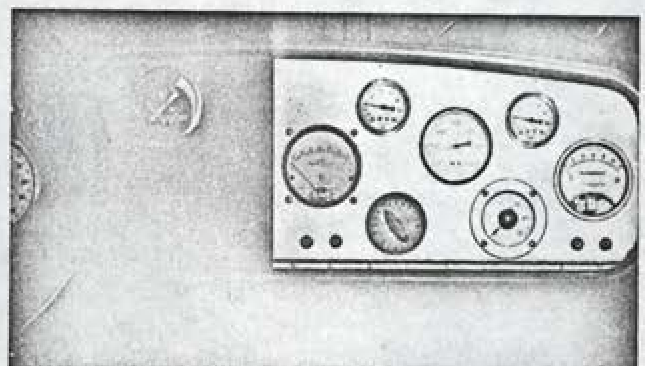

Fig. 27 - Instrument panel of Paxton steam car

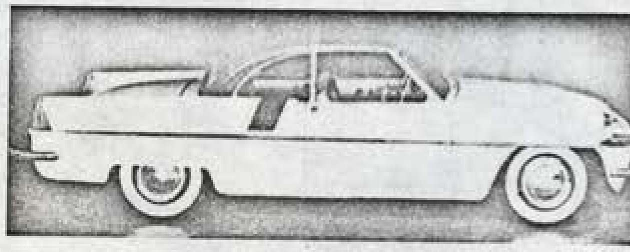

Fig. 28 - Paxton automobile - styled by Brooks Stevens