burning the fuel where they should, they came to the realization that the fuel, after passing the exhaust valves in the engine, would soon stop its combustion process. With this in mind, they decided that since the fuel only stops burning in the exhaust system because it has exhausted the supply of oxygen that was lost to the combustion, then why not just pump fresh air into the exhaust system.

So in 1973 and 1974, this is what they did. The only drawback was, if they pumped too much air into the exhaust system, they would melt the exhaust system because there was such a rich supply of fuel. For this reason the amount of air pumped into the exhaust system in these two years was limited. They could burn only a certain amount of this vapor. By the way, the device that is responsible for pumping this supply of air into the exhaust system is called a *Smog Pump*.

Well, to further complicate matters, someone came up with an idea to remedy the limited burning in the exhaust system due to overheating. It was apparent that no more air could be pumped into the exhaust. The temperature of the exhaust system had already reached a critical point. Why not put some sort of restrictor or collector in the exhaust system to hold this burning exhaust gas until the hydro-carbons or gas vapor was gone? This device did the job. They called it a catalytic converter.

Another thing that was done to prevent unburned fuel from escaping into the atmosphere was to take the lead out of the fuel. Lead caused fuel to burn more slowly than it did before. With leaded gasoline, it would be very difficult to burn all the hydro-carbons in the engine. Since leaded gasoline tends to linger unburned long after the combustion has taken place, it would have fried the catalytic converter.

Unfortunately, as the years have gone by, and since they took the lead out, our gasoline has become of very poor quality. The octane rating is dropping, and as a result, we need to buy more gas to get from one place to another. Remember the words of Pouge's last interview, "I could never attain the mileage that I did in the earlier days, the quality of the gasoline has dropped so much."

Now that we have followed the process of liquid gasoline particles through an internal combustion engine and seen how much of the fuel is wasted in that fashion, let's take a look at how gas vapor reacts when introduced to an internal combustion engine. You must remember the importance of the burn rate. Before you can appreciate the full value of vaporization, you will have to understand the value of burn rate.

A popular example of this is the atomic bomb. Whether or not you realize it, it is not the radiation from the bomb that creates the devastating shock wave that leveled cities, but the heat generated by the bomb. That's correct, the heat. When an atomic bomb is detonated, a chain reaction is the result. The atoms from within the bomb send out a tremendous chain reaction that spreads throughout the atmosphere (or air) surrounding the bomb. This air becomes so superheated in such a small period of time that the air itself, expanded by the heat, will literally explode. So the instant expansion of air due to the heat that it was exposed to has wiped out a city.If you would like to stand there and measure the exact amount of heat that was generated by the bomb with a temperature gauge, and were able to determine how many BTU's of heat were generated, you would find that it is equal to a number of days of sunshine. Sunshine? Yes sunshine. If the time that the air surrounding the bomb exposed to the heat were measured, then you could mathematically determine how many days of sunshine would equal the number of BTU's of heat generated and the volume of air. So what I am saying here is that if you could store the heat generated in your back yard for a number of days in a box, then release all that heat in a fraction of a second, your neighbors would not be happy with you. You would have equaled the force of the atomic bomb.

The overall point to be made is that the rate of speed at which you utilize a given amount of heat will determine how much explosive capacity the heat source had.

When we are talking about the internal combustion engine, we are talking about the pressure of the gases in the cylinders as the gasoline expands them from the amount of heat generated by the gasoline. Theoretically, if one drop of liquid gasoline were in a cylinder in the form of a drop, when ingnited, it would generate so many BTU's of heat, over a given time. If that drop had been given time, eventually it would transfer the heat generated to the air in the cylinder, providing the air supply was not exhausted before the drop of fuel was. As a result, the air in the cylinder would expand to a given pressure. Unfortunately, the engine is turning at a speed of 800 revolutions per minute. that means that the cylinder is occupied and then exhausted over six times a second. Even with seven atmospheres of pressure in that cylinder, that will not leave that one drop much time to burn.

Now, let's give that drop a chance to burn in the vapor state. In the cylinder with seven atmospheres of pressure with the molecules of air, the drop in vapor state will not only have time to burn, but it will have time to transfer it's heat to the air in the cylinder; therefore, expanding it and creating the pressure needed to drive the piston down.

This example, of course, is an over-simplification of the operation of an engine. The point made is that when gasoline enters the cylinder in the liquid form, before it has the chance to vaporize, it is expelled from the cylinder unspent.

Since the liquid gasoline continues to burn after the downstroke and even the exhaust stroke, a greater amount of heat is transferred to the engine block rather than to the expanding gases in the cylinder. This causes a greater amount of wear on the engine.

In burning pure gas vapor, the engine will not only last longer, but will operate at a much cooler temperature. This is because less fuel is burning in the engine. The fuel that is burning has a much shorter duration of combustion than liquid gasoline.

This theory is not only my own. Charles Pouge removed the radiator from an automobile and operated it in this fashion to illustrate this point. The spark plugs will have a longer life for the reduced amount of hydro-carbon deposits and the oil will have a much longer life due to the reduced amount of heat and carbon deposits. This was proven by the Flex Carburetor. I have heard the reports of mechanics who, after ten years of operation, have broken down the engines that have operated on the Flex system and report that they were shocked at the lack of wear.

Another advantage of gasoline vaporization is that the exhaust gases are almost completely non-toxic. Carbon monoxide is hardly detectable when operating on vapor and the hydrocarbons are almost nonexistent. The primary gas or chemical element composing the exhaust gases will be carbon dioxide.

As stated earlier in this book, carbon dioxide is harmful to the atmosphere. But in existing carburetion, the amount generated is much greater. When any hydrocarbon fuel is burned, carbon dioxide will result. Since far less fuel is required to be burned, far less carbon dioxide will result. Carbon dioxide is the same gas we exhale from our lungs.

Chapter 6
C.T.E. Vaporizers

In our initial vaporizer design, we did not know of what methods the other inventors used in vaporizing gasoline. Soon after the public disclosure of our unit, we found that the path that we had chosen was quite similar to the Pouge and Flex systems.

I chose, in my design, to use the engine's waste heat. Actually, there should be no such thing as waste heat in an automobile as precious as energy is today. Since it does exist, it might as well be put to a productive use.

The sources of the waste heat that I selected to use were the exhaust gases and, also, the engine coolant.

For the supply of this heat, I tapped into the exaust manifold and for the engine coolant, the heater hoses.

I will describe the construction of our units in order that they were developed. First, we used the exhaust gasses with a heat exchanger. This heat exchanger is composed of a series of tubes that transfer the heat from the exhaust gases to the flow of liquid droplets passing through them.

In this system, Wagner System #1, there are three basic sub-systems. System A, The fuel system; System B, the air supply system C, the exhaust gas system.

System A (Fuel system): The fuel in conventional carburetion is drawn forward to the engine by the existing fuel pump. Since the vaporizer unit requires engine heat for its operaton, then obviously the vehicle must be started from a cold start with the existing carburetor. For cold starting, the fuel supply must be routed from the fuel pump to the conventional carburetor. Once the engine has generated enough heat to operate the vaporizer system, the fuel flow must be directed to the vaporizer unit. There is a pre-manufactured valve that served this purpose. I found a fuel relay valve normally used in pickup trucks to switch the fuel flow from one tank to another when using dual tanks that would suffice.

The valve is electrically operated by a switch on the dashboard. I would wait until the heater in the vehicle got hot, then switch the fuel flow to the vaporizer. A more accurate and more expensive means of monitoring the unit's temperature is by installing a temperature sensor and guage. From the fuel relay switch, the fuel would be directed either to the carburetor or the vaporizer unit. On the way to the vaporizer, the fuel would first have to pass through a regulator valve. This regulator regulates the fuel pressure to the vaporizer unit. In addition, this valve regulates the flow of fuel in proportion to the engine requirements. This is accomplished by connecting the valve to the carburetor linkage by use of a mechanical linkage. This linkage, when the accelerator pedal was depressed, would open the valve. From the valve, the fuel would pass into the vaporizer unit where it then passed through a fuel nozzle. Here the fuel mixes with the supply of air that is on its way to the heat exchanger. The nozzle was difficult to locate. I needed a nozzle that would produce a fine spray of fuel at a very low fuel pressure.

The nozzle that I finally located for this application was a Volkswagen Rabbit cold start nozzle. This nozzle is used on the Rabbit and other fuel injected cars to prime the engine and bring it to idling speed by spraying a fine mist of fuel into the intake manifold. It was of great value due to the fact that it produces this spray at as little as one pound of pressure. Being this versatile, it was of great benefit in this application. The cold start nozzle also had a couple of extra benefits that I was not expecting. First, it had a solenoid valve built in that would immediately stop the flow of fuel when it is turned off. A twelve volt electrical current opens it again. Also, it has a heating coil in it that will bring the fuel up to a slightly higher temperature.

System B (Air supply system): In this first unit constructed, I drew cool fresh air from the atmosphere through an air filter for supporting combustion in the engine. The air was pushed forward by a fan that was driven by the fan belt. This supply of pressurized air then passed the fuel nozzle where the fuel was introduced. This fuel/air mixture would then pass into the heat exchanger where it would be vaporized from the heat of the exhaust gases. At this point, the vapor-rich air could proceed to the carburetor or, what was not allowed to pass into the carburetor, was sent back to the intake side of the fan. From this point, the vapor would continue through another cycle. This approach we latter abandoned.

After leaving the vaporizer unit, which was located next to the engine, the vapor would travel to the carburetor. The air cleaner was removed from the carburetor and, in its place was a safety box. This box was attached to the carburetor in the same manner as the air cleaner with the mounting bolt and wingnut. When the vaporized gas reached this box, it would push past a spring loaded door that would normally remain closed. It would then proceed into the mouth of the carburetor.

If a flashback or backfire occurs, the combustion in the intake manifold would reduce the vacuum in this box, therefore causing the spring loaded door admitting the vapor to close. This was to take place prior to the combustion reaching the top side of the venturi. If this occus, there was a bleed or relief door installed in this box to vent the pressure accumulation safely into the atmosphere. Again, the spring loaded door admitting the vapor to this box would close prior to the entrance of the combustion activity, thus preventing the combustion from traveling back to the vapor generator unit itself. In tests, this saftey system proved to function very nicely and safely. This arrangement in later units also was redesigned.

System C (Exhaust Gas System.) As earlier mentioned, the exhaust gases were extracted from the exhaust manifold. The exhaust gases, I realized, were from 400 to 1,200 degrees fahrenheit. This was adequate for vaporizing gasoline. Gasoline is composed of around 27 chemical elements. The lighter ones tend to vaporize at as little as 30 degrees F. The heavier elements will not vaporize until exposed to as much as nearly 900 degrees of heat. (See Illustration #1)

With the heat available from our unit, we were able to attain a satisfactory amount of vaproization.

The exhaust gasses travel out of the exhaust manifold through metal tubing to the heat exchanger box. The core of the heat exchanger is constructed of a cage of about 50, 1/2"

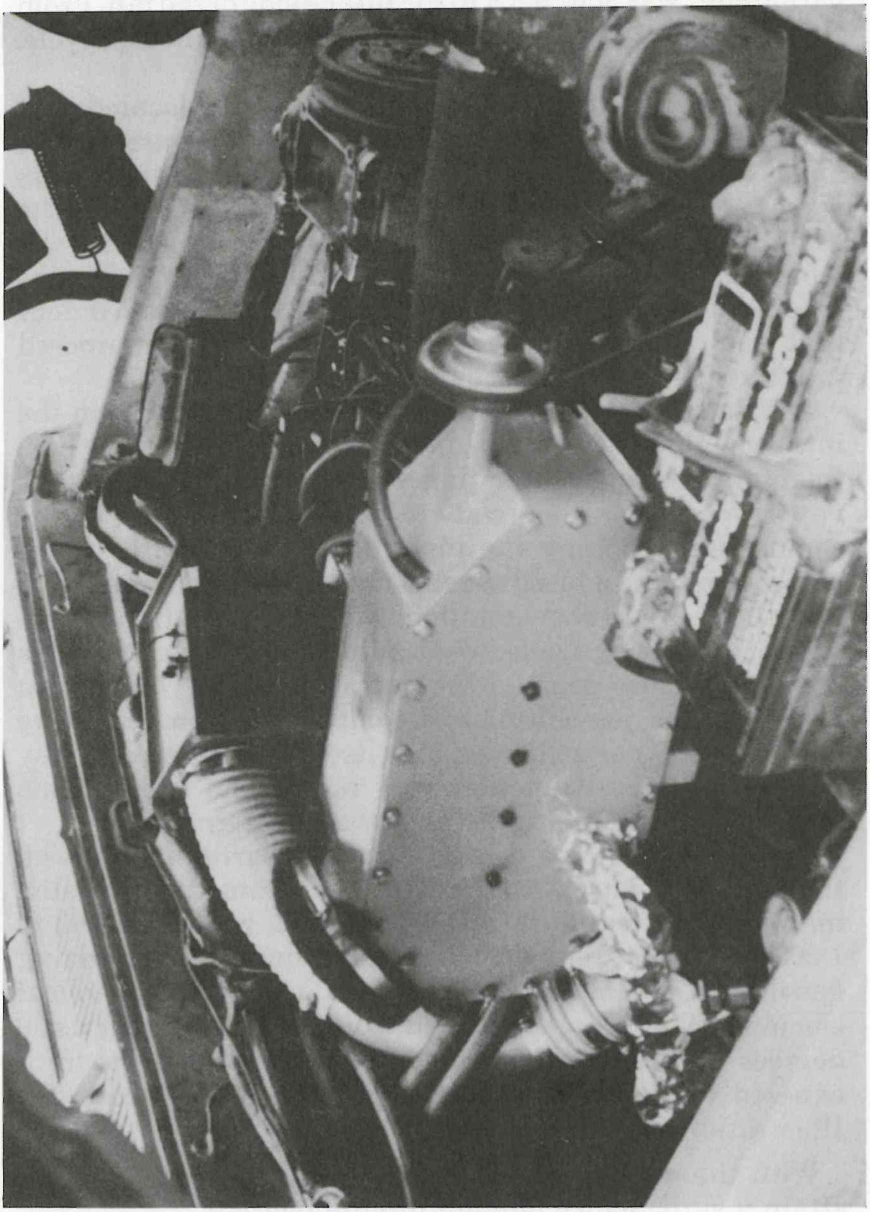

Illustration #1

tubes. These tubes have a face-plate on each end. These plates are simply two flat plates that a honeycomb pattern of holes drilled in them through which tubes will pass. Each of the tubes had to be carefully brazed into the flat plates to insure that no exhaust gases passing around the outside of the tubes would be able to reach the front or rear of the face plate. The fuel/air mixture will approch the face of this honeycomb plate, then pass through the 1/2 inch tubes. The heat that the outside of the tubes conduct from the exhaust gases will travel through the tubes and as a result, will vaporize the fuel particles passing through the tubes. If the spray of fuel were allowed to pass straight through the tubes, chances are that the particles would not come in contact with the heated tubes and therefore never become vaporized.

For this reason, steel or aluminum screens are inserted into each of the tubes. These screens collect the particles of fuel and bring them in contact with the heated walls of the tubes. What I used is standard screen of the same standard mesh as used in a screen door. This was cut into about one and a half inch widths and to the same length as the tubes. This was rolled around a pencil then loosely twisted and inserted into each tube. A retainer screen was required on the rear side of the heat exchanger to prevent any screens from being drawn through it and into the carburetor.

The exhaust gases did pass directly from the exhaust manifold and into the side of the heat exchanger. After passing through the exchanger, the exhaust gases then pass through a regulator valve. Placing this valve on the intake side of the exchanger would subject it to temperatures too great and would break down the packing of the valve. This valve is required to regulate the heat of the tubes. The more exhaust flow through the chamber, the more heat will be transfered to the fuel passing through the tubes.

That is the first basic system. With this arrangement, we attained 80 miles to the gallon according to our findings.

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Chapter 7
The Second System

The second system is basically a refinement of the first system. The second system will be discribed by each subsystem as the first was. "A" - The Fuel System, "B" - The Air Induction System, and "C" - the Exhaust System. (See Illustration #2)

System "A", (The Fuel System). Following the fuel flow from the gas tank to the vaporizer unit was considerably different in the second system. We found that the mechanical fuel pump produced a pulsating fuel pressure to the nozzle in the unit, for this reason the mechanical fuel pump was removed and replaced with an electric fuel pump. The electric pump needs to be located as close to the fuel tank as possible. Electric fuel pumps push fuel much more efficiently than they pull. After the fuel was directed forward from the fuel tank by the pump it reaches the fuel relay solenoid. This valve either directed the fuel to the vaporizer or the conventional carburetor as in the first system.

From this valve, the fuel, if directed to the vaporizer, will reach the fuel heater. We felt that the actual heat exchanger in the vaporizer wouldn't have to work quite so hard if the fuel was pre-heated prior to reaching it for vaporization, especially if the fuel is the same temperature as the outside temperature on a sub-freezing day. This fuel heater attained its heating capacity from the engine coolant. The heater consisted of a small 6 inch long by 4 inch diameter piece of pipe with a coiled copper fuel line through the center. Of course the ends of the pipe had to be capped to contain the heated water flowing through it. Two holes were drilled into the side of the case and then two nipples of the same outside diameter as the existing heater hoses were attached. Our hose was 5/8". By clamping a "T" in each of the hoses leading to and from the heater, we were able to

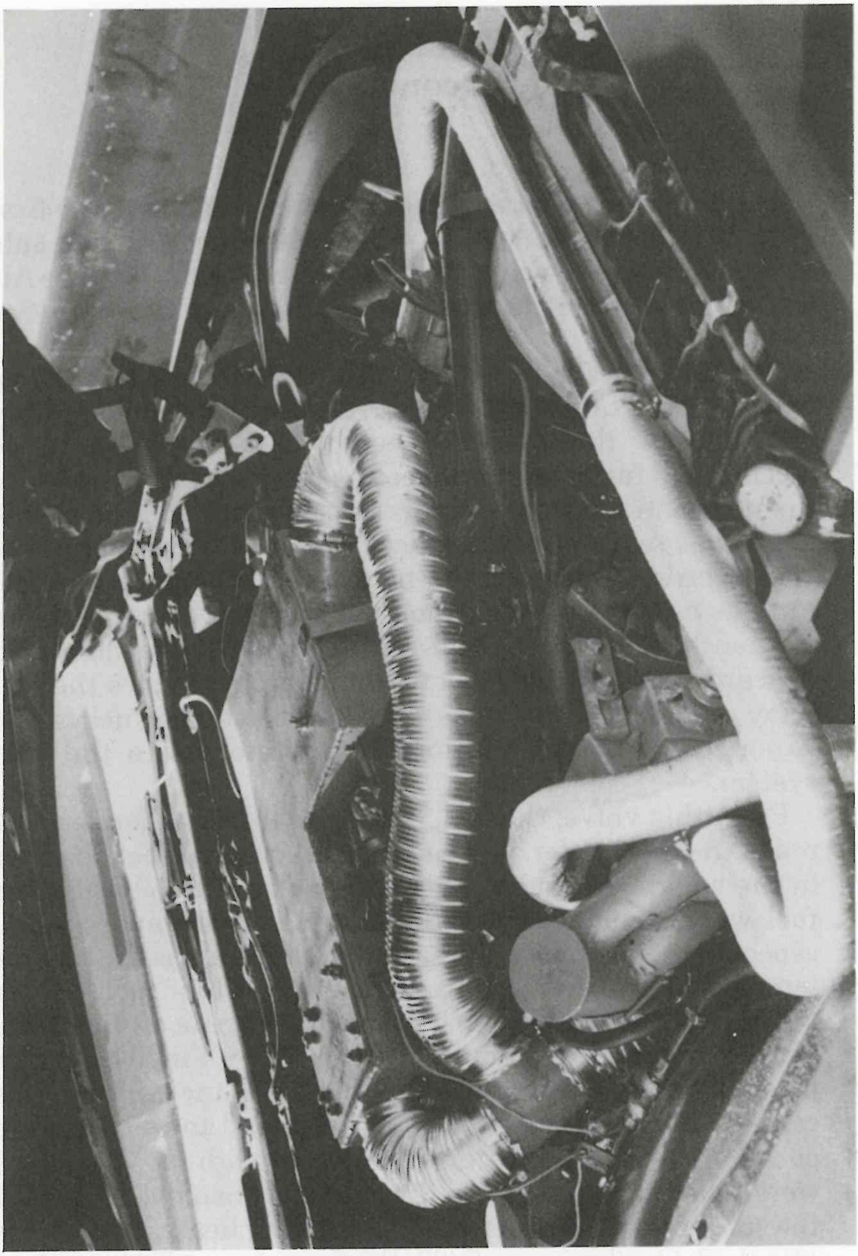


Illustration #2

attain a consistant flow of heated water through the pipe that housed the coil. We could therfore transfer the desired amount of heat to the fuel passing through the coils. Some automobiles and trucks have a thermostat set at 195 degrees. This is too much heat to expose the fuel to for this pre-heating process. A water regulation valve had to be installed to regulate the amount of heat to be transferred to the fuel. This was installed in one of the heater hoses leading from the heater hoses to the fuel heater. (See Illustration #3)

The copper tubing used inside the heater was of the same diameter as the existing fuel line. Generally this is 5/16ths". One important factor that we had to consider was to make all of the attachments from the engine to the frame of the vehicle with rubber fuel line. We have since learned that some people tried using copper tubing from the engine to the frame or fender of their vehicle and the vibration of the engine broke or cracked the line, creating a fire hazard. We tested the heater by attaching a garden hose with a clamp to it and blocking the other nipple. Once we turned on the water pressure, if there were any leaks in the canister, they became apparent at this time rather than when the unit was installed on the vehicle. Heating the fuel in this manner without a vaporizer has increased mileage according to reports that we received by as much as 50%. This was directly routing the fuel from the fuel pump to the carburetor with a fuel heater in the line.

In this system, after leaving the fuel heater, the fuel then passed the fuel regulator valve. Either a needle valve or preferably a metering type ball valve had to be secured to the engine manifold or another location. But as long as it was on the engine, this linkage could be attached to the carburetor arm and then to the valve.

The method that we chose to link the valve to the accelerator linkage was to drill a hole into the arm of the carburetor, pass a connecting rod through the hole and, as the arm moved, the valve would also be moved in direct proportion. (See Illustration #4)

FUEL HEATER

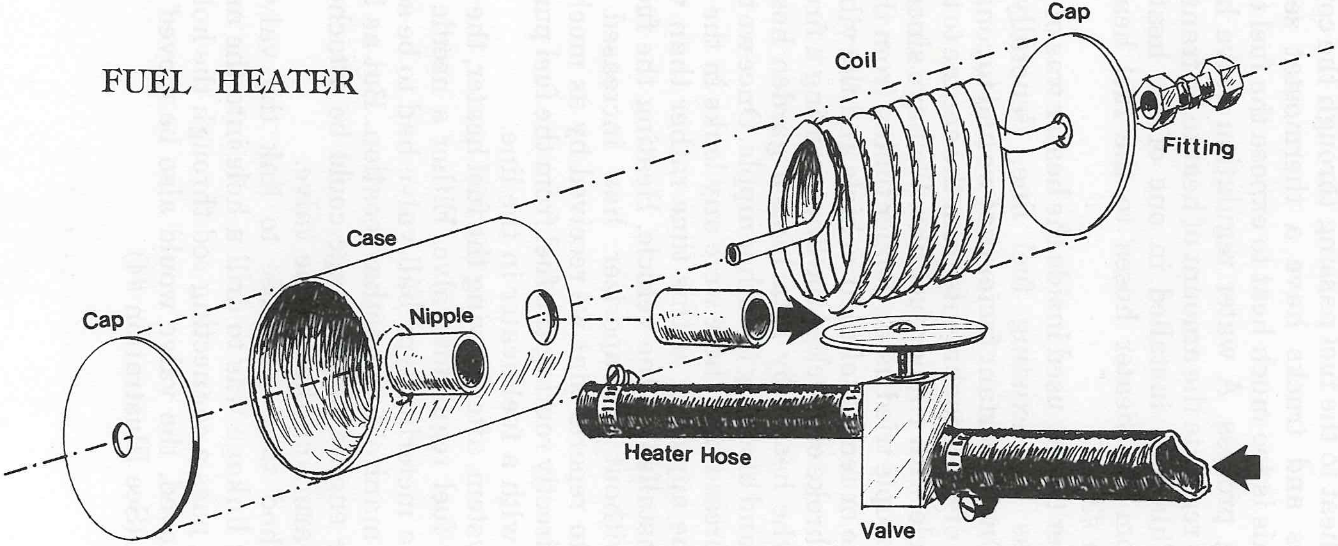


Illustration #3

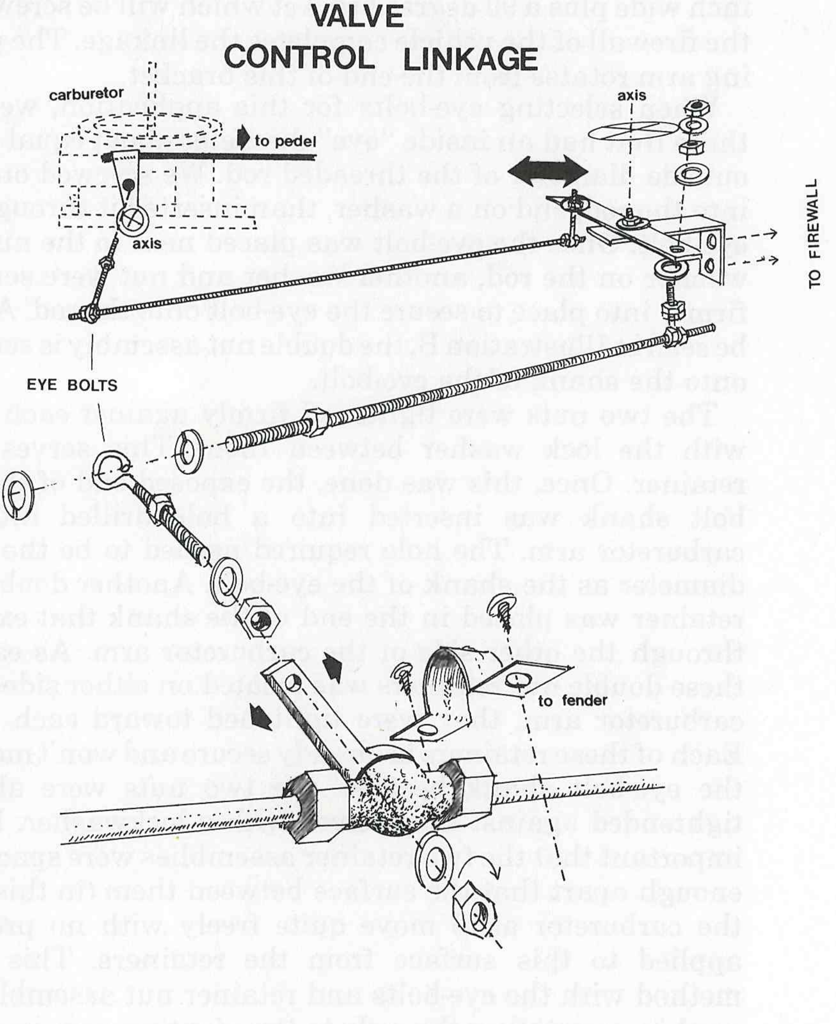


Illustration #4

As shown in illustration No. 4, the linkage tying the carburetor to the valve consists of two pieces of threaded rod, four eye-bolts that slide onto the rods, a double nut arrangement for each retainer nut required consisting of two nuts of the proper thread size to fit onto the threaded rod and lock-washer to fit between the two nuts. A flat piece of metal to serve as a pivoting arm that is 6 iches long and 1 inch wide plus a 90 degree bracket which will be screwed to the firewall of the vehicle completes the linkage. The pivoting arm rotates from the end of this bracket.

When selecting eye-bolts for this application, we used those that had an inside "eye" diameter about equal to the outside diameter of the threaded rod. We screwed one nut into the rod, slid on a washer, than inserted it through the eye-bolt. Once the eye-bolt was placed next to the nut and washer on the rod, another washer and nut were screwed firmly into place to secure the eye-bolt onto the rod. As can be seen in Illustration B, the double nut assembly is screwed onto the shank of the eye-bolt.

The two nuts were tightened firmly against each other with the lock washer between them. This serves as a retainer. Once, this was done, the exposed end of the eye-bolt shank was inserted into a hole drilled into the carburetor arm. The hole required needed to be the same diameter as the shank of the eye-bolt. Another double nut retainer was placed in the end of the shank that extends through the other side of the carburetor arm. As each of these double nut retainers was located on either side of the carburetor arm, they were tightened toward each other. Each of these retainers is already secure and won't move on the eye-bolt shank because the two nuts were already tightended against themselves with a lockwasher. It was important that the two retainer assemblies were spaced far enough apart that the surface between them (in this case, the carburetor arm) move quite freely with no pressure applied to this surface from the retainers. This same method with the eye-bolts and retainer nut assembly was used in connecting the rods to the pivoting arm and then from the opposite end of the arm to the valve.

Before we could connect the rod to the valve, we had to find how far the valve must travel. With most of the vehicles that we installed the unite on, the path of travel did not exceed over 1/2 inch. We determined where the valve was to be set when the vehicle was idling by running the engine up to full temperature with the valve wide open. Then, bit by bit, we began closing the valve. By starting the process with the valve completely open and then by slowly closing it a fraction at a time (allowing a few minutes between adjustments), we found where the engine began to run rough from lack of fuel. At this point, we opened the valve until the engine began to smooth out. In doing this, we found just how little fuel was required to operate the engine at an idle when the fuel and air were both heated and the vaporizer operating. Once we found this valve setting, we marked the valve for future reference. We knew that when we set the valve to the linkage that we never wanted to have the linkage push the valve past this mark; othewise, the engine would die. Now, what we needed was to find the maximum setting for this valve.

Considering that the vaporizer is operating correctly in the efficiency of the heat exchanger's operation, the maximum setting of the valve must be determined without allowing an over-rich mixture of fuel to be permitted into the engine.

The proper setting and operation of the heat exchanger will be explained in the description of the exhaust system later in this book.

Once the vaporizer is operating properly and satisfactory results were attained while idling, the unit was ready for the road test. The vehicle needed to have the fuel regulator valve opened all the way. Again, only if the vaporizer was satisfactorily vaporizing the amount of fuel pasing through the primary heat exchanger would the vehicle be ready for the road test. Once the fuel was being totally vaporized, the vehicle was taken for the road test. We made sure that it was at a time of day or night when the least amount of road traffic would be encountered. If the vehicle was getting too much fuel, it was best not to operate it for long periods of time. Too much heat would be transfered to the engine and valve. Once on the road, the vehicle would be put to the test. If the acceleration was sufficient and the fuel was sufficient for cruising, the valve would be closed to a smaller setting. If the fuel was still sufficient, this process would be repeated until performance problems. were encountered. The valve could be opened until the results were again satisfactory. This setting would be the maximum setting for the valve. Cruising requires far less fuel than acceleration does. This process is time consuming and difficult to perfect. As a matter of fact. I cannot claim that I mastered it to perfection. The weather changes also effect the preformance once the system is properly adjusted.

Different fuel nozzles and methods of regulation may be experimented with for improved control of the fuel regulation. The fuel system consists of the fuel pump (electric), the fuel relay solenoid, the fuel heater, the fuel regulator valve and the fuel nozzle. (See Illustration #5)

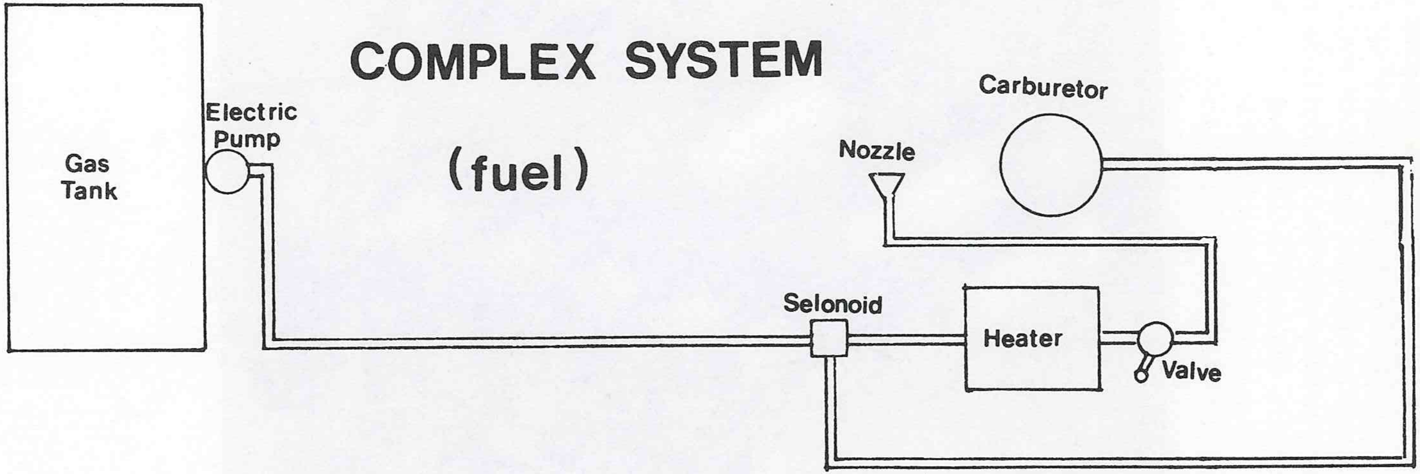
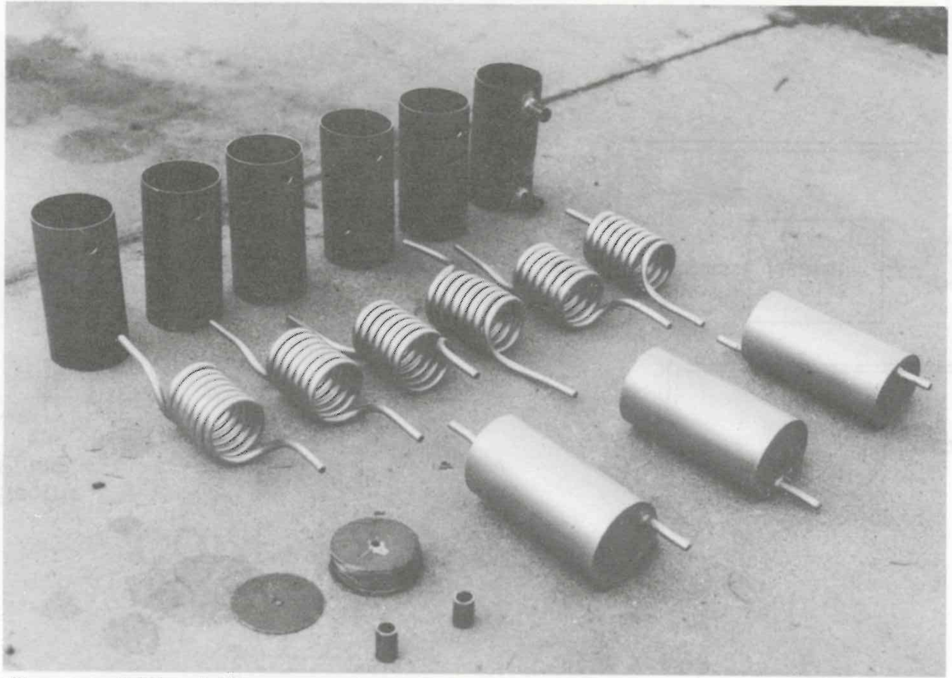


Illustration #5



Several Fuel Heaters in
Various stages of completion

Chapter 8
Air Induction

System B (The Air Induction System): The air induction system was quite a bit different than in the first unit also. We decided to heat the fuel in this unit to ease the job of the primary heat exchanger. We knew that the cold air would also tax the exchanger, so we therefore heated the air prior to introducing it into the vaporizer system. This was accomplished by drawing heated air from the outside of the exhausted manifolds in the same manner that many cars do now for warming the engine. A shroud was placed over each exhaust manifold encasing it with a spout on the top to which a two inch diameter flexible tube was affixed. This tubing is already used for this purpose in automobiles. It will either be made of aluminum or asbestos. We purchased it in six foot lengths. The shrouds were constructed of drain guttering used on house roofs. The type of guttering that we selected had a downspout in it. This spout nipple had an outside diameter of about two inches.

With tin snips, we fashioned the tin guttering to the contour of the top of the enhaust manifolds. Holes were drilled in the guttering through which the exhaust manifold bolts would pass to secure it in place. On newer vehicles, we found that one of the exhaust manifolds already came with an exhaust manifold shroud. The was ideal. All we had to do was fabricate one for the other side. Four and six cylinder engines required the fabrication of only one shroud. The heated air that was attained from the shrouds was then drawn into the pump or blower. Before the air was able to reach the blower, it had to pass through an air cleaner. The vaporizer unit was sitting in the place of the old air filter, so it needed to be located in another area. An air filter was located that was tall and cyclindrical. The older 1955 era cars quite often had filters of this shape. A tall piece of pipe or tubing that was large enough to loosely encase this filter was selected to house the filter. An upper and lower cap for the pipe had to also be fabricated and attached. The air was drawn in through the sides of this “can” and was then drawn out after passing through the filter through the top of the can. The heated and filtered air then proceeded up into the intake side of the air blower. Blowers of this sort could be purchased prefrabricated, but or cost, we decided to build our own. The function of the blower was to produce a pressurized supply of air. The reason we needed the pressurized air was to compensate for the expanded air that had become far less dense due to the fact that the air had been heated. In other words, for increased air density.

The air supply needs to be kept in proportion to the engine requirements, therefore, we had to drive the blower with the fan belts. The advantage to this was when the engine speed increased, the blower speed would increase at the same rate.

The only short-coming with this design was that in acceleration, the engine would require the increased air flow before the engine speed increased. Also when the engine was to decelerate in speed, the air pressure had to decrease before engine speed did. What I designed to deal with this problem was an air bleed door. This door would be spring loaded closed. Once the engine was operating, the pressure from the blower would blow open the spring loaded door allowing a certain amount of air pressure to escape. When the engine was to accelerate in speed, the intake manifold pressure will lower, and therefore the spring on the door will close, maintaining the pressure going to the carburetor. When the engine is to decelerate,the door will be forced farther open because of the increased pressure, maintaing a fairly constant pressure under different engine operations.

For the blower construction, the only blower fan or impeller that I could find to fit this requirement was a vacuum cleaner impeller. Squirrel cage type fans do not produce any significant pressure but Vane type fans are designed to produce pressure. The impeller that I selected is cast from aluminum and is areeady precision balanced. The impeller was originally from an upright Kirby, Eurika or Hoover vacuum cleaner. All of their impellers are basically