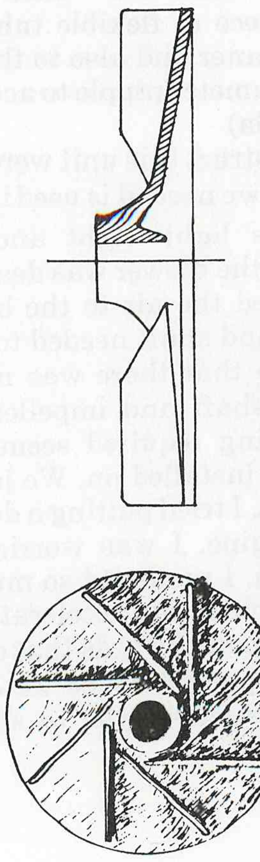
the same. (See Illustration #6b)



Aluminum Impeller

Illustration #6B

We got ourselves into quite a project with the construction of a blower. All of the angles and measurements needed to be precise. If one bearing support was not exactly in line with the other, the bearings would be worn out almost immediatly. As can be seen in the illustration, the blower is basically constructed of a metal box, (1/8" steel) two plates, and bearing supports. We used ball type bearings packed with synthetic lubricant due to the stress that they would be placed under. We used 1/2" hard steel shaft for the assembly. A 3" piece of flexible tubing connects the air pump to the air cleaner and also to the vaporizer unit, also needed was a 3" diameter nipple to accomodate this tubing. (See Illustration #6a)

The parts to construct this unit were found all over town. The 3" tubing that we needed is used in fireplaces and in air conditioning. It is lightweight and tough. The rear bearing support in the blower was dead center in the intake nipple that supplied the air to the blower from the filter can.The bearings and shaft needed to be secure with small retainers to insure that there was no back and forward movement of the shaft and impeller in the blower. The tension of the spring required seems to vary with each vehicle that it was installed on. We just had to guess and tinker to get it right. I tried putting a double impeller blower on my 455 c.i. engine. I was worried that one impeller wouldn't be enough. I produced so much pressure into my carburetor that I blew my accelerator pump gasket out completely. I decided afterwards that one was enough. This blower was not supposed to be as efficient as a turbo-charger. Its only function was to slightly condense the expanded and heated air.

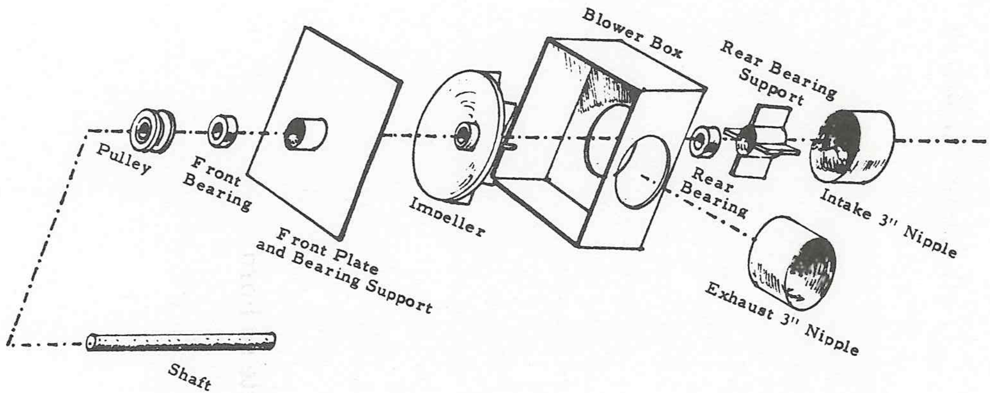


Illustration #6A

A smaller amount of the air flow is directed through the primary heat exchanger. The reason for this was that we discovered that passing all of the air to be consumed by the engine through the primary heat exchanger tended to cool it too greatly. Heat that could have been vaporizing the fuel particles was being lost in great quantities to the air flowing through it. Less than one seventh to one eighth of the air flow will pass through the heat exchanger. In fact, as little as possible will pass through in order to carry the fuel. A restrictor "T" was constructed for this purpose. The opening to the heat exchanger was reduced until we were satisfied. Again the bulk of the air flow was directed to the mouth of the carburetor where the airflow met the vapor.

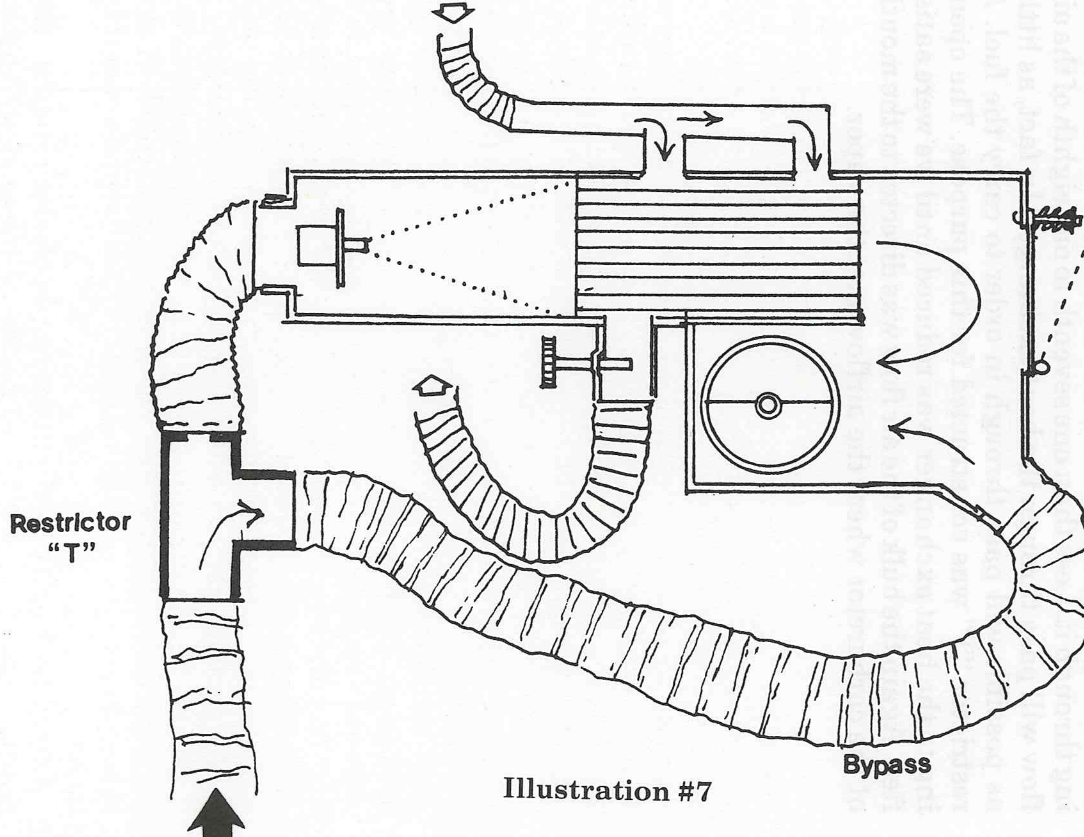


Illustration #7

Chapter 9
The Exhaust Gases And Heat Exchanger

Mentioned earlier was the fact that we need to be sure that the flow of fuel vapor did not come in contact with the exhaust gases flowing around the outside of the tubes in the heat exchanger.

Up to this point, we had heated the fuel, regulated down the fuel flow, heated the air, and now pressurized the air. These factors combined are enough to not only produce an increase in mileage, but should do it with a considerable amount of consistency.

But all we have done at this point is encourage the vaporization of fuel by applying heat to the fuel and air. In order to attain the maximum efficiency from gasoline, it must be completely vaporized. We cannot find a way of completely vaporizing the fuel using the existing carburetor, so we decided to generate the pure gas vapor outside the carburetor.

As we mentioned earlier in this book, the medium for producing pure vapor is to use the waste heat from the exhaust system. What we do at this point is route the fuel that has already been heated and regulated to a fuel nozzle that will spray this heated fuel into the airstream which has already been heated and pressurized. This mixture will pass through what we call the primary heat exchanger.

The heat exchanger is composed of about 50 small tubes, one-half inch in diameter. The number and length of the tubes varies with each installation, but we will discuss this later.

Once the heated fuel enters the heated airstream, the mixture passes through the inside of these super-heated tubes. Again, the exhaust gases are passing around the outside of these tubes, heating them. Inside of each one-half inch tube, there is a loosely wound piece of stainless steel or aluminum screen. This screen is the same as the length of the tube and, before it is inserted into the tube, it is cut to a width of one and one-half inches. It was wound around a pencil or similar object to form it into the proper shape. Before inserting it into the tube, it was slightly twisted. The function of the screen is to catch the fine particles or droplets of fuel as they pass through the tubes. The droplets must be brought into contact with the tube surface itself or the fuel could be drawn through the tube without being vaporized within the hot tubes. (See Illustration #8)

Here the two will combine, evenly distributing the fuel vapors and the hot air supply. The box is shaped in the "L" configuration for space utilization. Notice that the opening for the carburetor is located along side the primary heater. This more or less centers the entire unit over the engine. If we tried to build the unit with everything in a straight line, the unit would not fit under the hood of *any* vehicle.

Since this unit is to be mounted on a carburetor, it is necessary to weld a lip or riser to the underside of the hole to space the unit slightly above the carburetor's mouth. There are obstacles around the mouth of most carburetors that will not allow the box to rest evenly unless a lip or riser consisting of a short (3/4-inch) piece of pipe is welded to the underside of the hole in the box.

The size of the hole to be drilled in the bottom of the box and the 3/4-inch spacer should both be the same diameter as the throat of the carburetor on which the unit will be mounted.

The size of the box depends on the size of the engine and also the amount of room under the hood of the vehicle. The unit on our test vehicle (the 1974 Buick) is 24 inches wide, 12 inches from front to back at the carburetor, and 6 inches from front to back at the fuel nozzle area. The unit is three inches tall plus the 3/4 inch spacer on the carburetor mouth.

This unit is larger than it has to be, but when building an experimental unit of this kind, it is better to over compensate than to under compensate. The tubes in the primary heat exchanger of this unit are 9 inches long. We have tested a 351 c.i.d. engine on vapor with 4 inch long heat exchanger tubes. There is a lot of room for varience, but if the heat exchanger is smaller, more heat must be applied.

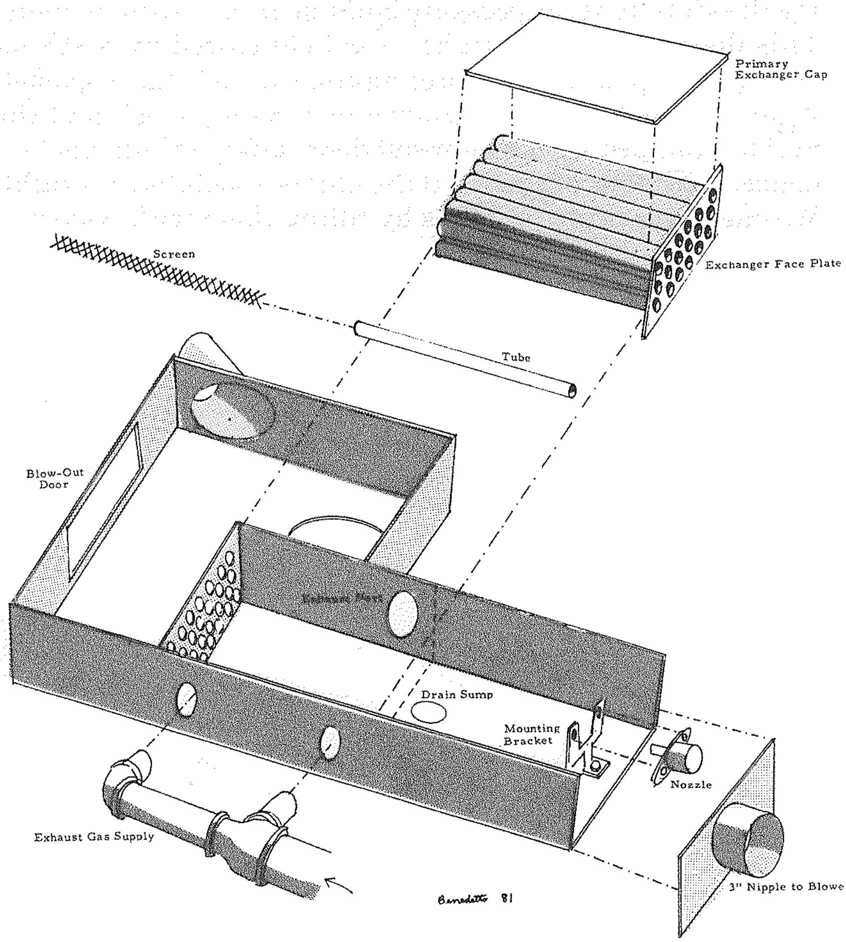


Illustration #8

In this heat exchanger box, you will notice a blow-out door. The requirement for this component is vital. The entire box must be air tight. If a leak in the box allows the pressurized gas vapor to escape the unit, the vapor will fill up the underside of the hood. Since the distributor cap is not sealed or airtight, the vapor will be ignited. This blow-out door keeps in the pressurized vapor, but, if a backfire occurs, it will safely vent the pressure build-up into the atmosphere. This door must be air tight. It is held closed by a strong spring (ten pounds or more) against an air tight gasket. Again, if the box is constructed of 1/8-inch steel, and the unit is equipped with a blow-out door, safety should not be a concern. That is, of course, if the unit is absolutely air tight. We check our units for leaks by filling them with water.

Chapter 10
The Primary Heat Exchanger Unit

We have touched on the primary heat exchanger and its purpose. It consists of around 30 to 50 one-half inch diameter, thin wall tubes that range in length from four to nine inches. The size of a heat exchanger for a particular vehicle depends on the size of the engine. As we mentioned before, it is better to play it safe and build it a little larger than the vehicle might require. For a four cylinder engine, we use 4-inch tubes; for a 500 c.i.d. V-8, we use 9-inch tubes. The number of tubes would range from 30 to 50 on those engines.

In constructing the tube carriage, we first determined the dimensions of the heat exchanger. On the example of the Buick, the box was three inches tall, and the case for the heat exchanger assembly was six inches wide. The tubes were nine inches long. This was to be size and shape of the exchanger assembly. We started with two solid 1/8-inch thick steel plates, three inches by six inches. On these plates, we scribed an arrangement of about 44 one-half inch holes through which the 1/2-inch tubes would pass. Actually, we had to measure the outside diameter of the tubes and mark the holes for them to be slightly larger. The tubes were thin walled steel.

The holes marked were arranged in a honey-comb pattern. It was important that as much of the face of this heat exchanger as possible be tube ends allow maximum exposure to the gas that would be sprayed into them.

Again, the holes that the tubes were through in the plates were drilled slightly larger than the outside diameter of the tubes in order for the tubes to be inserted with ease. Once all the tubes were extending through both plates, the tubes were brazed to the base plates, insuring that each was air tight. It was important to keep in mind that one side of the plate would contain pressurized exhaust gases and the other side, a fuel/air mixture. The two should never mix.

The tube carriage is lowered into the "L" shaped box. Before the carriage is permanently mounted, the inlet and outlet ports for the exhaust gases are drilled.

The size of the exhaust line carrying the supply of heat was also determined by the size of the engine. It was critical here that we also over compensate rather than under compensate. The exhaust gas flow could be easily regulated down, but once the installation of the line was made, it would be very difficult to increase the flow. On the test vehicle, the exhaust gas line is one and a half inches in diameter. If the unit were installed on a Pinto, needless to say, the exhaust pipe would not be that large, but the more exhaust gases that can be applied for heating, the better.

Also shown in the illustration, the exhaust gases enter the exchanger at two locations. This helps the heat to be evenly distributed across the heat exchanger tubes. The gases exit on the far side of the unit through a port the same size as that of the line carrying the supply of exhaust gas to the unit. The flow of exhaust gas would be increased if the exhaust port were larger.

A gate type valve was required at this exhaust port on the primary heat exchanger. The inside diameter of this valve had to be the same as that of the exhaust port. This would offer no restriction should the valve be opened completely. It was important to locate the valve on the exit side of the heat exchanger. The exhaust gases are up to 1,400 degrees F entering the heat exchanger. This temperature would break down the packing in most valves in a very short time. Most of the heat from the gases would be extracted by the exchanger tubes prior to reaching the valve if it were placed on the exhaust side of the exchanger. The gases exiting the unit should not exceed 250 degrees.

Once the unit was placed into the box it was welded air tight. When this was completed, the top of the unit (the tube carriage) was exposed. A plate or lid was cut, then placed over the carriage to seal in the tubes and the exhaust gases. This too was brazed or welded air tight.

What we had constructed was a unit within a unit. A sealed heat exchanger mounted inside the outer box.

Inside the tubes of the heat exchanger, screens were inserted. In each of the tubes, a piece of stainless steel or aluminum screen the length of the tube and one and one-half inch wide, was rolled loosely, then slightly twisted, prior to being inserted into the tubes. A retainer screen was required at the rear of the tubes to keep the screens within the tubes from being sucked out by the vacuum created by normal engine operation. The screens inserted in the tubes were standard mesh, normally found in screen doors. A heavier more rigid screen or wire mesh was used for the retainer screen.

HOW AND WHERE TO EXTRACT THE EXHAUST GASES

The exhaust gases that are used to supply heat to the exchanger tubes were attained from the exhaust pipe, as close to the engine as possible. A hole with the same diameter as the exhaust gas supply line should be drilled in the exhaust pipe as close as possible to the engine. The hole into which we tapped the exhaust system was located *after* the cross-over pipe joins in. This was in a single exhaust vehicle with a V-8 engine. If the exhaust gases were extracted from one side only, there would be an uneven balance in the exhaust pressure to the engine. The engine would run very rough. If the vehicle was equipped with dual exhaust, exhaust gases were extracted from both sides evenly. On a straight four or six cylinder engine, there is no concern with this problem.

Once the hole was drilled, a nipple of that diameter was welded into place. From the nipple, a piece of flexible exhaust tubing was connected to the exchanger unit where there is another nipple. This tubing is available in many auto parts stores, is very workable, and once installed, becomes rigid with time.

DRAIN SUMP AND FUEL RETURN

As the fuel passes the nozzle and enters the airstream, some of the fuel will not pass through the tubes. Unused fuel will collect on the front plate of the primary heat exchanger and drain to collect in a puddle on the floor of the box below the nozzle. If this fuel is allowed to collect, it could become a hazard. For that reason the fuel is directed back to the fuel tank or to the intake side of the fuel pump. We had to be careful here since the unit was pressurized. Air pressure could enter the return line, pumping air into either the fuel line or the fuel tank. Both are undesirable conditions. This could be avoided by placing a check valve in a drain sump at the bottom of the box just forward of the nozzle where the unvaporized fuel could collect. A tube, one inch in diameter and four inches long, was placed at the bottom of the box in this location. In the bottom of this tube is a needle and seat valve from a carburetor float bowl. A float, such as a cork, was attached to the needle valve. As the fuel level rises, the cork would rise, lifting the needle from the seat, thus draining the tube. Before the tube empties, the cork would drop, re-seating the valve. This would not allow any air pressure to escape the tube. (See Illustration #9)

HEAT EXCHANGER BOX INSTALLATION

When installing the heat exchanger box, we fitted the box onto the carburetor. The carburetor had a threaded rod that extended upward, normally securing the air filter onto the carburetor. A small hole was drilled in the top of the vaporizer box at a point exactly centered so the wing nut could secure the vaporizer box onto the carburetor in the same manner as the air filter. Doing this would pull the spacer under the box securely against the mouth of the carburetor. (See Illustration #10)

We placed a gasket between this spacer and the carburetor mouth to insure that there would be no vapor leaks. Using the wing nut to mount the box was not enough support for the box. The weight of the box, combined with the engine's vibration, would damage the gaskets in the carburetor in just a short time if some type of external bracing was not used. We welded several brackets to the box itself, then bolted them to the intake manifold until the unit was solidly mounted. We had to remember that the carburetor was only made of soft "pot" metal and did not offer any strength for support.

Drain Sump

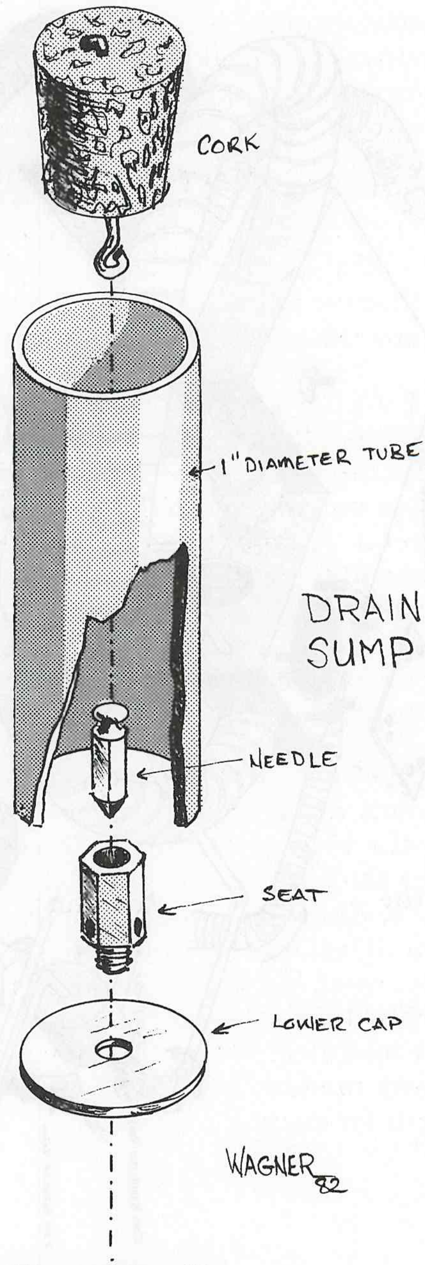


Illustration #9

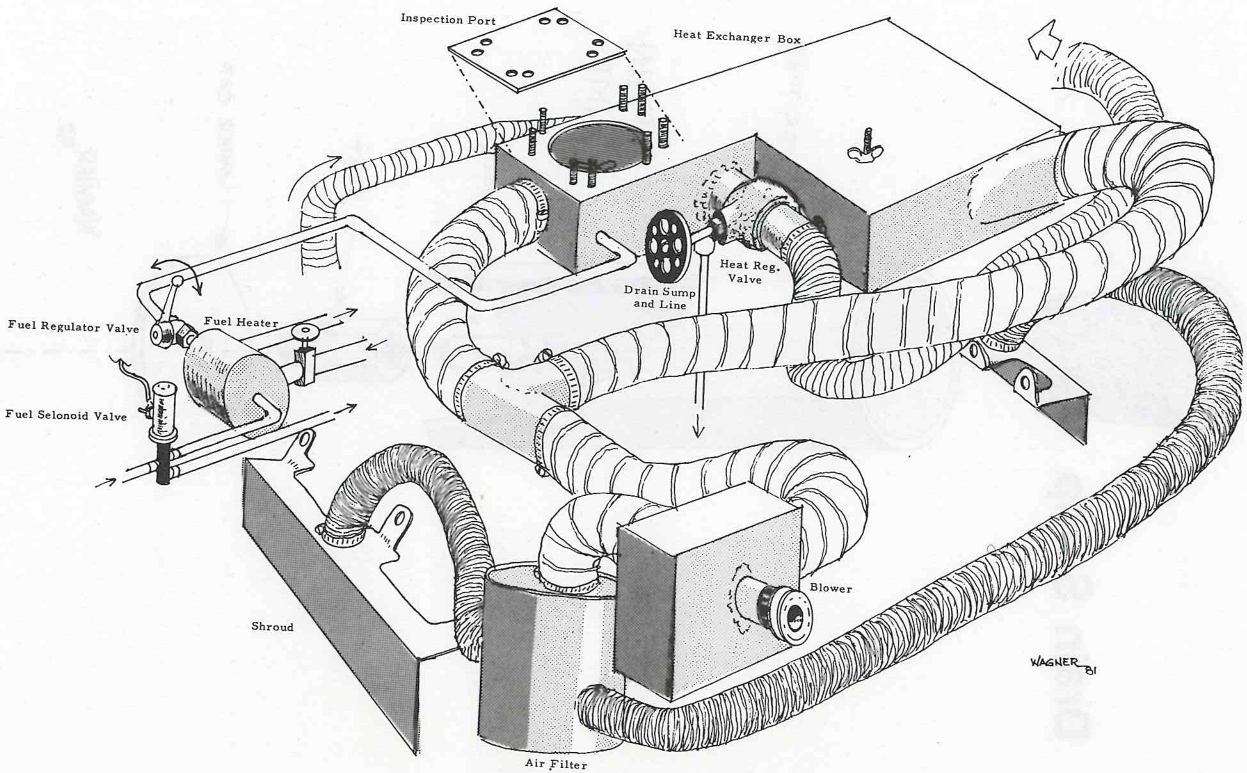


Illustration #10

Chapter 11
Water/Steam Injection

The useful concept of water injection is far from new. Prior to and during the Second World War, water injection was used to increase the power of aircraft during takeoff. It is still used, even in jet aircraft. As a matter of fact, the B-52 cannot get off of the ground fully loaded without water injection. You now see kits that you can purchase from your auto part dealers anywhere from $60 to $160 for converting your vehicle to water injection or water vapor injection. Your question would be, does it really work and if so, how and why?

If I am going to successfully explain the theory involved in this concept, I must first refresh your understanding of the operation of the internal combustion engine as far as its involvement with heat.

The gasoline that we use contains so much heat energy per volume, about 10,000 BTU's per cup. Unfortunately, due to our engine design, 85 percent of this heat energy is lost to the cooling system, exhaust, and to mechanical inefficiency. The purpose of the internal combustion engine is to convert this heat energy into torque. This is done by introducing gasoline to the cylinder along with enough air, (or oxygen) to support the combustion of this fuel. When the combustion takes place, what actually happens is, the fuel releases its heat energy which is accepted or conducted by the air and gaseous matter in the cylinder. Once these gases accept this heat they will expand to a certain degree. This supply of pressurized gas will exert its pressure on the piston surface, driving it downward in the power stroke or cycle. As explained in the earlier chapters of this book, the bulk of the fuel introduced to the cylinder does not have the opportunity to release its heat energy during this cycle due to the fact that it is not in a workable state (liquid).

Regardless of how much heat energy is being lost, there still remains a great amount of heat generated in the cylinders by the combustion.

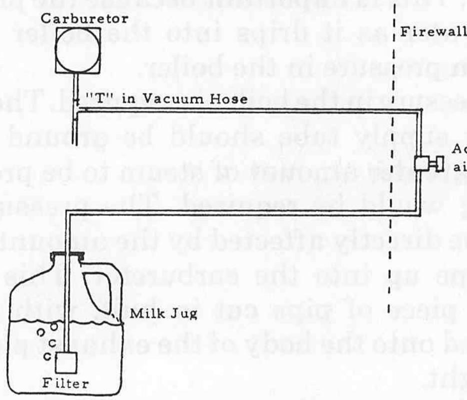
Steam has been greatly valued for centuries for its tendency to produce a useful pressure with relatively little heat. Steam will expand to a greater pressure than air if heated to a given temperature. Now, in our automobile engines, air is the primary gas to receive this heat from combustion. If steam is introduced, it will accept this heat and produce an overall higher pressure during the power cycle or stroke. Needless to say, if you have more power, you will use less gas.

Water injection has been commonly used to introduce this steam to the cylinders in the past. The greatest drawback is that the heat of combustion must first turn the water into steam before it will become useful. We have accumulated data that more or less indicates that water injection creates an average of from 5 percent to some reports of 50 percent increases in gas mileage. Generally, the people who install these systems claim that they have noticed an increase in power more than economy.

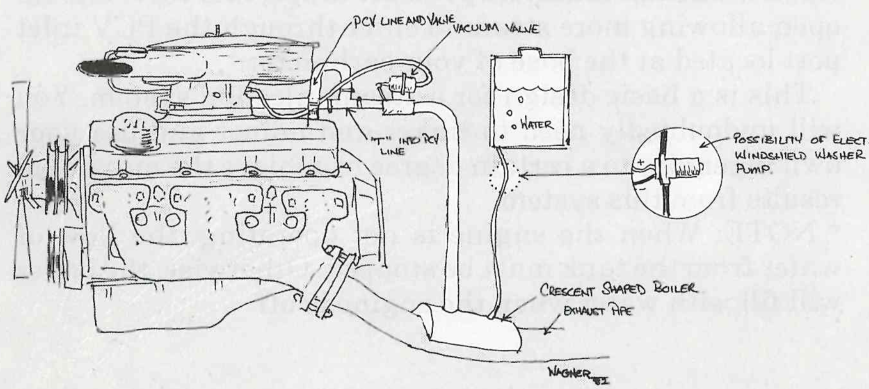
I would recommend steam injection over water injection by far. I have talked with a few who claim that too much steam or too rich a fuel mixture with steam injection will create so much extra power, that they have blown out their head gaskets. So be sparing! I have a newspaper clipping in my possession that tells of a man who claimed 106 mpg using steam injection alone. Maybe!

I have constructed my own water injection system for considerably less than you would pay for a premanufactured system of $160. I invested a total sum of $5. I used a milk jug, some vacuum line, an aquarium air regulator valve, and a filter. By running the vacuum line from the milk jug that had been secured to the fender to the air valve that was mounted on the dash, I was able to control the flow of water through the line from inside the car while I was driving. The vacuum line led from the air valve mounted on the dash, back out to the carburetor. So, the water was drawn out of the milk jug, through the vacuum line, through the regulator air valve, and into the venturi by the vacuum of the carburetor. I just used the most convenient vacuum line I could find to tie into. It works like a charm. I did find that allowing the engine to warm up prior to opening the regulator valve to introduce the flow of water was certainly to my benefit.

WATER INJECTION



Personally, for the reasons stated in this chapter, I would rather tinker with steam over water, though, doing this involves a little more time and patience.



As you can see by this illustration, some welding is involved. A water tank can be easily enough acquired in the form of anything from a milk jug to a coffee can. This can, or tank, must be mounted high. The reason for this is that the water will flow down a small tube into a homemade boiler. The distance between the holding tank and the boiler will determine what the weight of the water will be as it enters the boiler. This is important because the pressure or weight of the water as it drips into the boiler will help maintain a given pressure in the boiler.

A fairly low pressure in the boiler is required. The opening from this water supply tube should be around 1/16″ in diameter. For a greater amount of steam to be produced, a smaller opening would be required. The pressure of the boiler will also be directly affected by the amount of steam allowed to escape up into the carburetor. This boiler is simply another piece of pipe cut in half, with end caps welded on, welded onto the body of the exhaust pipe. It will need to be air tight.

As the water drips onto the exhaust pipe, it will turn to steam. This steam will travel upwards to a regulator valve. This valve can be acquired from a wrecking yard, previously used as a water flow valve in a heater system. Late '60 and early '70 model Fords are equipped with these vacuum operated valves. It is desirable to have a greater amount of steam in the engine for acceleration, therefore, when the intake manifold pressure drops, this valve should open allowing more steam to enter through the PCV inlet port located at the base of your carburetor.

This is a basic design for a steam injection system. You will undoubtedly need to tinker and adjust and use your own ingenuity to a certain degree to achieve the maximum results from this system.

* NOTE: When the engine is not operating, the flow of water from the tank must be stopped. Otherwise, the boiler will fill with water when the engine is off.

Chapter 12
The Simple System

This complex system was successful, but not to the degree that would satisfy us. It would compare to the old Pouge vaporizer. It worked when the adjustments and weather were just right. As I may have mentioned earlier, most persons who tried to build their own units using our work as a reference, generally did not attempt to build this unit. We could not guarantee the degree of their ability to duplicate our efforts, so therefore they were reluctant to invest the time and money required to assemble this unit. At the same time, with the design of this unit, we also developed a much simpler and easier to build system. This "simple" system, as we call it, has many of the same components as the complex just described. It has been quite popular in the Northwest area. People have built this type of system, from what we can determine, by the thousands. There are those who have not attained a sizable increase in mileage, but when we get a report back on those who have, generally these people who have succeeded have a list of others that have succeded also. It does seem that the quality of the installation and adjustment makes the greatest varience in the results. It seems that some vehicles are just not compatible with the simple system. I have tried, with very little success, to attain a sizable increase in four and six cyclinder engines. But the larger engines, as a rule, seem to be considerably more receptive. We do have quite a few reports of 100% increases in larger engined vehicles. (Illustration #11)

In the simple system, we were not aiming at vaporizing the fuel entirely before its consumption. What our goal was, was to encourage the vaporization of the gasoline in the intake manifold. This could be accomplished by pre-heating the fuel and air to be injected by the engine. The fuel is heated in the same fuel heater that we used in the complex

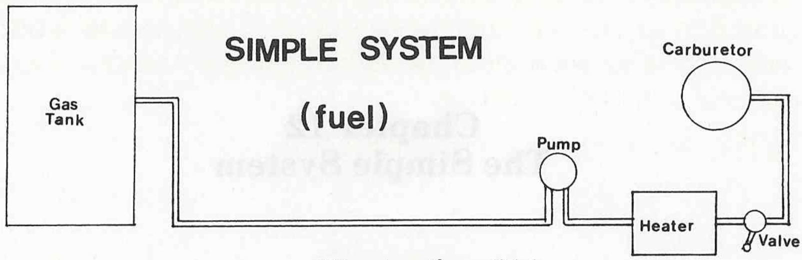


Illustration #11

system. A 6″ x 4″ diameter piece of tubing or pipe that is capped on both ends with a copper coil running through the center of it. The heat in the simple system is regulated by the same water valve that we used in the complex system also.

When setting this valve, rather than try to set it with a temperature guage, we set it by the engine's performance. With an unobstructed flow from the fuel pump to the carburetor, (with the exception of the fuel heater) we ran the engine up to operating temperature. We made sure that for this test that the supply of heated air was complete. The valve to the heater that controlled the water flow was completely open. If too much heat was being transferred to the fuel passing through the fuel heater because the valve was open too far, the heat would begin to create what is commonly referred to as "vapor lock." The lighter elements of the gasoline begin to turn into a gas vapor in the fuel line.

For this reason the fuel temperature must be regulated down to a safe temperature. It is not difficult to find the proper temperature. If too much heat is being transferred to the fuel, since the fuel in the simple system is still flowing into the carburetor bowl, the vehicle will lurch and sputter from these vapor bubbles. We simply take the vehicle out and find out where the engine runs its best at the greatest amount of heat that we can get away with without causing a loss of power or lurching as a result.

Once the fuel temperature has been set the only time that we have had to change it was seasonally. As the ambient temperature changes so does the temperature of the fuel the temperature of the in-coming heater. If there is a severe change in fuel then the temperature of the fuel existing in the fuel heater will vary accordingly. Another factor that has a bearing on the requirement to change the fuel temperature setting seasonally is that the grade and composition of fuel changes seasonally. There exists what is referred to as seasonal gas. All oil companies, that I know of, sell seasonal gasoline.

THE SUPPLY OF HEATED AIR

The method that we use to supply the engine with heated air is to draw it from the outside of the exhaust manifolds. We have found that later model cars and trucks are already supplied with an exhaust manifold shroud and heat pick-up tube. We have found this to be ideal for this application. The only obstacle is the valve located in the air breather assembly. This, we discovered, must be removed to allow a total flow of hot air. The valve would shut off the heated air once the engine is heated if we did not do so. This shroud is fine and can be used on four and six cylinder engines, but we found that a V-8 engine has a larger demand for hot air and requires two of these shrouds. Since the car only comes with one, another shroud must be fabricated to incase the other exhaust manifold. This we constructed from a simple piece of drain gutter normally used on houses. We selected the part of the drain gutter that has a downspout fitting attached. This downspout fitting that protudes from the bottom of the section of the gutter is 2″ in diameter which is ideal for fitting on a section of 2″ flexible tubing to duct the heated air over to the mouth of the air cleaner. This tubing should be the type normally used to connect the exhaust manifold shroud of a newer car to the air cleaner neck. It is either made of an asbestos or aluminum material.

All INCOMING COLD AIR MUST BE COMPLETELY BLOCKED OFF! If the car has a four or six cylinder engine, and only one shroud is being used, the valve that shuts off the air flow is removed. We must then block off the mouth of the air cleaner to ensure that absolutely no cool air is drawn in through the air cleaner at all. If we are working with an eight cylinder, the mouth is fitted with a tube that is connected to the other homemade exhaust manifold shroud. We found that it is very important when installing a homemade shroud that it be firmly secured to the manifold by using the maifold bolts for attaching the shroud.

The hot air is urgently needed in building this system. We have tried to construct one of these simple systems without it and found that if the air is not heated, there is little or no increase in mileage. The reason for this is that the air passing through the venturi is very cold, even in the summer. If you are a light aircraft pilot, you know that even on the warmest day when you throttle back for the descent that it is urgent to apply the carburetor heat to prevent icing. If the fuel has been heated, it has a much greater potential for providing energy output. If it is injected through the carburetor jets into a cold airstream, it will lose its heat and, therefore, its added energy potential. (See Illustration #12)

The simple system consists of a fuel heater, a water regulator valve, a fuel regulator valve, control linkage and the hot air pick-up, and shrouds. (See Illustration #13)

Many people have duplicated our efforts with this system with an amazing amount of success. Systems similar to this one have been used for generations. This system does not seem to work on all vehicles with the same degree of success. For this reason we found it necessary to either refine this system or the complex system to a more consistently performing unit. Or, possibly develop one that is more consistent than both.

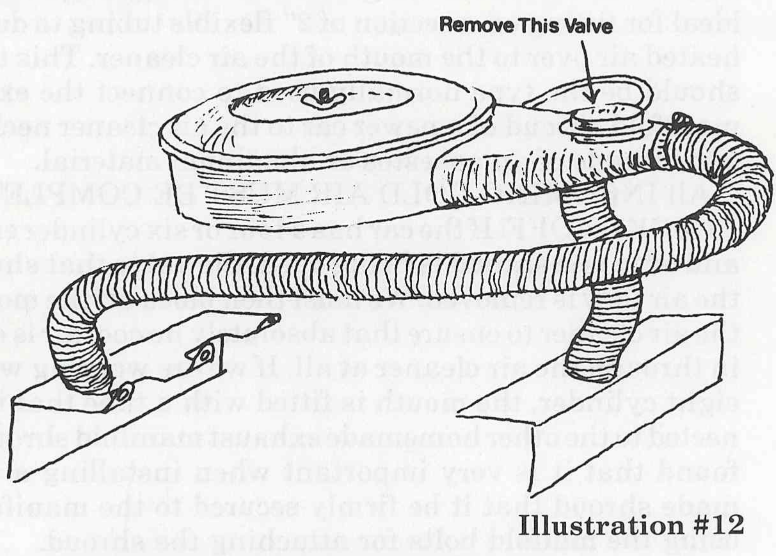


Illustration #12

Simple System Hot Air Pick–up

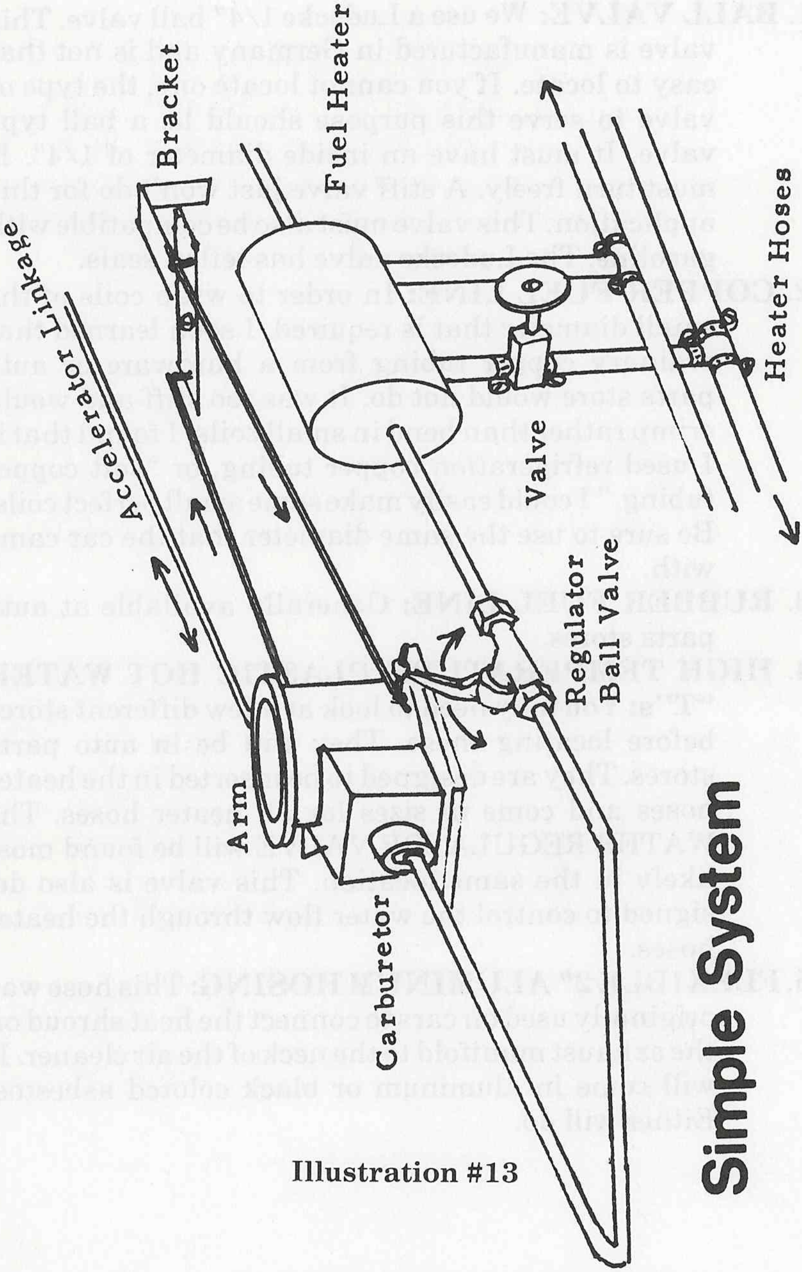


Illustration #13

Parts of this system can be located mostly in auto parts stores and hardware stores. The following information is a discription of the parts and an explanation of the qualities that they should possess.

1. **BALL VALVE:** We use a Ludecke 1/4″ ball valve. This valve is manufactured in Germany and is not that easy to locate. If you cannot locate one, the type of valve to serve this purpose should be a ball type valve. It must have an inside diameter of 1/4″. It must turn freely. A stiff valve just won't do for this application. This valve must also be compatible with gasoline. The Ludecke valve has teflon seals.
2. **COPPER FUEL LINE:** In order to wrap coils of the small diameter that is required, I soon learned that ordinary copper tubing from a hardware or auto parts store would not do. It was too stiff and would crimp rather than bend in small coils. I found that if I used refrigeration copper tubing, or "soft copper tubing," I could easily make some small perfect coils. Be sure to use the same diameter that the car came with.
3. **RUBBER FUEL LINE:** Generally available at auto parts stores.
4. **HIGH TEMPERATURE PLASTIC HOT WATER "T"s:** You may need to look at a few different stores before locating these. They will be in auto parts stores. They are designed to be inserted in the heater hoses and come in sizes for all heater hoses. The WATER REGULATOR VALVE will be found most likely in the same location. This valve is also designed to control the water flow through the heater hoses.
5. **FLEXIBLE 2″ ALUMINUM HOSING:** This hose was originally used on cars to connect the heat shroud on the exhaust manifold to the neck of the air cleaner. It will come in aluminum or black colored asbestos. Either will do.