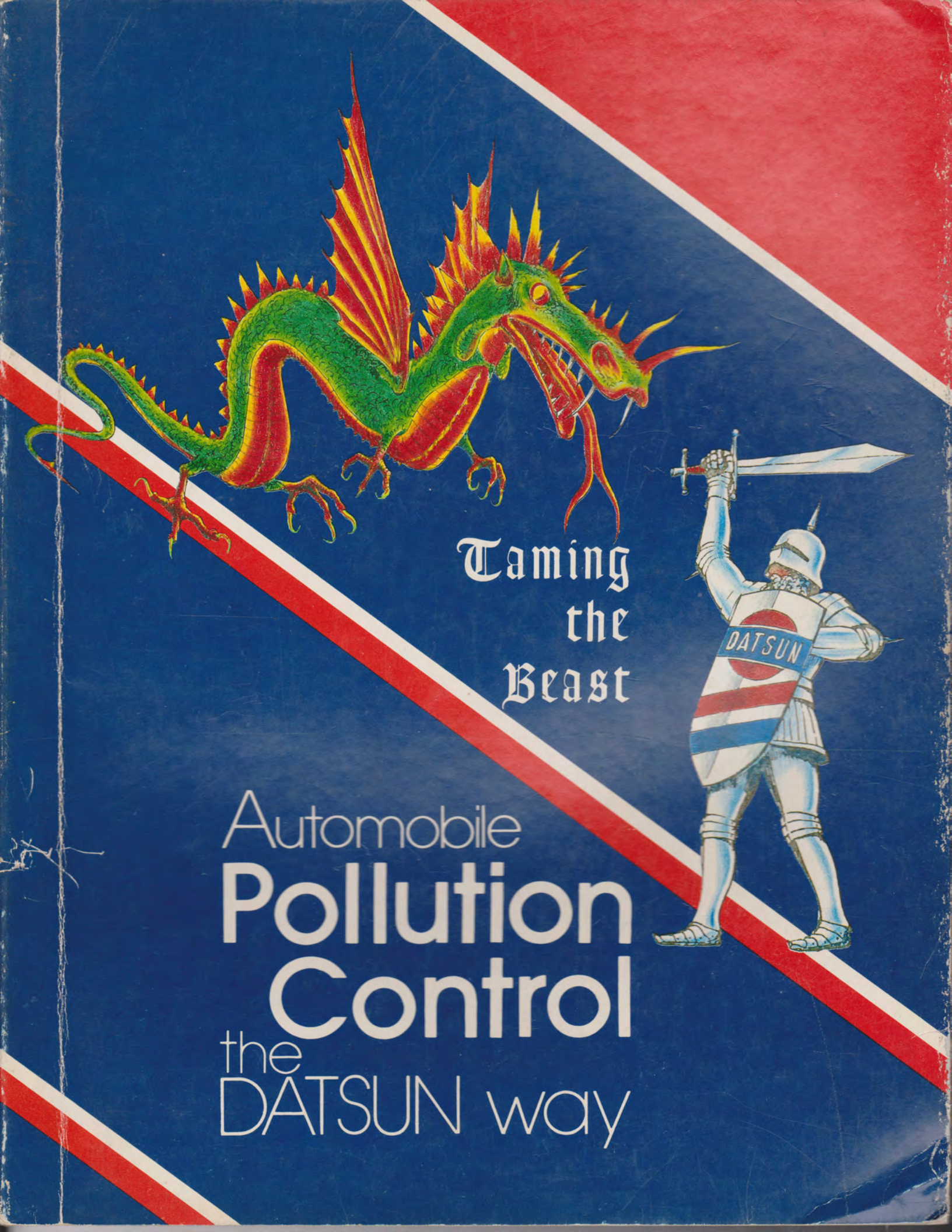


Automobile Pollution Control

the DATSUN way

Produced by:

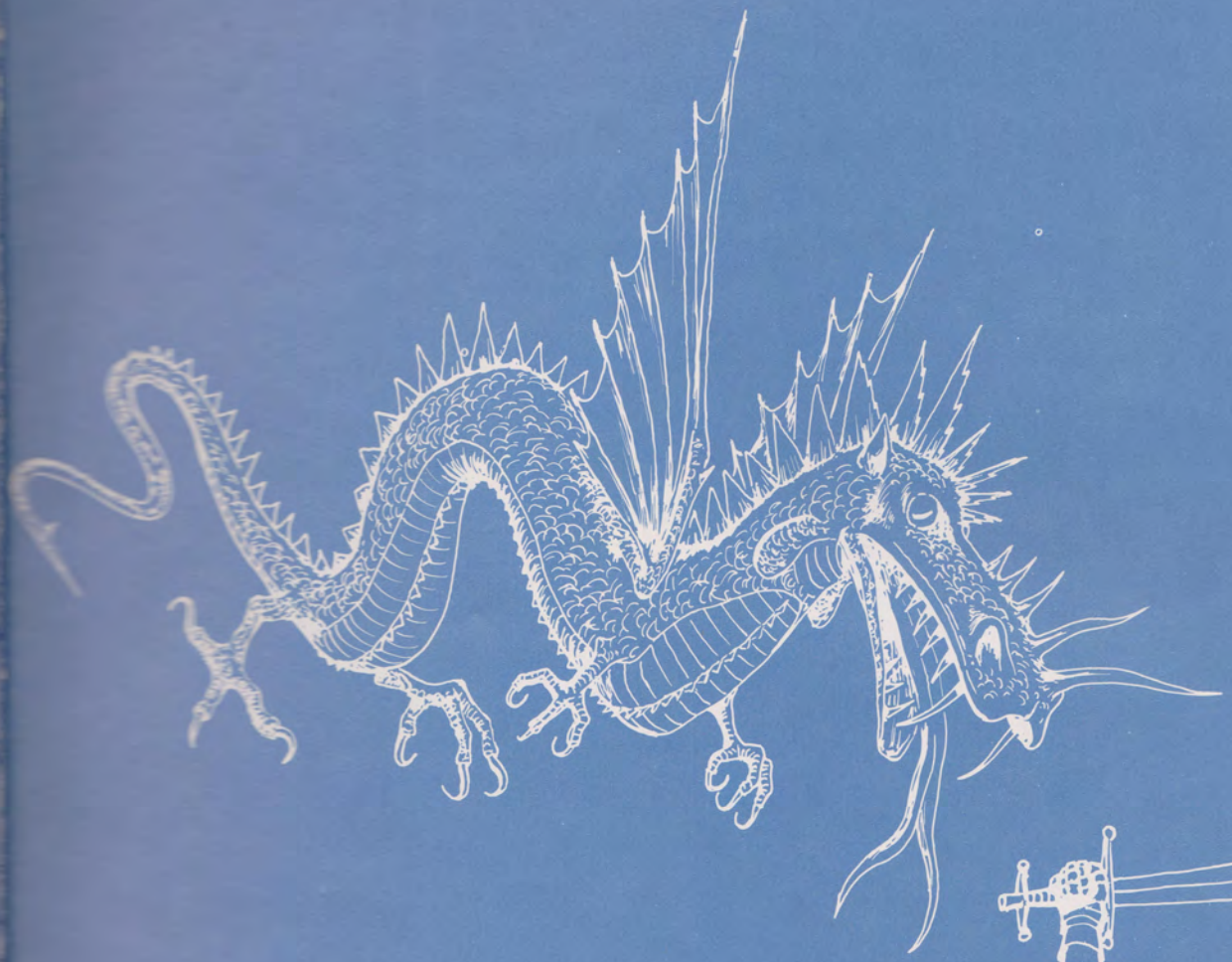
The Service Technical Training dept.

This book is designed for instructional use only for authorized Nissan/Datsun dealer personnel. For additional copies contact:

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National Service Department,
Service Technical Training/Development
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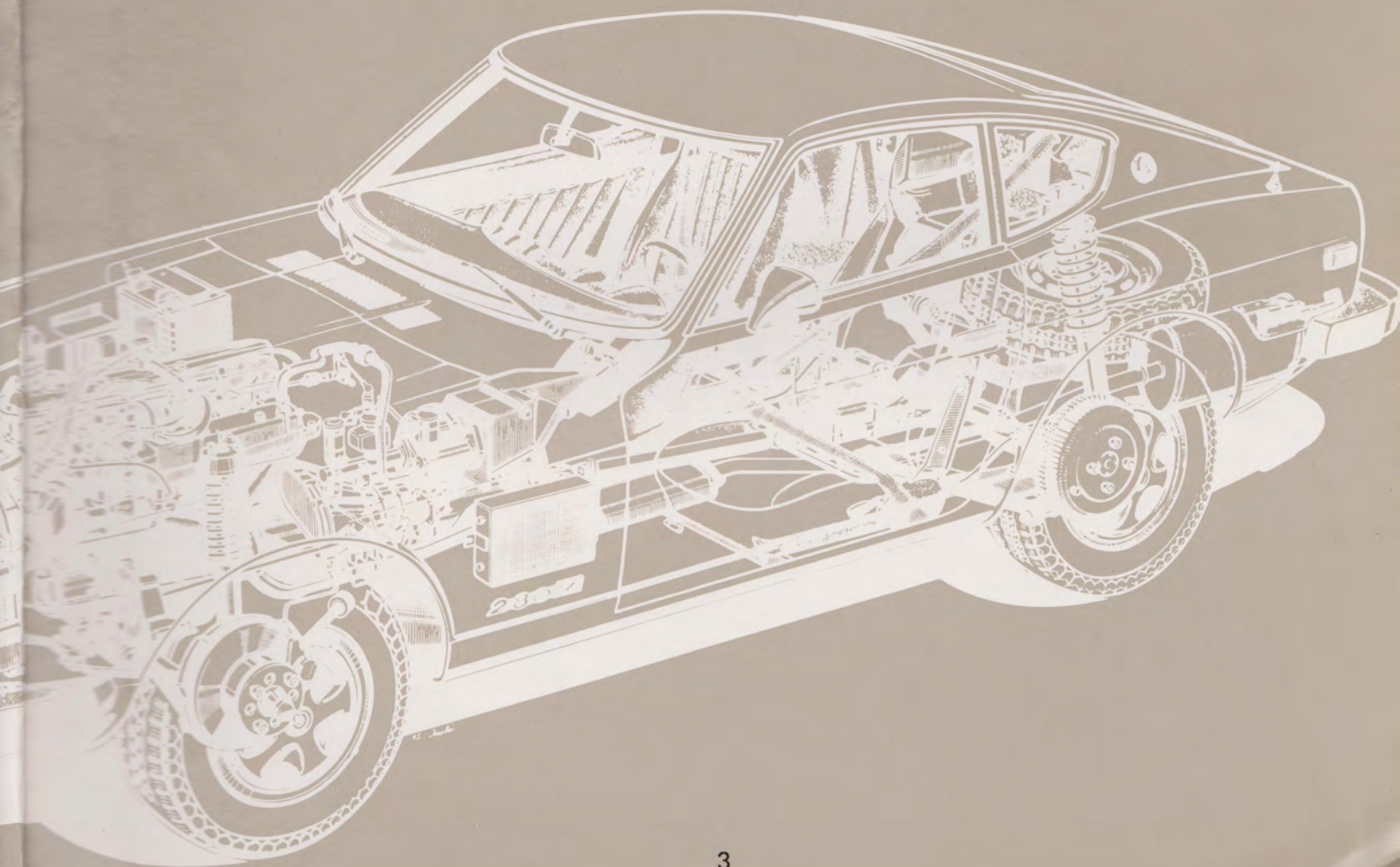


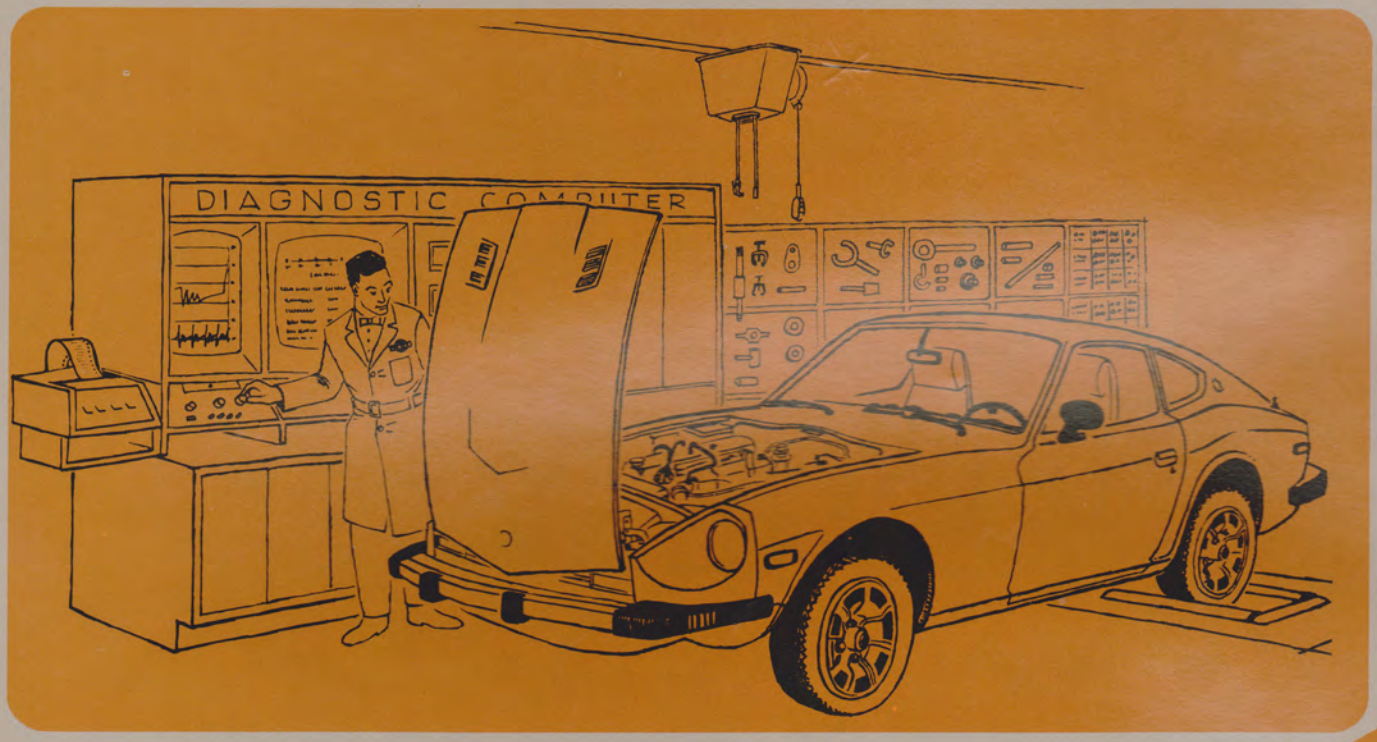


DATSUN EMISSION CONTROLS: THE HOWS AND WHYS

This manual was written for you, the Datsun Technician, by a staff of Datsun Training Instructors. We sincerely hope that this information will be useful to you, the key man in pollution control device maintenance for cleaner automotive emissions.

Beginning in 1968, the automobile industry, in cooperation with the Federal Government, made a commitment to the American public to limit the harmful pollutants produced by automobiles. It's been a tough job, but today's cars are incredibly pollution-free compared to those of ten years ago.





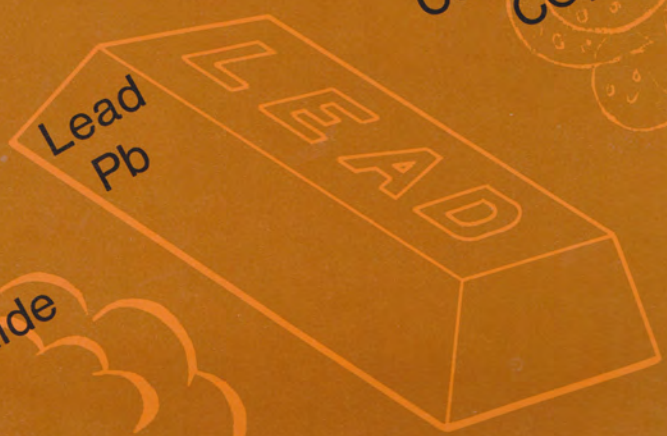
Of course, there's been a price to pay for cleaning up the air, and that price is the increased complexity of the modern automobile. It takes a knowledgeable technician and sophisticated equipment to diagnose and service late-model cars and their emission control systems.

There's really nothing difficult about understanding automotive emissions and how to control them. Take the time to read and understand what is in this book. Then, familiarize yourself with the specific diagnosis and service procedures outlined in the Service Guide. The time you spend here will bring back dividends many times over in terms of both your efficiency as a Datsun Technician, and the quality of the air we breathe. And really, that's a small price to pay to clean up the air our children will breathe, isn't it?

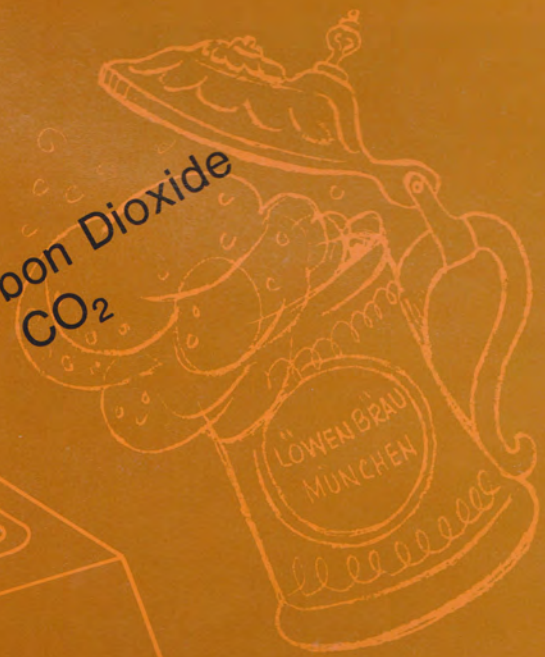
AUTOMOBILE EMISSIONS & POLLUTANTS

Not all of these compounds are pollutants. Carbon dioxide, for example, is not only essential to life, but also puts the head on a glass of beer. Water is obviously not harmful. Lead, which is a pollutant, can be eliminated by simply changing the gasoline formulation.

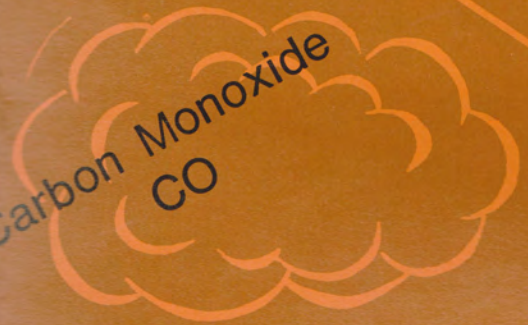
The modern automobile produces and emits:



Lead
Pb



Carbon Dioxide
CO_2



Carbon Monoxide
CO



Hydrocarbons
HC



Water
H_2O



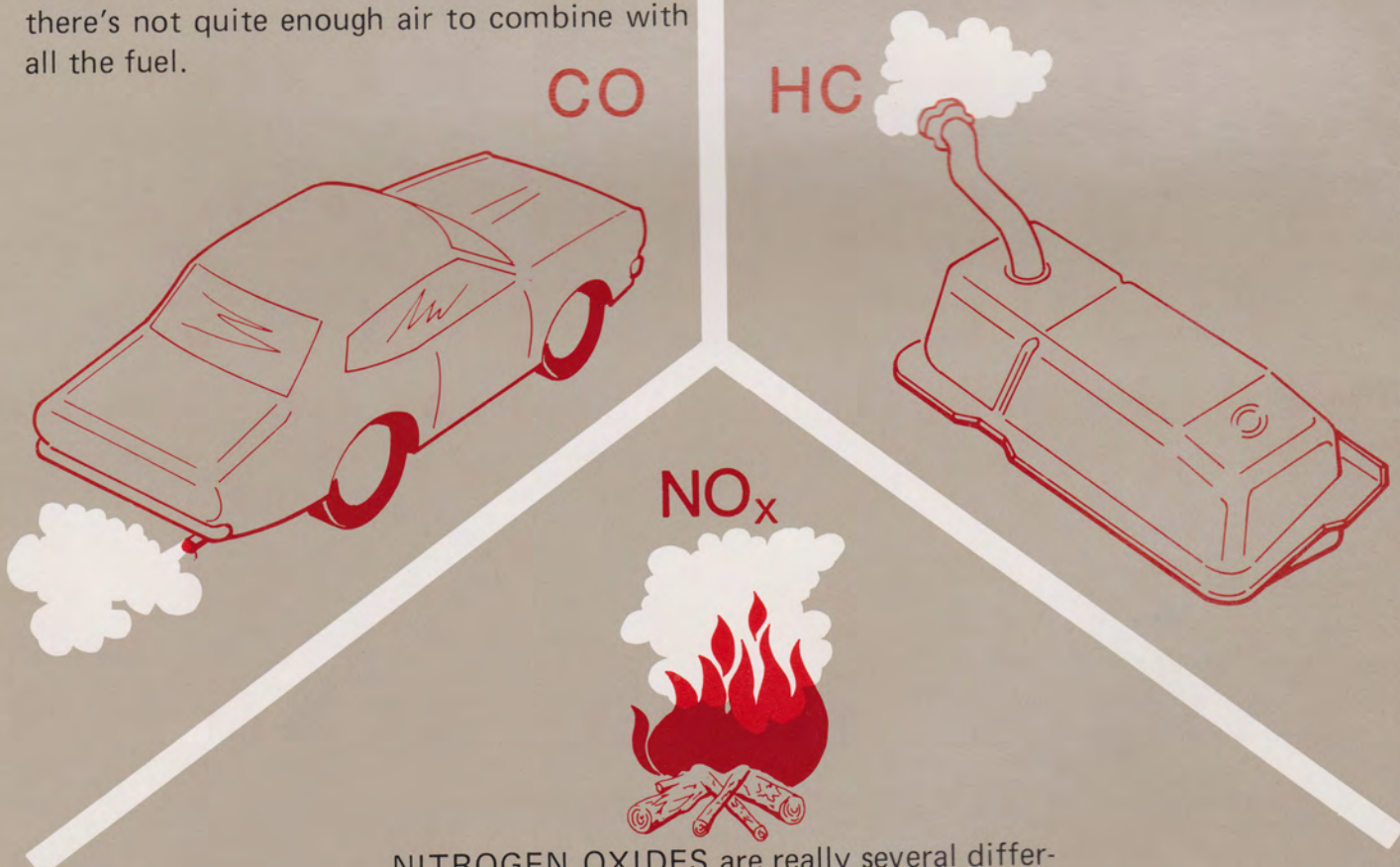
Nitrogen Oxide
NO_x

THE POLLUTANTS: CO – HC – NO_x

We are concerned mostly with environmental pollution resulting from the output of the car's "TERRIBLE TRIO", alias:

CARBON MONOXIDE is a gas formed by oxygen and incompletely burned gasoline which is produced during combustion when there's not quite enough air to combine with all the fuel.

HYDROCARBONS are what gasoline is made of. Hydrocarbon emissions are nothing more than unburned gasoline which enters the air.



NITROGEN OXIDES are really several different compounds of nitrogen and oxygen which form in the combustion chamber when fuel burns under tremendous pressure and temperature.

THE DANGERS OF POLLUTION

Carbon Monoxide is the tasteless, odorless, and deadly gas which could kill you if you run a car for too long in a small, closed garage. Medically speaking, it hampers the blood's ability to carry oxygen to all parts of the body. Without enough oxygen, living cells shut off their life process and die - and, unfortunately, the most important cells, those in the brain, are the first to go. In smaller concentrations, CO gives you headaches and causes you to be sluggish.





Since automotive HC emissions are basically just unburned gasoline, expelling them from a car is about as desirable as spraying raw gas into the atmosphere. In fact, many weed killers, most insecticides and poisons are made up primarily of hydrocarbons. To make matters worse, HC combines with other pollutants in the presence of sunlight, thus producing photochemical "smog" (more about smog later).

NITROGEN OXIDE

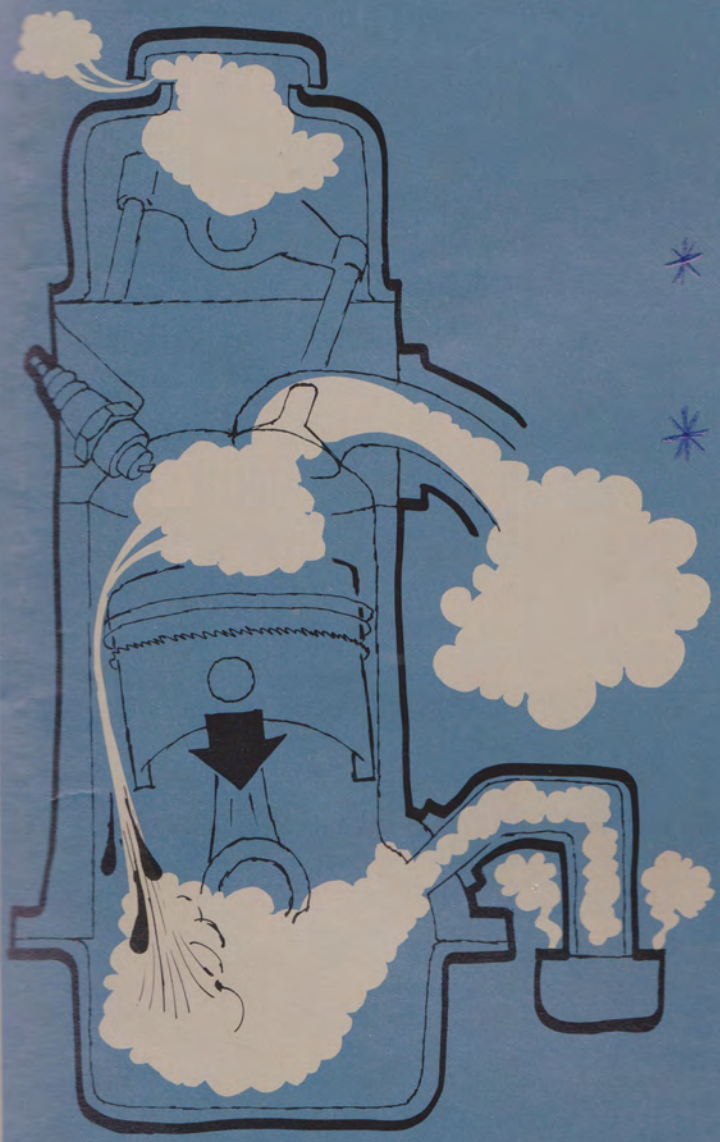
The air in the Earth's atmosphere is a mixture of about eighty percent nitrogen and twenty percent oxygen. Under the high temperature and pressure of automobile engine combustion, these two elements are forced together into compounds we call nitrogen oxides, or NO_x for short. These compounds sting your eyes and irritate your nose on warm days. Worse yet, in the presence of sunlight, NO_x combines with HC to form "photochemical smog", the brown haze which hangs over most of our cities on warm days when the sun is bright. The really bad news about "smog" is that researchers now know that smog causes, complicates, or aggravates such diseases as cancer, emphysema, asthma, and many other heart, lung and circulatory diseases.

You can see that the combined, cumulative effects of automotive pollution are quite frightening from both the medical and the "quality of life" standpoints. And while the emissions from a single vehicle may seem insignificant, thousands of tons of this garbage are dumped into the air every day by automobiles in even medium-sized metropolitan areas.



POLLUTANTS: WHERE DO THEY COME FROM?

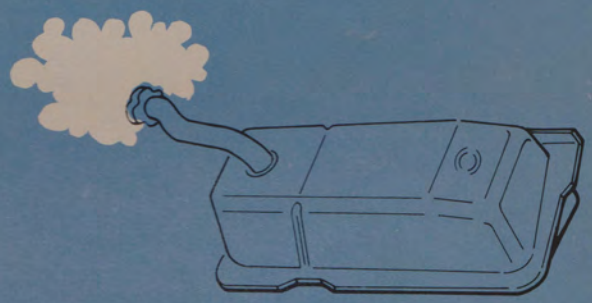
The automobile emits pollutants from three different places: the fuel system, the crankcase, and the exhaust system.



- About twenty percent of the automobile's total pollution can come from the crankcase in the form of combustion blow-by and oil fumes, and is made up mostly of HC, with a little CO and trace amounts of NO_x.

- Another twenty percent of the car's pollutants can be caused by gasoline evaporating out of the fuel system in the form of HC.

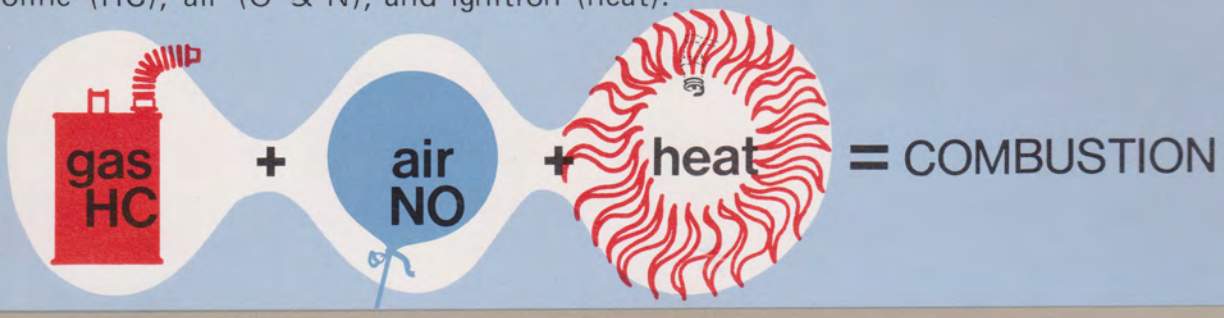
- The biggest share of automotive pollutants, sixty percent or more, are in the exhaust from the car's tailpipe. In fact, with late model cars, about ninety-five percent of the pollution comes out of the tailpipe. This pollution is made up of HC, CO, and NO_x.



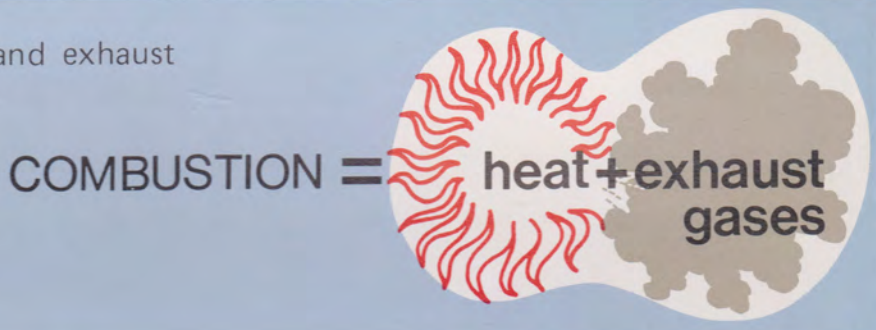
THE COMBUSTION PROCESS,

OR, what goes IN must come OUT

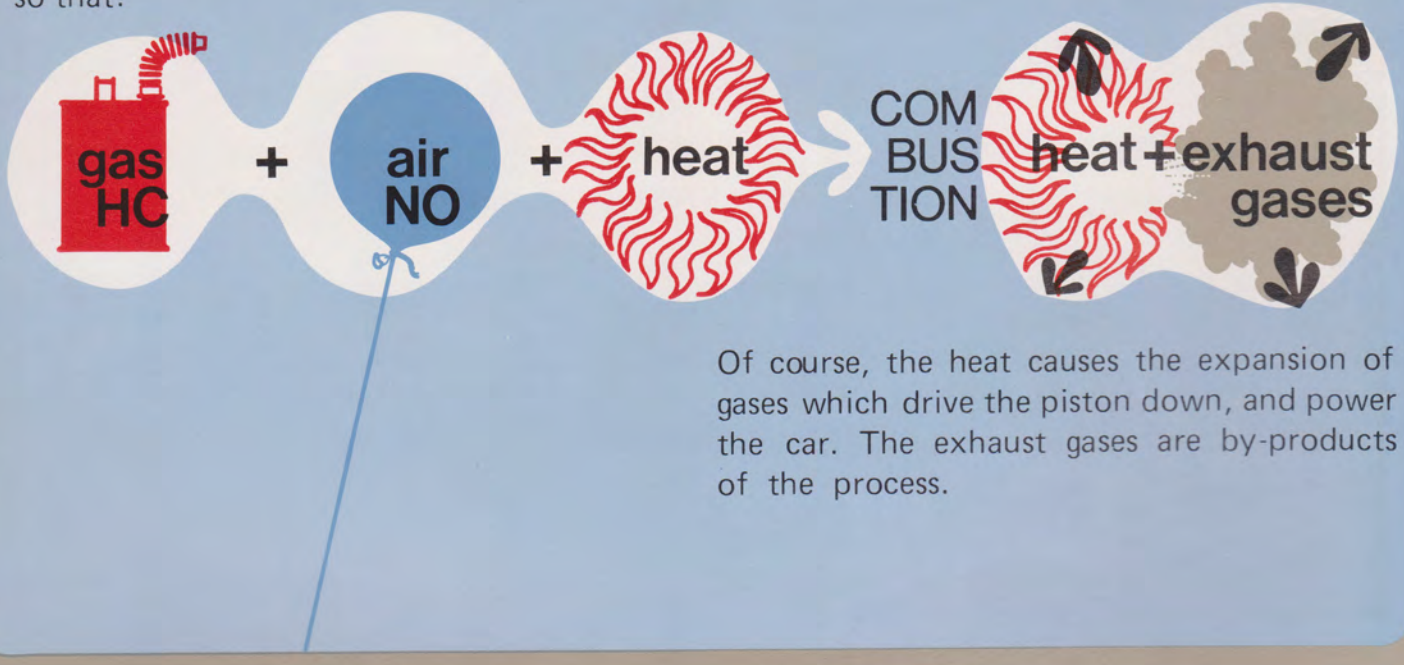
The basic ingredients of combustion are: gasoline (HC), air (O & N), and ignition (heat).



The results, of course, are heat and exhaust gases, which could be pictured as:



so that:



Of course, the heat causes the expansion of gases which drive the piston down, and power the car. The exhaust gases are by-products of the process.

OR, using different symbols, we could say that:

HC+O+N+heat



exhaust gases

Or, in other words, "gasoline + oxygen + nitrogen + ignition yields power + exhaust gases".

We are taking for granted that heat is required to start the reaction and that usable power is the result.

HC+O+N = exhaust gases

Now, under ideal conditions, if everything would just combine the way we would like it to, the process would read:

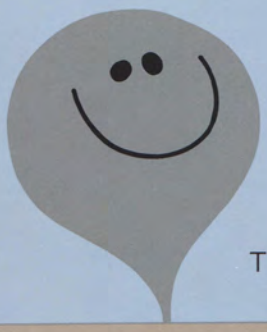
HC+O+N = H_2O+CO_2+N

OR, Gasoline + Air YIELDS Water + Carbon Dioxide + Nitrogen.

OR, some oxygen combines with hydrogen to form water (H_2O), and . . . .

some carbon combines with oxygen to form carbon dioxide (CO_2), and . . . .

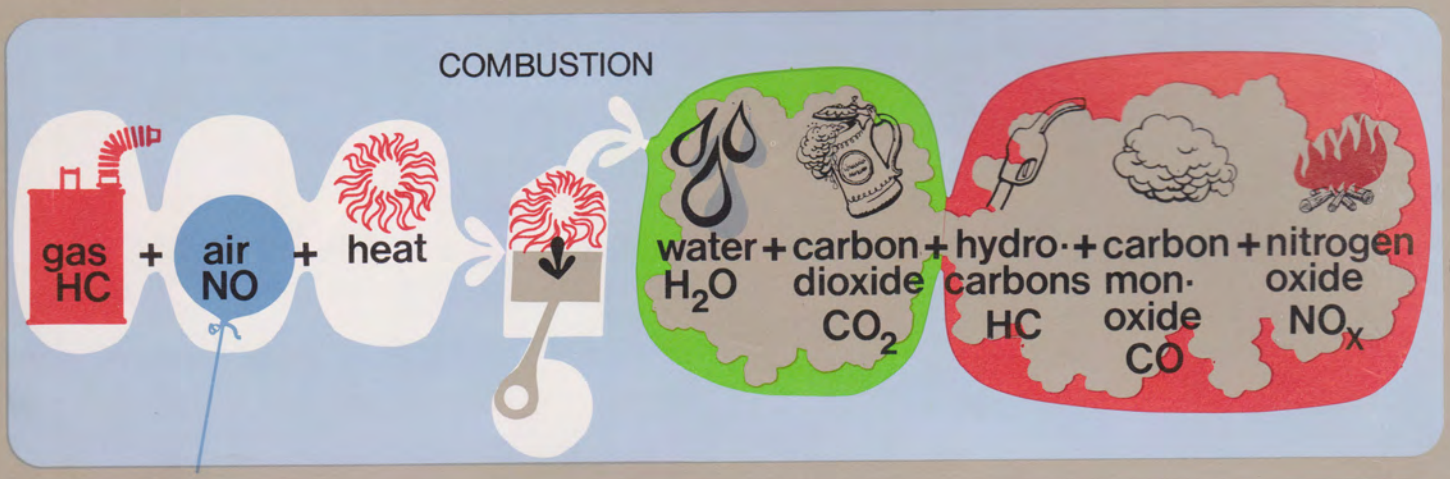
The nitrogen is released into the atmosphere as a pure, harmless gas, and the end result could be a pollution-free environment!



THE END?

THE AWFUL TRUTH IS . . . .

Unfortunately, it doesn't really work out that way. What really happens is more like this:



$HC + O + N =$ COMBUSTION $H_2O + CO_2 + CO + HC + NO_x$

OR, Gasoline + Air YIELDS: Water + Carbon Dioxide + Hydrocarbons + Carbon Monoxide + Nitrogen Oxides,

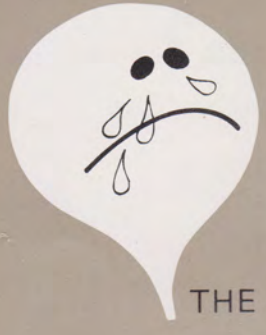
Some oxygen combines with hydrogen to form water (H_2O), and . . . . .

Some carbon combines with oxygen to form carbon dioxide (CO_2), and . . . . .

Some gasoline doesn't burn at all, and leaves the combustion chamber as unburned hydrocarbons (HC), and . . . . .

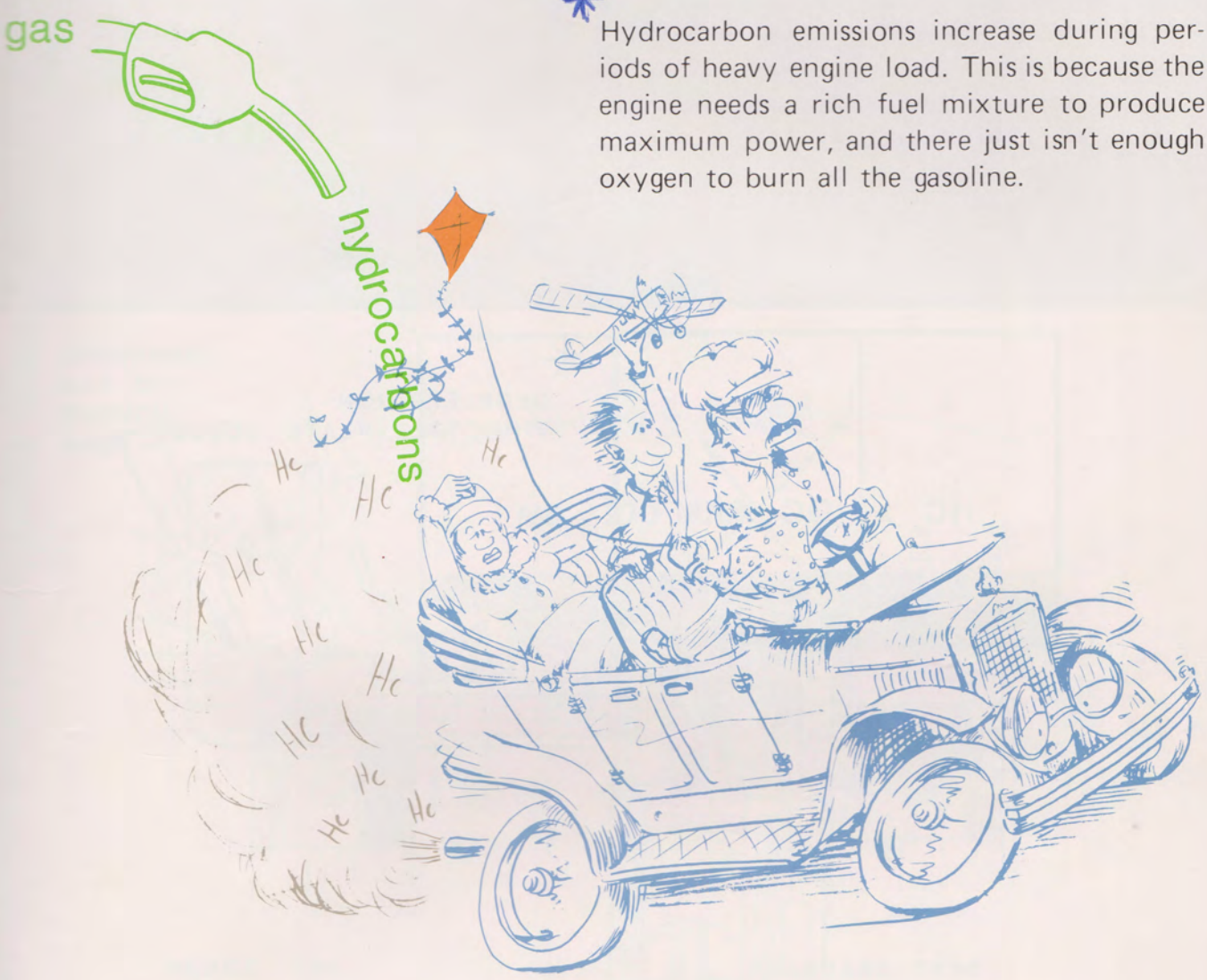
Some carbon combines with oxygen to form carbon monoxide (CO), and . . . . .

Some oxygen combines with nitrogen under the tremendous heat and pressure to form several kinds of nitrogen oxides (NO_x), and . . .



THE SAD BEGINNING

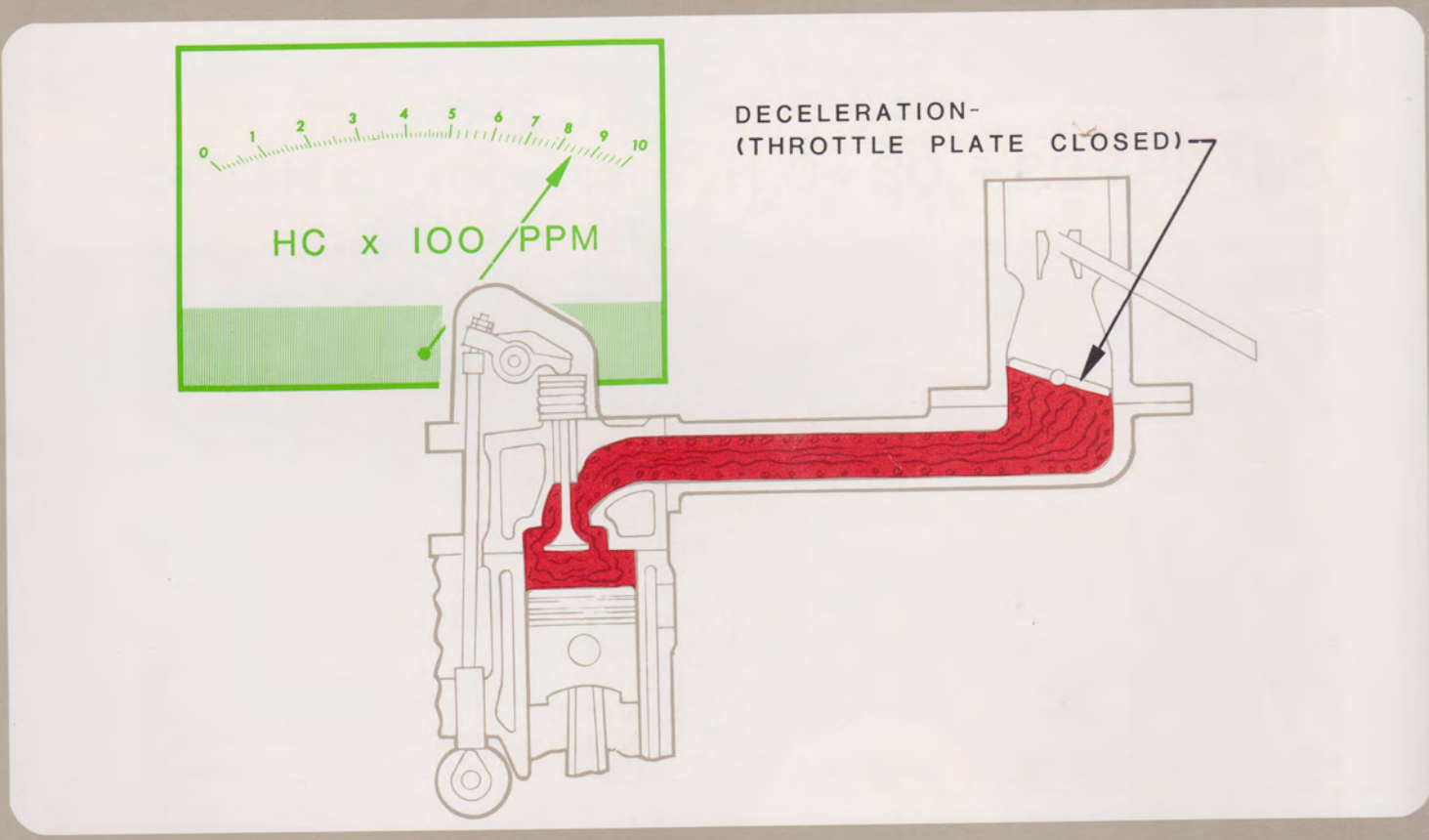
WHY HYDROCARBONS FORM



Hydrocarbon emissions increase during periods of heavy engine load. This is because the engine needs a rich fuel mixture to produce maximum power, and there just isn't enough oxygen to burn all the gasoline.

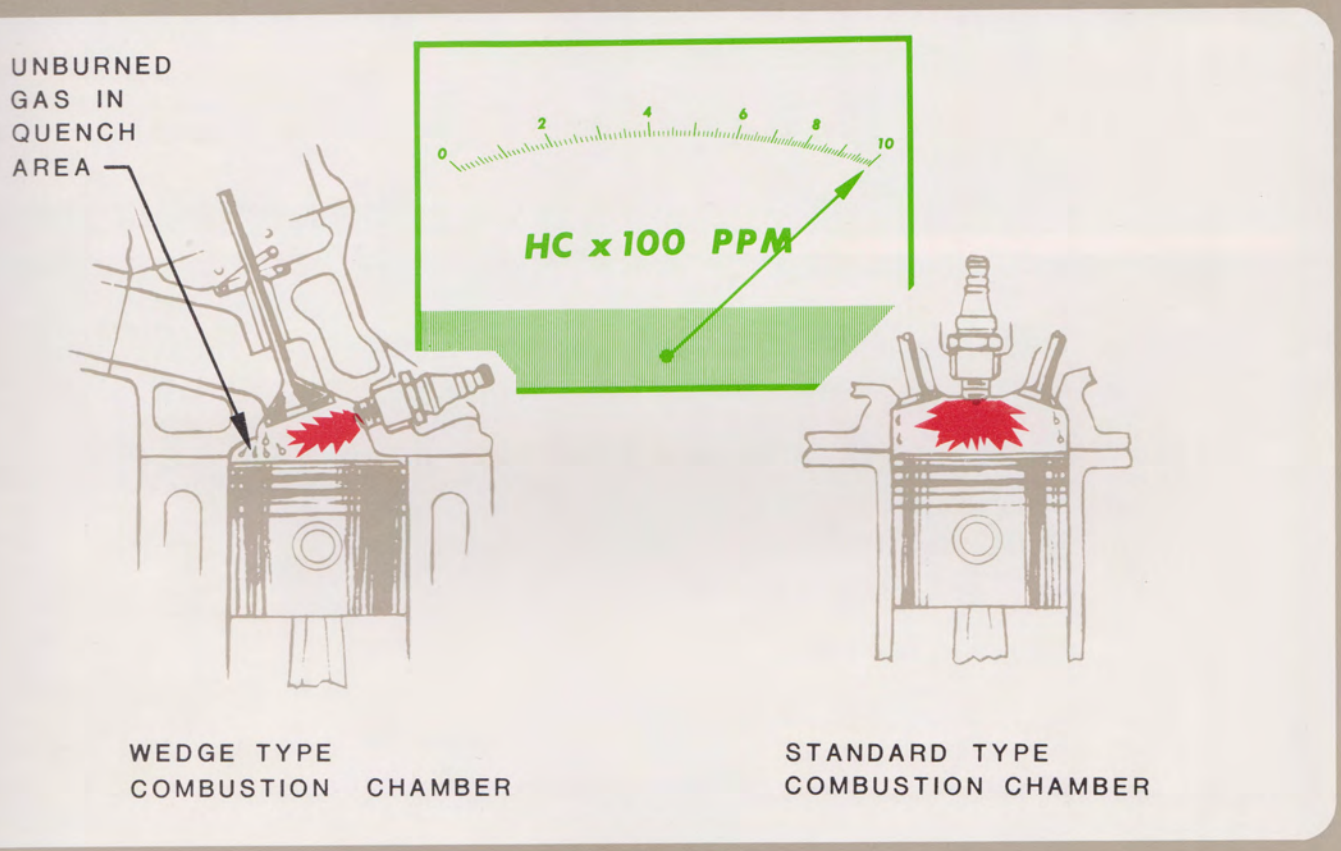
OVER-RICH MIXTURE OCCURS DURING DECELERATION

During deceleration, hydrocarbon emissions increase when the throttle plate snaps shut. Manifold vacuum rapidly increases, and liquid fuel on the manifold walls vaporizes. It's similar to evacuating an air conditioning system with a vacuum pump - like the moisture in the A/C system, the fuel on the manifold walls vaporizes or boils off. Too rich to burn, the gasoline vapor passes out the tailpipe as hydrocarbon emissions.



QUENCH AREAS CAUSE **HIGH** HYDROCARBONS

Quench areas cause hydrocarbon emissions, too. When a spark plug fires, a "flame front" spreads to all corners of the combustion chamber. To keep the "flame" going the fuel must remain above a certain temperature. Yet the combustion chamber, surrounded by the water jacket, is constantly being cooled, and the mixture in the area nearest the chamber surface is coolest, too cool, in fact, to ignite. The unburned gasoline leaves the tailpipe as hydrocarbon emissions. There are even more emissions if the combustion chamber configuration includes thin pockets or wedges.

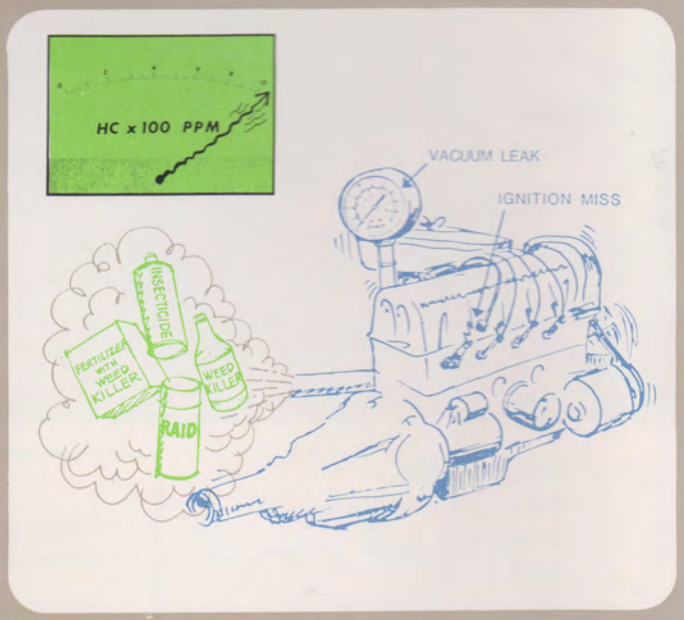


WEDGE TYPE COMBUSTION CHAMBER

STANDARD TYPE COMBUSTION CHAMBER

ENGINE MISFIRE
is a major source of hydrocarbon emissions

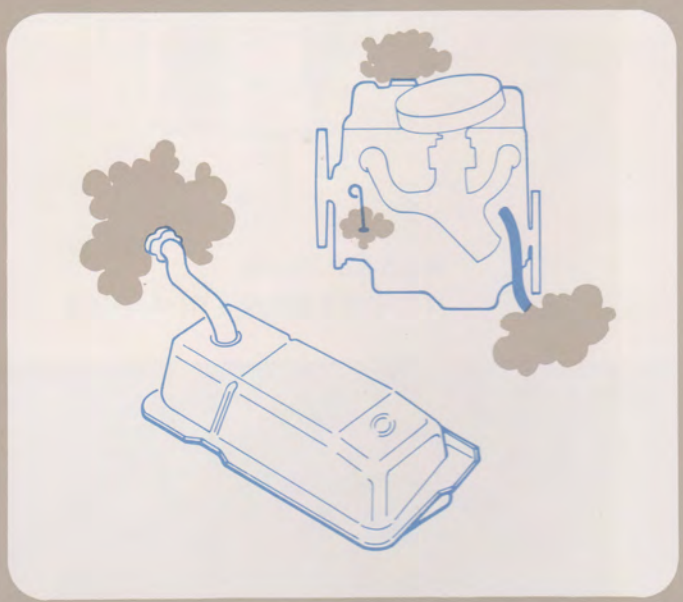
Another cause of HC emissions, and a very common one, is any form of cylinder "miss". If there is no spark, or a poor spark, the fuel charge never ignites in the cylinder and goes out the tailpipe. A defective carburetor or a vacuum leak may produce a mixture too lean to burn, and the same thing happens.



CRANKCASE VAPORS AND EVAPORATIVE EMISSIONS

Crankcase vapors consist of combustion blow-by and oil fumes, both of which are mostly HC. If these fumes are vented to the atmosphere, HC pollution results.

Inside the fuel tank, gasoline tends to vaporize, enriching the air in the tank with HC. Still, the tank must be vented to allow for expansion and contraction. If this gasoline vapor is vented to the atmosphere, HC pollution is unavoidable.

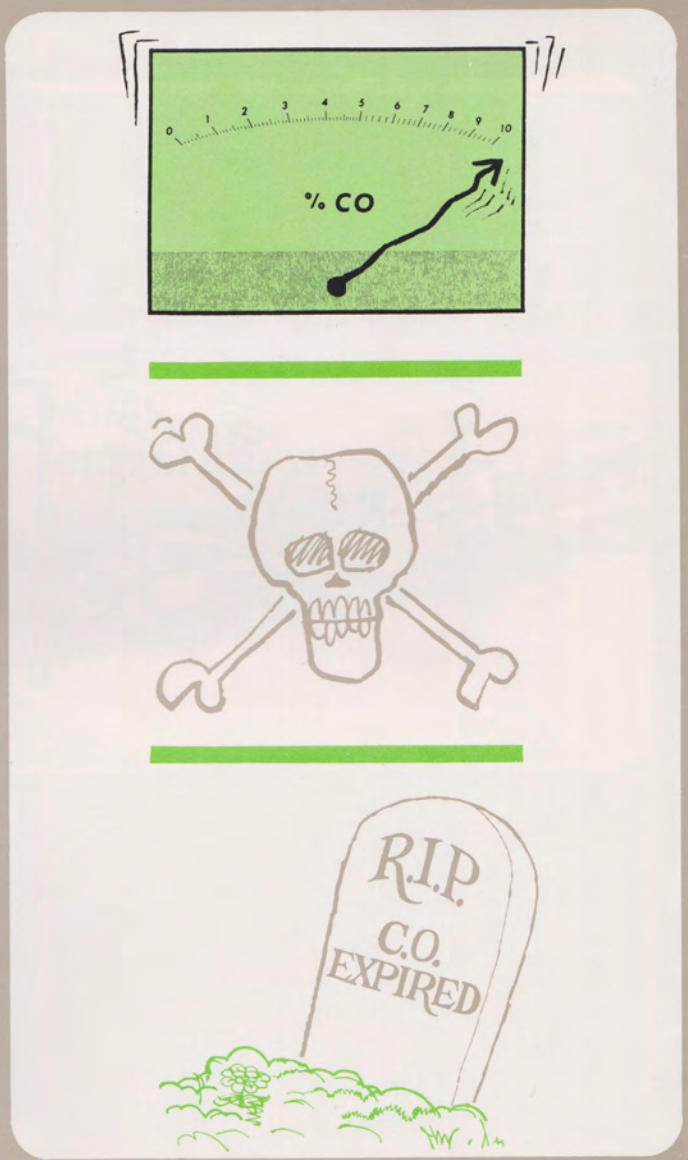


WHY CARBON MONOXIDE FORMS

CARBON MONOXIDE (CO) IS A DEADLY GAS

It's odorless, invisible and can be lethal if inhaled.

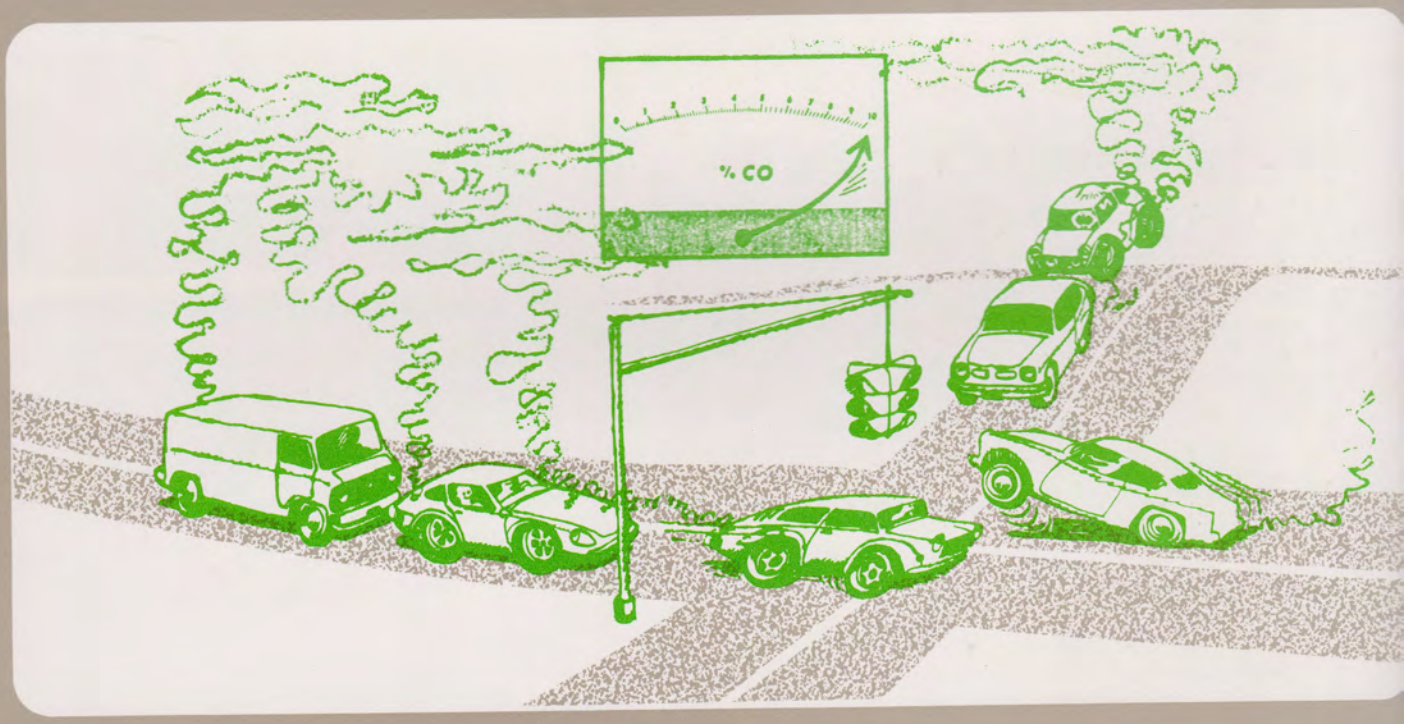
CO can only be caused by a rich fuel/air mixture. Complete combustion doesn't cause CO, only safe CO_2. A too rich fuel/air mixture can't supply enough oxygen for the amount of gasoline, and this causes CO. To avoid lean-running problems, such as surging, most fuel systems provide slightly more gasoline than is really needed. The price of this "insurance" is slightly higher CO emissions.



RICH MIXTURE CAUSES CARBON MONOXIDE (CO)

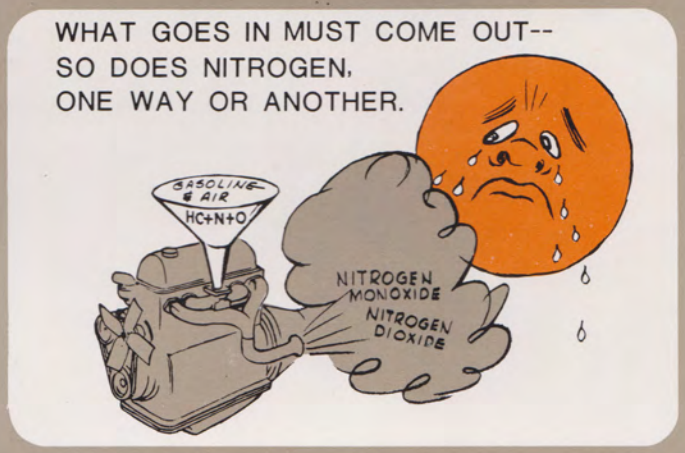
Whenever a richer-than-normal mixture is produced, such as during heavy-load operation and at deceleration, CO emissions increase.

Excessive CO levels are almost always caused by faulty carburetion or fuel injection systems. On the other hand, CO is never produced by cylinder misfire. No burning occurs during misfire, and CO is only produced by PARTIAL or INCOMPLETE burning.



WHY NO_X FORMS

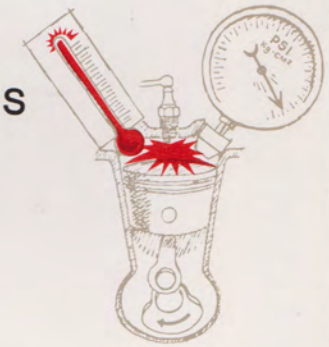
The group of compounds referred to as nitrogen oxides, or simply NO_X for short, are not really a natural by-product of combustion. You see, NO_X forms just AFTER combustion and ONLY if the pressures and temperatures are both very high. It seems that combustion temperatures of about 2800 degrees and above cause large amounts of NO_X to form.



OXIDES OF NITROGEN ARE FORMED in the combustion chamber...

Controlling NO_X emissions is very difficult, since the only presently practical method is to lower the compression and the peak temperature of combustion. But the automobile engine is a "thermal converter," that is, it releases gasoline energy in the form of heat. It uses this heat, in the form of expanding gases, to push the pistons down to propel the car. If we artifically lower the compression and peak combustion temperature, then we are not using all of the gasoline's available energy, lowering engine efficiency.

when temperature and pressures are too high...

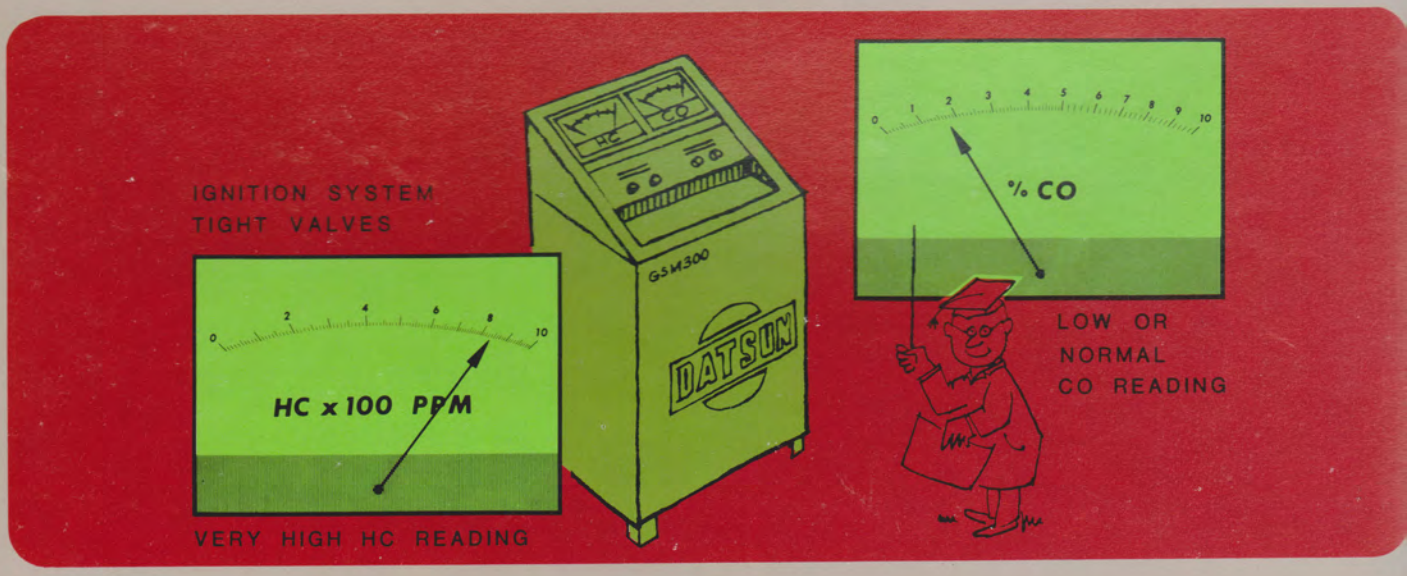


Oxides of Nitrogen cause eyes to sting!

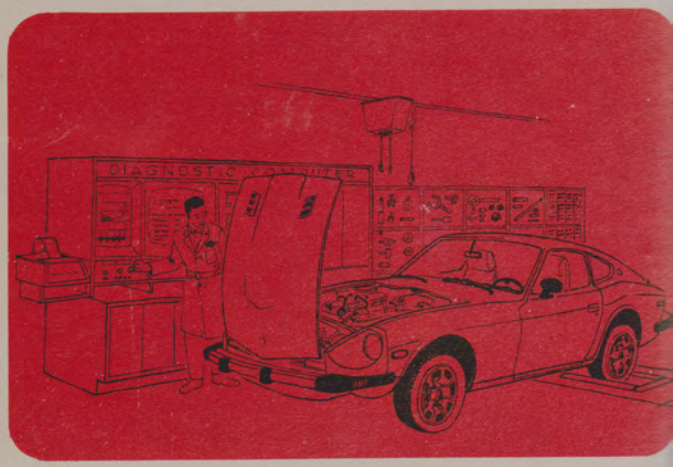


THE DIFFICULTIES OF EMISSION CONTROL

Controlling automotive pollutants is a complex task. You see, almost everything we do to limit HC and CO formation will cause an engine's NO_x output to go up. Conversely, most methods of limiting NO_x cause an increase in HC and CO, and a decrease in engine efficiency.



Add to this never-ending circle the additional requirements of smooth driveability, good performance and stingy fuel economy, and you can better appreciate the problems facing automotive engine designers.



MEASURING EMISSIONS

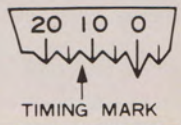
The method used to measure the exact amount of automotive exhaust pollutants is called Constant Volume Sampling, or CVS for short.

The results of this procedure are used by manufacturers and the government to determine if a particular vehicle conforms to Environmental Protection Agency requirements. Here's how it works:

VEHICLE EMISSION CONTROL INFORMATION

THIS VEHICLE CONFORMS TO U.S.E.P.A. REGULATIONS APPLICABLE TO 1977 MODEL YEAR NEW MOTOR VEHICLES FOR SALE AT ELEVATIONS EQUAL TO OR LOWER THAN 1,219 METERS (4,000 FEET).

- ENGINE FAMILY: L200F, 119.1 C.I.D.
- EXHAUST EMISSION CONTROL TYPE: A.I.S.+E.G.R.
- ENGINE TUNE UP SPECIFICATIONS AND ADJUSTMENT
  - *AT NORMAL OPERATING TEMPERATURE
  - *LIGHTS AND AIR CONDITIONER OFF



TRANSMISSION	AUTOMATIC	MANUAL
IDLE SPEED	600 R.P.M. (D)	600 R.P.M. (N)
IGNITION TIMING	12° B.T.D.C.	
IDLE MIXTURE SETTING	CO 1.0 $^{+1.0}_{-0.7}$ % WITHOUT AIR INJECTION	
ALTERNATIVE LEAN IDLE DROP	1. SET BEST IDLE TO: 650 R.P.M. (D) | 650 R.P.M. (N) 2. TURN IN MIXTURE ADJUSTMENT SCREW UNTIL: 600 R.P.M. (D) | 600 R.P.M. (N)	
VALVE LASH	INTAKE : .25 MM (.010 IN)—HOT EXHAUST: .30 MM (.012 IN)—HOT	

INERTIA WEIGHT (FOR EMISSION TEST): 2,750 LBS

14805 N5900 NISSAN **NON CATALYST** NISSAN MOTOR CO., LTD. L20B ㉑

The tests are run inside an insulated room, so that the temperature of the vehicle and the surrounding air can be closely controlled. Before the actual test begins, the vehicle is weighed and the dynamometer is calibrated accordingly, thus duplicating actual driving conditions. After the tailpipe has been sealed to the sampling machine's intake, the test begins. It lasts about forty minutes.

THE INERTIA WHEEL WEIGHT
FOR EMISSION TEST ON THIS VEHICLE SHOULD BE

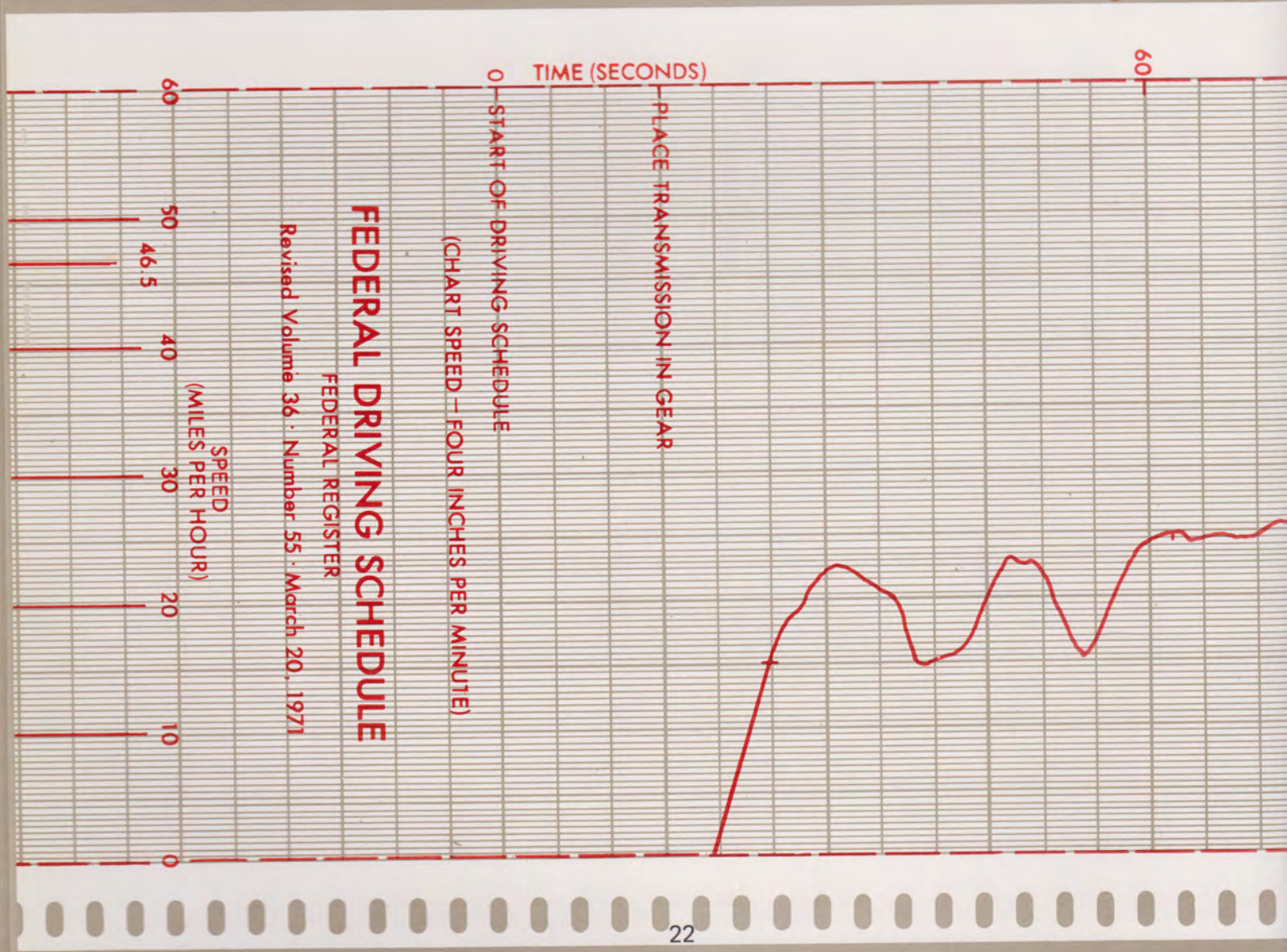
2750 lbs

NISSAN NISSAN MOTOR CO., LTD.

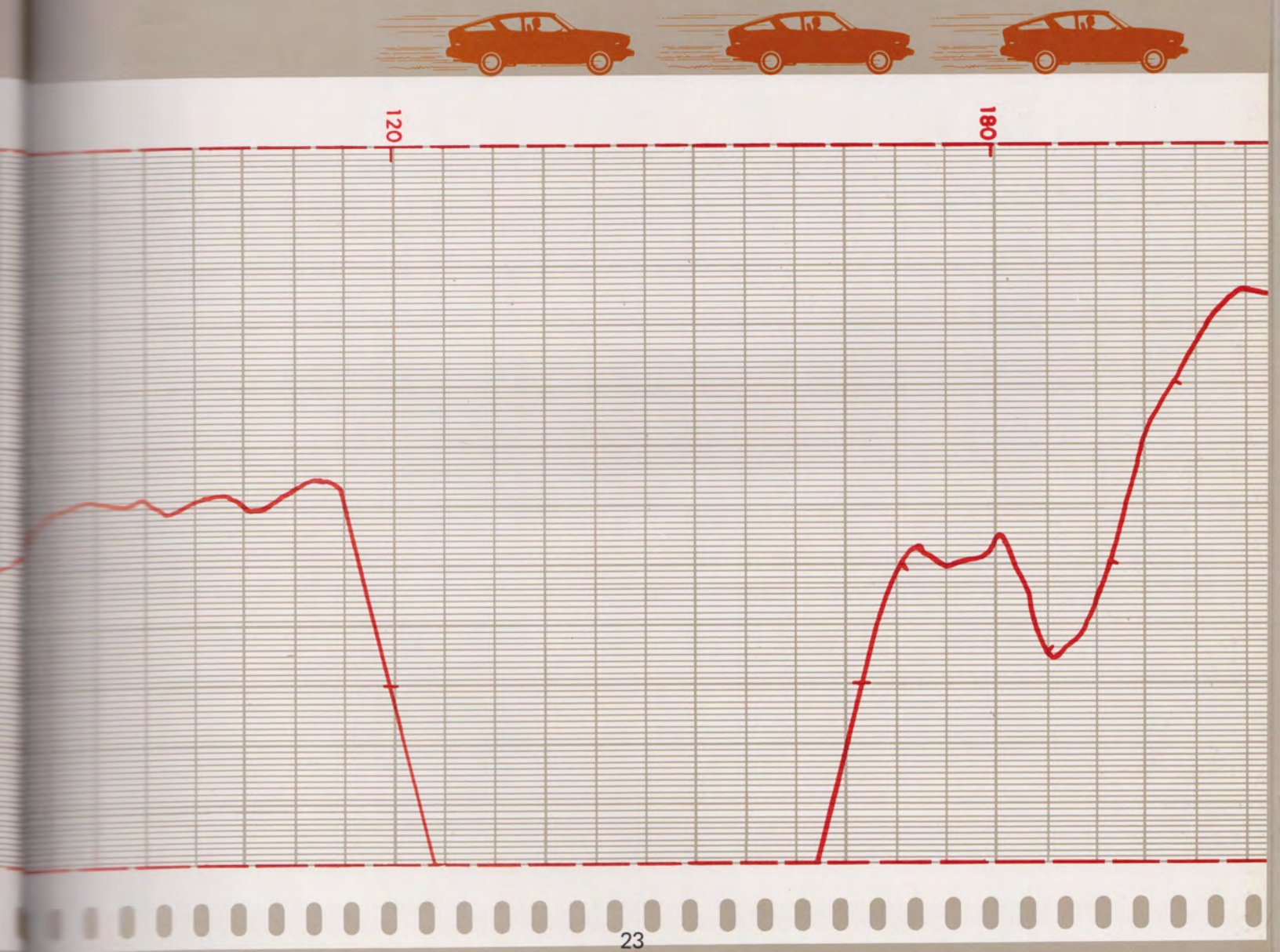
CVS SPEED TEST

During the test, the car is started cold and driven through the full range of driving modes: idle, acceleration, cruise, and deceleration. Then, after a ten minute hot soak with the engine off, the car is driven through another different sequence of the four operating modes. To insure that the cycles are identical during each test run, the actual vehicle speed is superimposed over a graph of the standard speeds required by the test procedure. If the driver deviates from the standard speed by more than one mile per hour, for more than a certain number of seconds, the entire test must be redone.

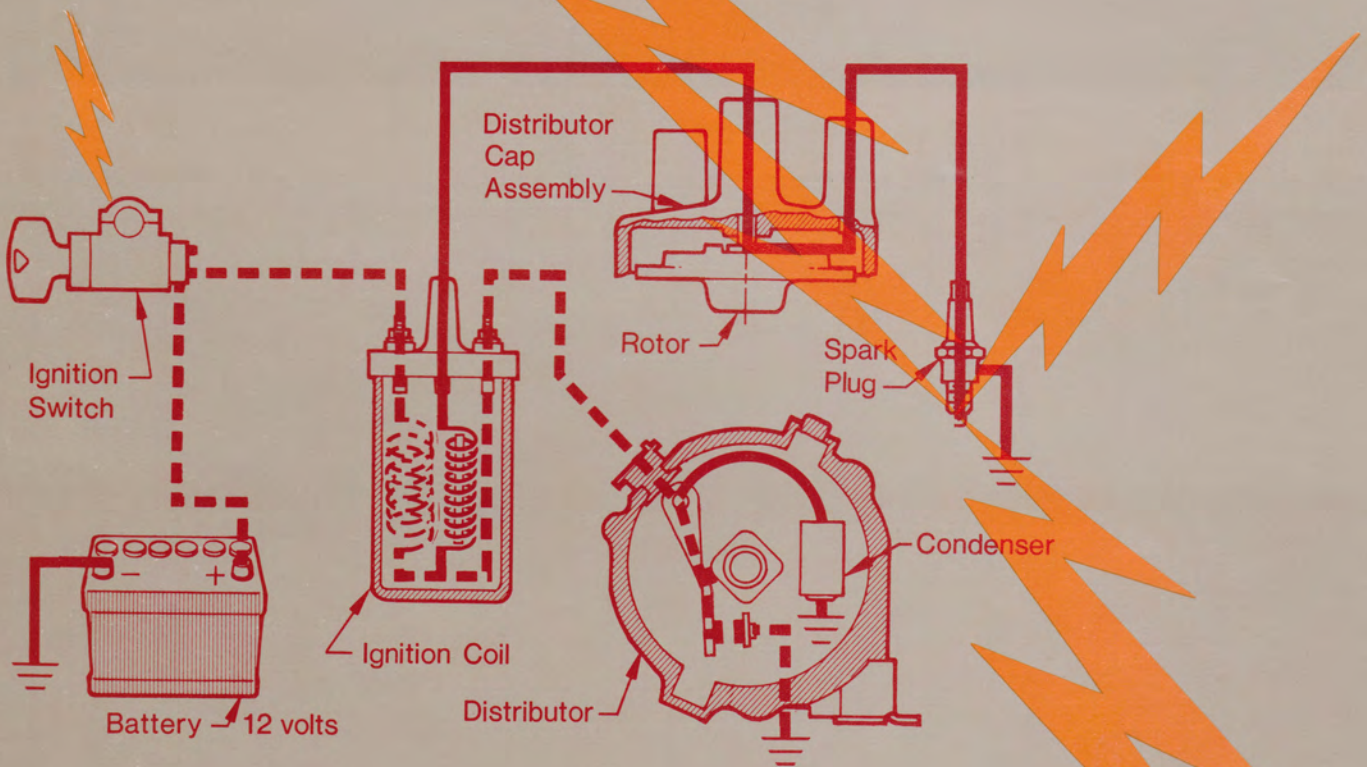




A certain amount of the exhaust is collected in large plastic bags while the car is running. Also, a sample of the ambient (surrounding) air is collected in separate bags. The ambient air is analyzed for pollutant content, and this measurement is used as a correction factor during analysis of the exhaust gases in the bags. After this pollutant content has been found, a standard mathematical formula is used to determine the vehicle's output of pollutants in grams per mile.

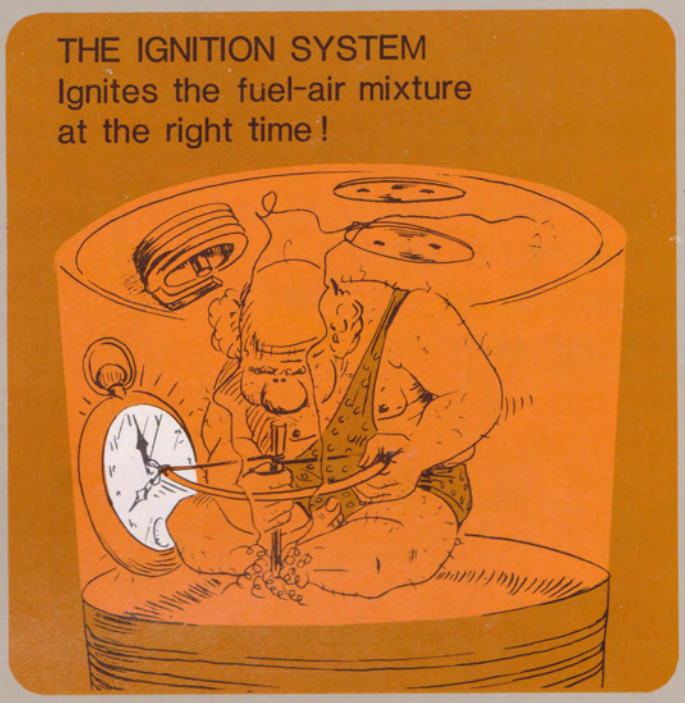


THE IGNITION SYSTEM

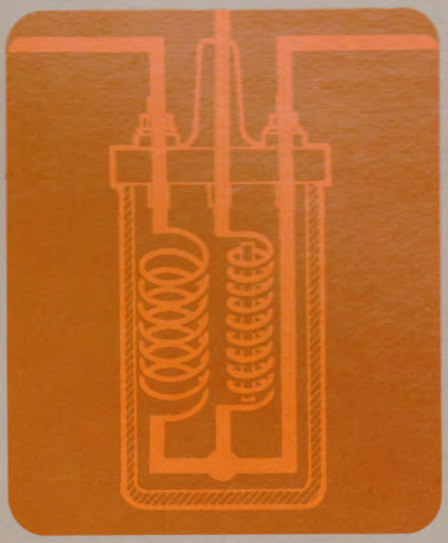


Although we usually don't think of the Ignition System as an emission control device, it really does play an important role in controlling exhaust pollution.

In order to better understand the ignition system, you have to remember why it's on the car in the first place. It actually does two jobs. First, it supplies the spark that begins the combustion process. In order to make this so-called electrical fire or spark, we have to create a voltage which is so high that it will push current across an air gap. The second job of the system is to supply this high voltage at exactly the right time for each cylinder, so that combustion can be as efficient as possible.

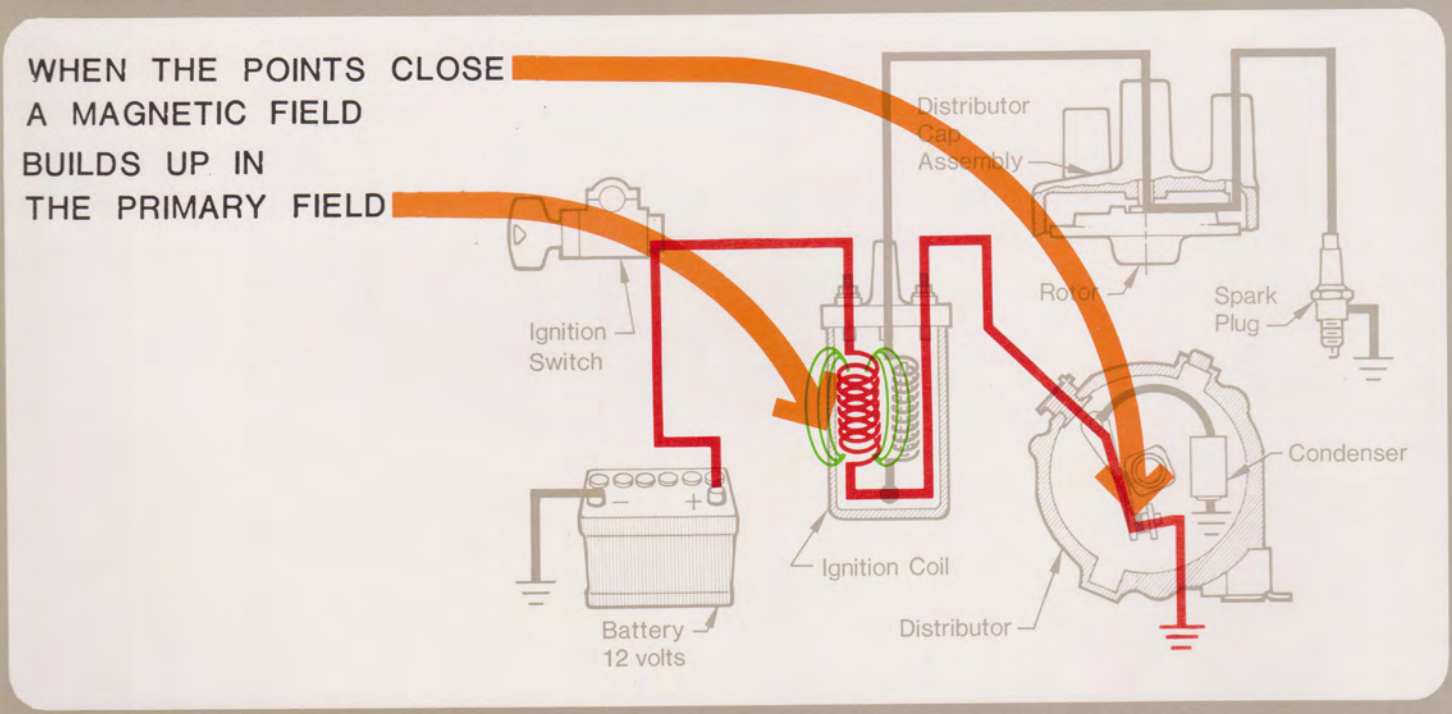


THE COIL SUPPLIES HIGH VOLTAGE



The coil does the job of supplying the high voltage which is needed to push current across the spark plug gap. Actually, the coil is what we call a transformer - that is, it transforms battery voltage into very high voltage. Because it increases the voltage, it is called a step-up transformer.

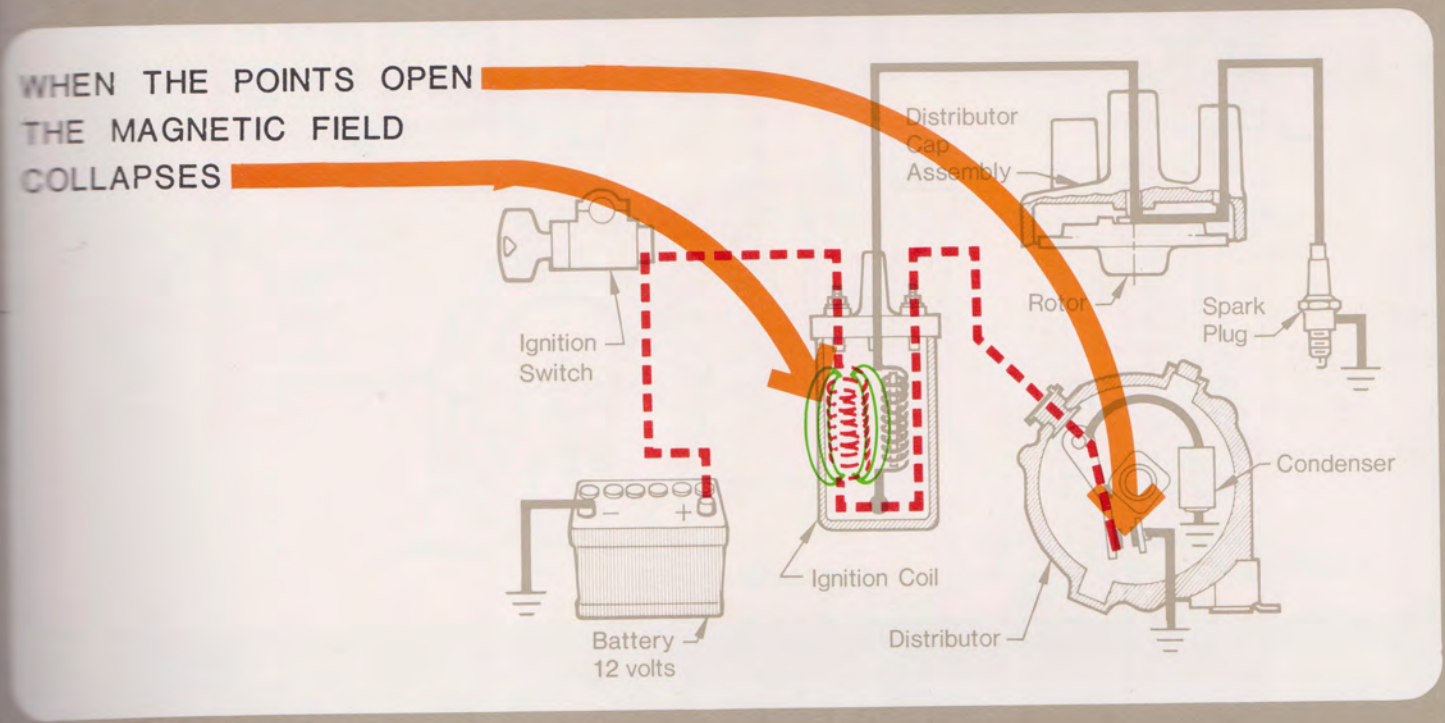
The coil contains two windings of wire called the primary and secondary. The primary winding is made up of a few hundred turns of fairly large diameter wire, so that its resistance is not too high. The secondary winding is made up of many thousandths of turns of very fine wire, so its resistance is much higher than that of the primary winding.



When you turn the ignition key on, current flows from the ignition switch to the primary winding. After passing through the primary winding on the coil, the primary current flows to the distributor and goes to ground across the breaker points. Now we have a complete circuit from the ignition switch, through the coil, to ground at the breaker points. Since we have current passing through a coil of wire, a magnetic field is built up around the coil - just as in a relay coil or in a solenoid.

WHEN THE POINTS OPEN THE MAGNETIC FIELD COLLAPSES

When the distributor cam turns, it pushes the breaker points open. This causes the current flow to stop. In turn, the magnetic field in the coil collapses. When the field collapses, the magnetic lines cross the secondary winding of the coil. This winding is made up of many thousand turns of very fine wire.



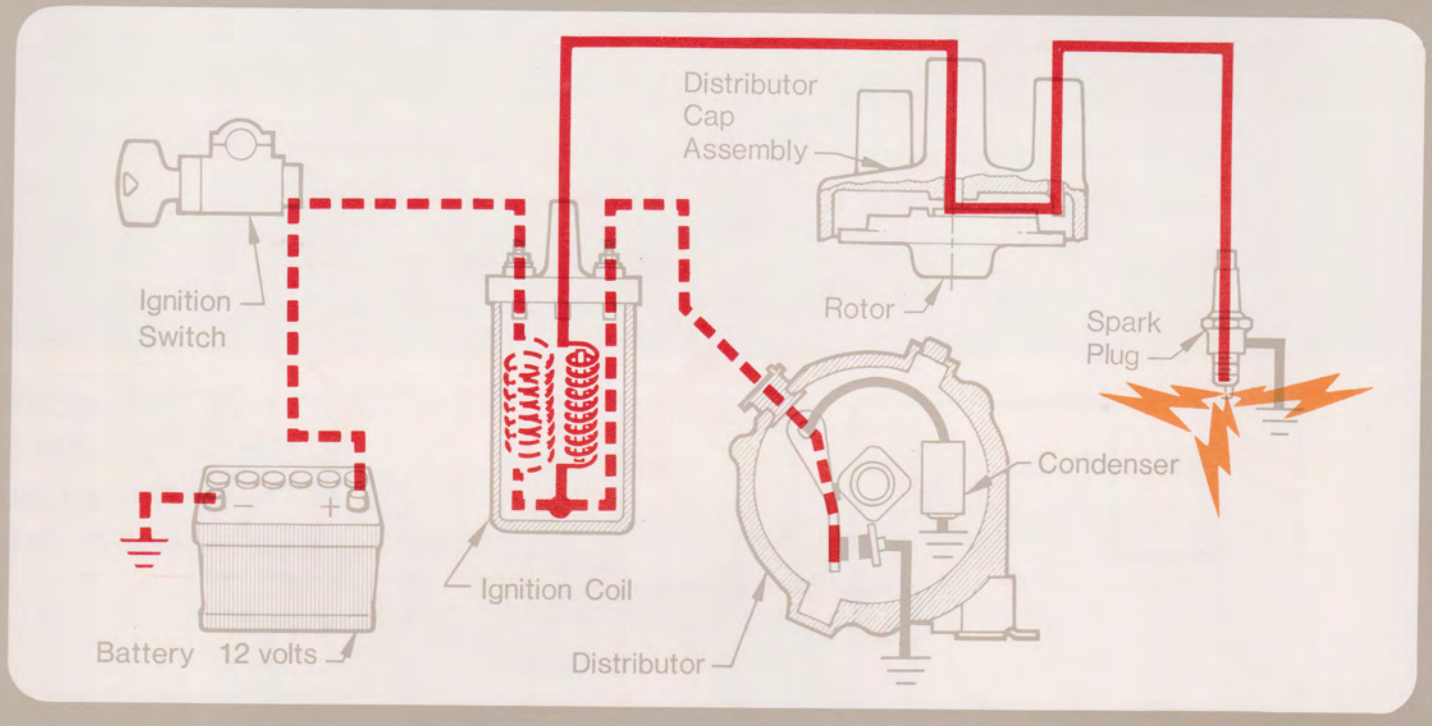
Movement of the magnetic field creates current in the secondary field



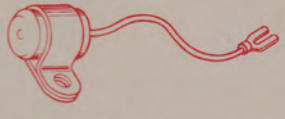
Now, if you've studied the alternator, you will remember that anytime we move a magnetic field past a wire, we will create a current in the wire. This is what happens in the secondary winding. The voltage of this secondary current is much higher than the primary circuit voltage. In fact, it mounts to several thousand volts. The amperage, on the other hand, is decreased from about four or five amperes to a few thousandths of one ampere.

HIGH VOLTAGE GOES TO THE SPARK PLUGS

This high voltage now leaves the coil tower and goes to the distributor, which distributes the spark to each cylinder. The rotor directs the spark to the proper distributor tower and thus to each of the spark plugs.

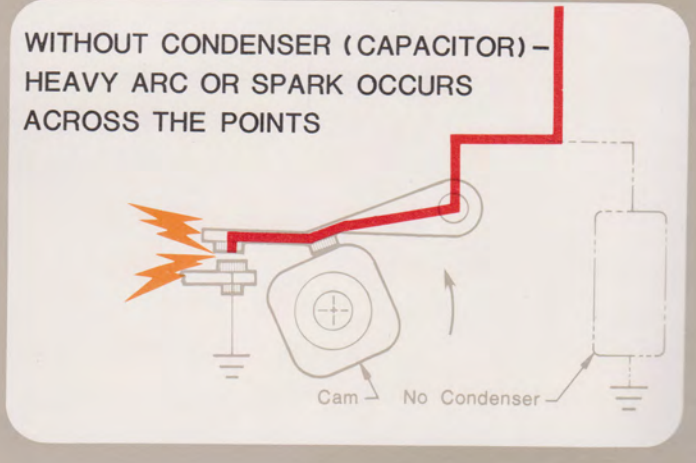


WHAT IS THE CONDENSER FOR?



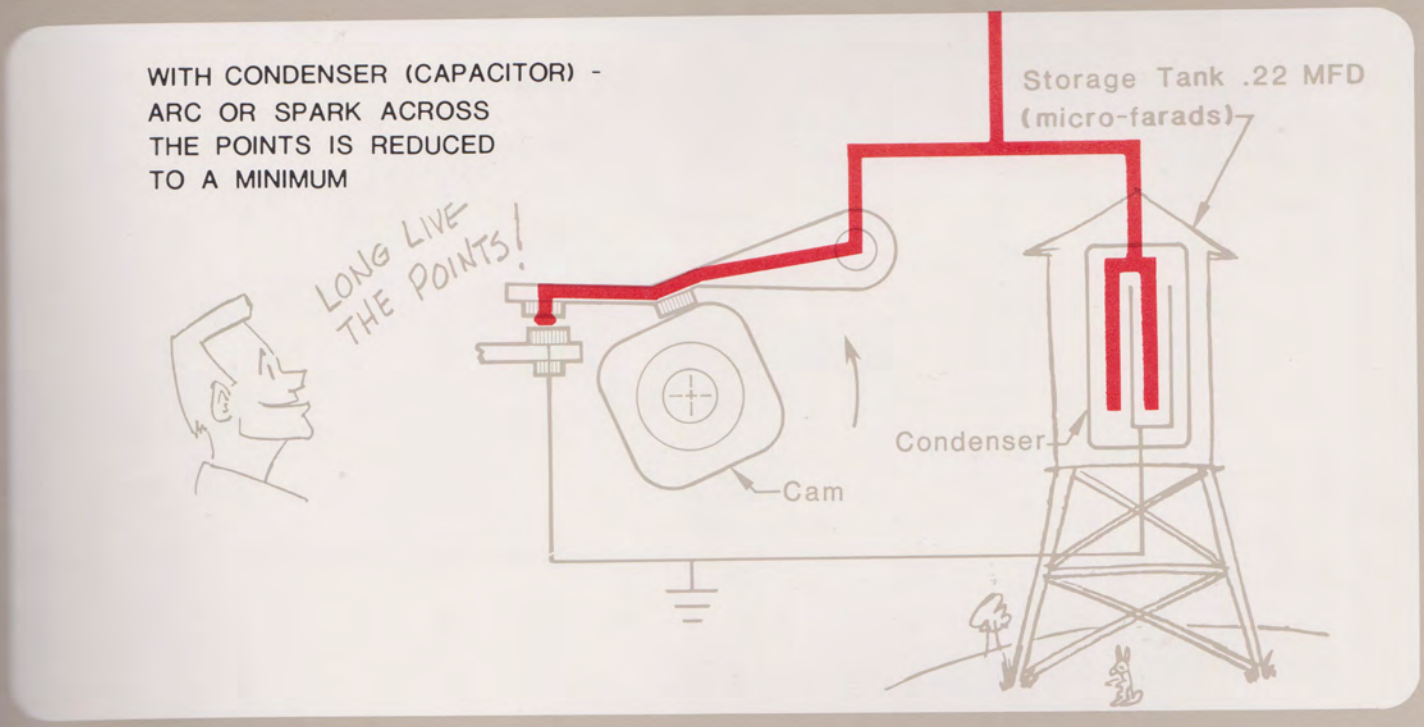
What is the condenser used for? Actually, it has two purposes. First, it protects the points from burning. Let's see how this happens.

When the points first start to open, the current flowing through them tends to form an arc. This arcing would tend to burn the points and thus reduce their life.



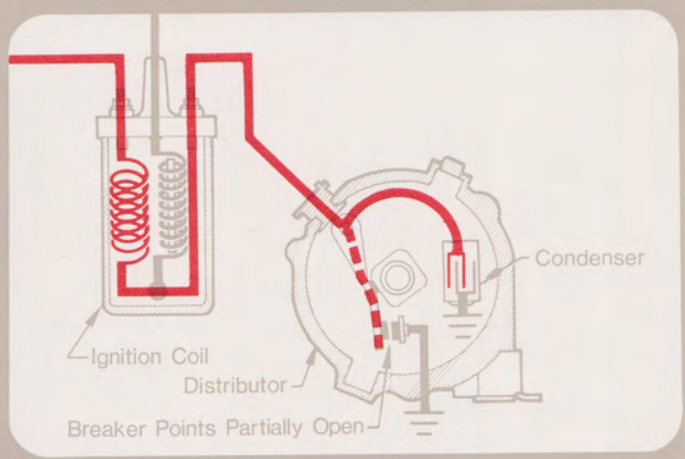
THE CONDENSER IS AN ELECTRICAL STORAGE TANK

A condenser, or capacitor, is an electrical storage device which can store a certain amount of electricity. Condensers come in different sizes, and the amount of electricity which they can store is measured in micro-farads. The condensers used in most Datsuns are rated at twenty-two hundredths of a micro-farad.



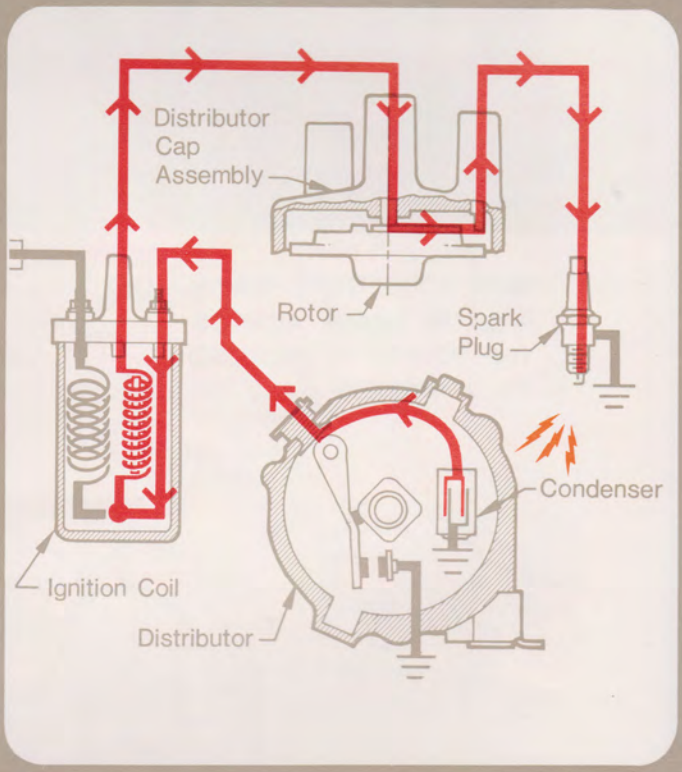
WHEN POINTS OPEN, current surges into the condenser

Here's what the condenser does when it's installed between the coil and the points. When the breaker points start to open, the current continues to flow - but not across the points. Instead, it surges into the condenser and actually fills it up. By the time the condenser is filled up all the way, or fully charged, the points have opened so far that twelve volts is not enough to push a spark across them, so little arcing occurs.



CONDENSER CAUSES HOTTER SPARK

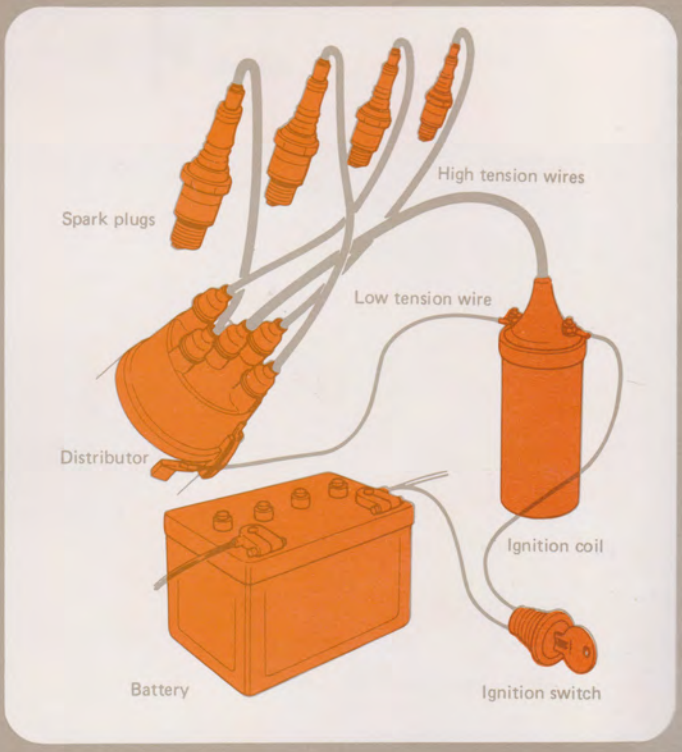
The condenser also serves another purpose. Once the condenser is charged, no more current will flow – so the current flow through the primary winding is stopped immediately. Without a condenser, the current would not stop abruptly, but would taper off as the points opened and the spark across them died out. With an abrupt stopping of the current flow, the magnetic field collapses much more rapidly, so that the voltage which is built up in the coil secondary winding is much greater – so the condenser makes for a hotter spark.



BALLAST RESISTOR

There are other parts to an ignition system. First, why is a ballast resistor installed in the car?

On early ignition systems, full battery voltage was applied to the coil, and the coil was built to work on full battery voltage. But, this system had disadvantages, especially in cold weather. With the ignition key in the "start" position and the starter cranking, battery voltage could drop excessively, producing a weak spark just when a stronger spark was needed.



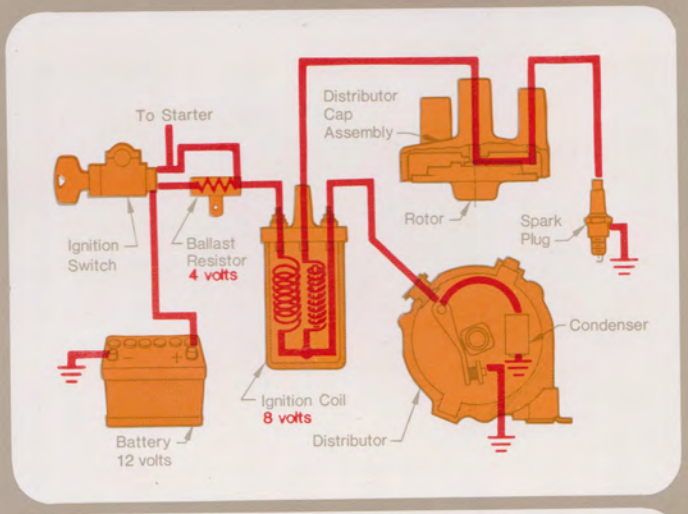
BALLAST RESISTOR reduces operating voltage of coil to approximately 8 volts

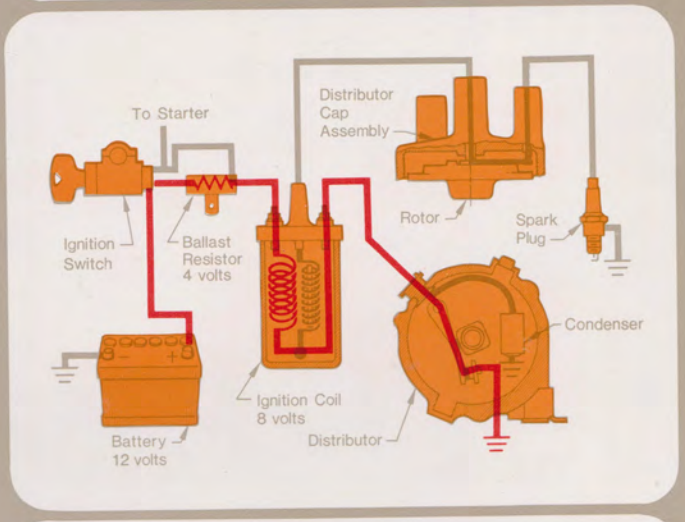
Today's ignition coils aren't designed to function on full battery voltage. They are built to function on eight volts, so nine volts is plenty of power to create a hot spark during cranking.

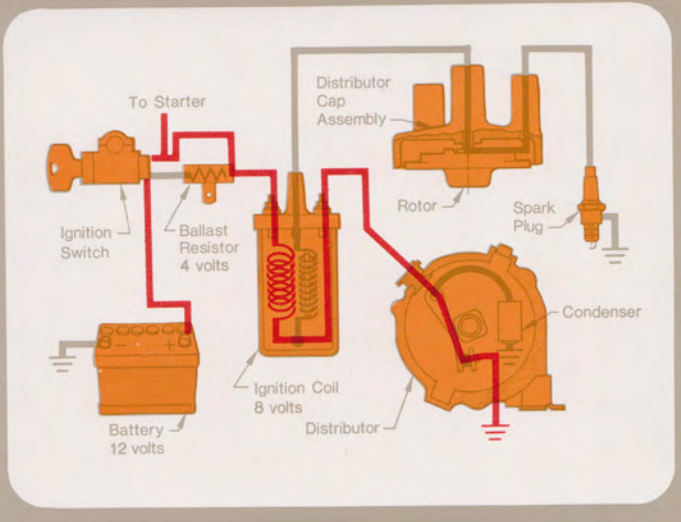
Car manufacturers have installed a ballast resistor in series with the ignition coil to accomplish the reduction.

Once the engine starts, the voltage, with the alternator running, can go as high as fifteen volts. To protect the coil, a ballast resistor is installed in the line from the ignition switch to the coil. When the engine is running, current must flow through this resistor and the voltage is dropped.

On the other hand, during cranking, current passes from the "start" side of the ignition switch directly to the coil, bypassing the ballast resistor. The end result is that there is the right amount of voltage at all times.

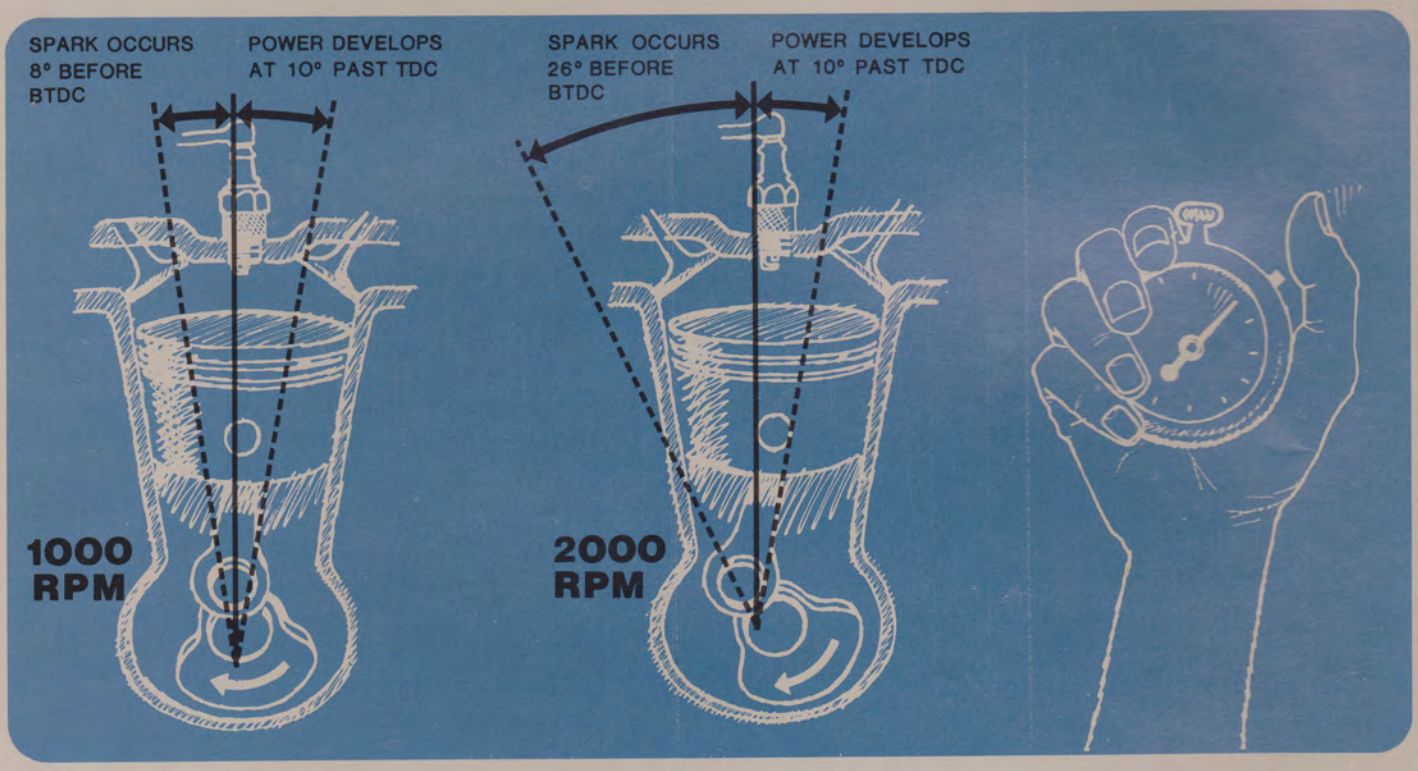






CENTRIFUGAL (MECHANICAL) ADVANCE

Now let's look at the centrifugal and vacuum advances. Each of these modifies the engine timing for different reasons, to suit different driving conditions.

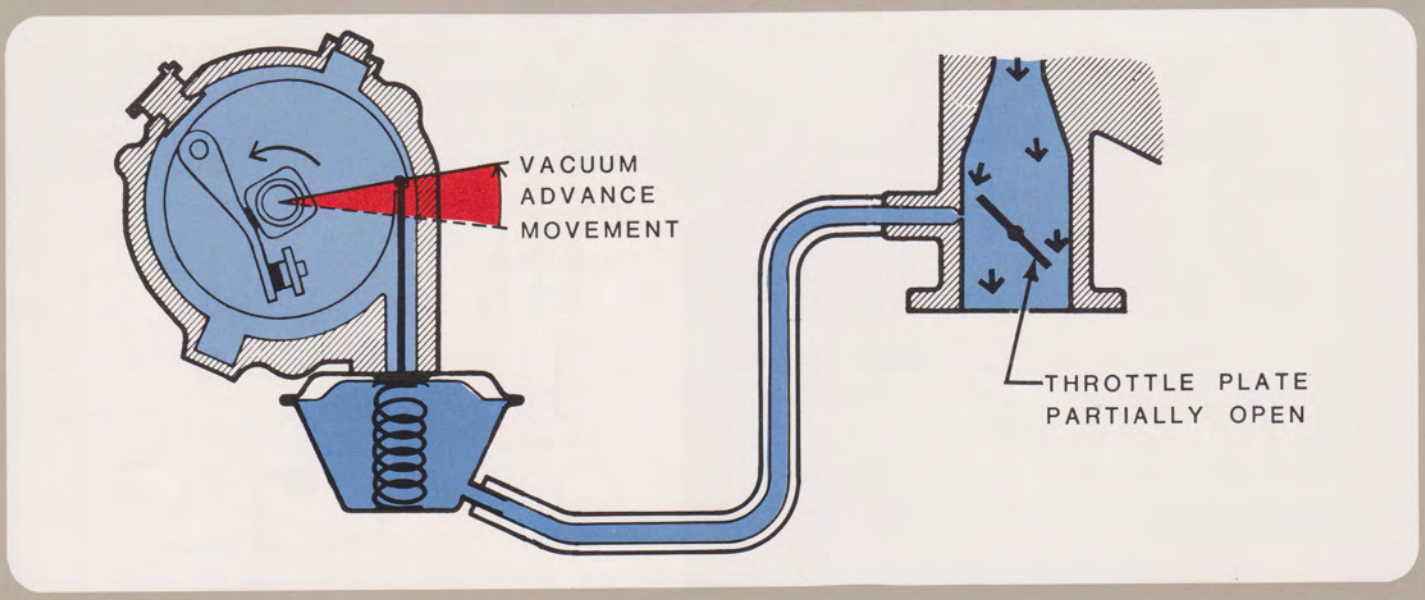


First, the centrifugal advance causes the timing to advance as the engine speeds up. You see, if engine load remains the same, combustion takes the same amount of time at one thousand RPM as it does at two thousand RPM. However, since the engine is moving faster at higher speeds, there is less time between strokes. Without an advance mechanism to compensate, the combustion would begin to lag behind the piston, and combustion would take place after the piston had started moving downwards, and power would be lost.

The centrifugal advance causes the spark to occur earlier as engine speed increases, so that when the piston gets to top dead center, there has been enough time for combustion to take place and the power is at its peak.

VACUUM ADVANCE

Vacuum advance is supplied to modify the timing according to the quantity of fuel and air in the cylinder. During hard acceleration, the throttle plate is wide open and the cylinders are well filled with fuel and air. Therefore, the gasoline particles, or molecules, are very close together in the combustion chamber. This means that the flame front, or burning, will pass through the chamber very quickly - one particle of gasoline will ignite the next and so on.



However, during periods of high manifold vacuum, the throttle plate is limiting the amount of mixture which reaches the cylinders. The particles are, therefore, farther apart in the combustion chamber, and this means that it takes longer for the complete burning to take place. Therefore, the vacuum advance allows the timing to advance during periods of part throttle, high vacuum operation, and does not affect the timing during periods of low manifold vacuum, such as acceleration.

Full Charge:
FAST BURN
(less advance
needed)





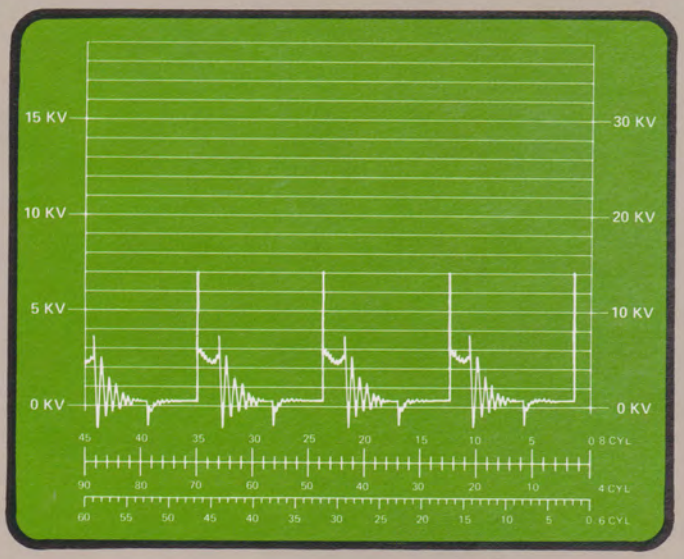
Lean Charge:
SLOW BURN
(more advance
needed)

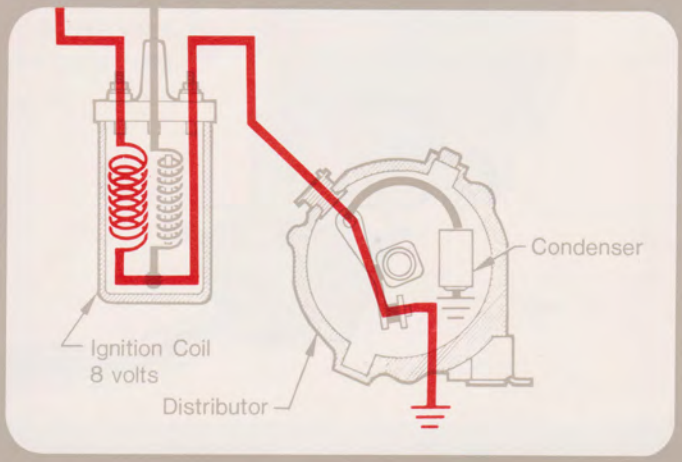
THE MODERN AUTOMOBILE requires a modern ignition system

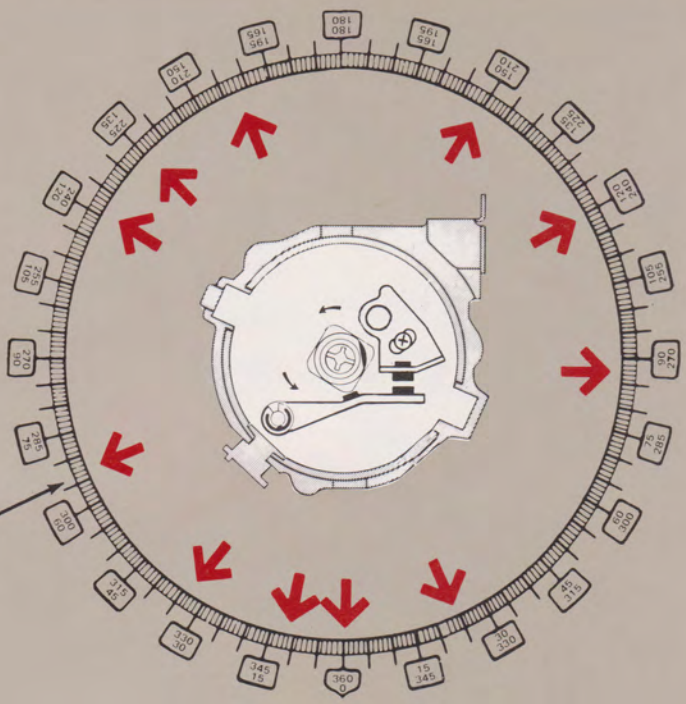
While the conventional ignition system has done an adequate job in the past, it suffers from the following drawbacks:

1. It can consistently supply only about 15,000 volts to the spark plug. With today's higher rear axle ratios, lean mixtures, EGR, and wide specified spark plug gaps, 15KV may not be enough to fire the plugs, and misfire can result. The problem could be lessened by increasing primary circuit voltage. The increase in electrical pressure would force more current through the primary windings, and thus raise the potential secondary voltage. Unfortunately, the points would burn in a very short time due to increased current flow.

2. The breaker points must remain closed long enough for a strong magnetic field to build up in the primary windings. This is called coil saturation. If coil saturation is poor, low secondary voltage results, and the engine might misfire. At high speeds, the points open and close so quickly that proper coil saturation is hampered. The problem is further compounded if the points bounce, or float, at high speed, because this further reduces coil saturation.

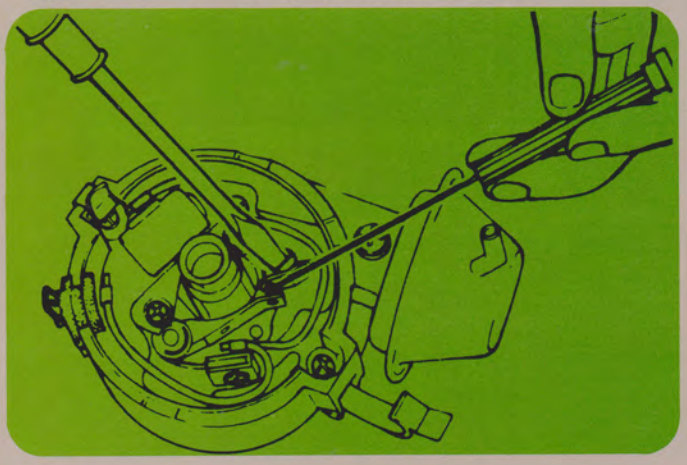






SCALE ON DISTRIBUTOR TESTER

3. Breaker points require frequent adjustment and replacement. This is due to two factors. First, even in normal service, the points will become oxidized. Such oxidation increases primary circuit resistance and lowers secondary voltage, which could cause misfiring to occur. Second, the rubbing block on the movable point arm wears down in service, thus effectively decreasing point gap and retarding ignition timing.



4. The breaker point rubbing block bears against the distributor shaft with approximately 20 to 25 ounces of pressure. This lateral force causes the distributor shaft and bushings to wear, and this results in unaccurate point opening and ignition timing.

The points, then, can be the cause of engine misfire and inaccurate ignition timing. Both of these conditions can cause both poor engine performance and economy, as well as increased emissions.

You can see that most of the problems with the conventional Breaker Point Ignition System are caused by the limitations of the points themselves. If we could find a better way to open and close the primary circuit, the functioning of the other parts of the system would be adequate to ensure proper ignition.





TRANSISTOR IGNITION MADE EASY

Transistor ignition systems offer many advantages over conventional breaker point systems.

1. The transistor system can consistently deliver secondary voltages of over 20,000 volts.

2. There are no contact surfaces to oxidize.

3. There is no rubbing block to wear, so ignition timing should never change.

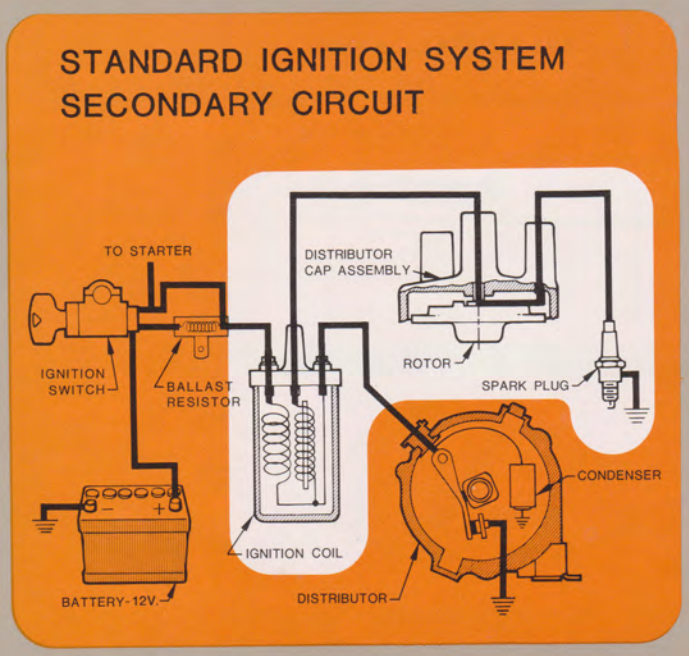
4. There is no mechanical side thrust on the distributor shaft from the points, so distributor bushing life will be extended.

5. There is no possibility of point bounce or float at high speeds.

6. Dwell time can be electronically lengthened at high speed, thus assuring adequate coil saturation.

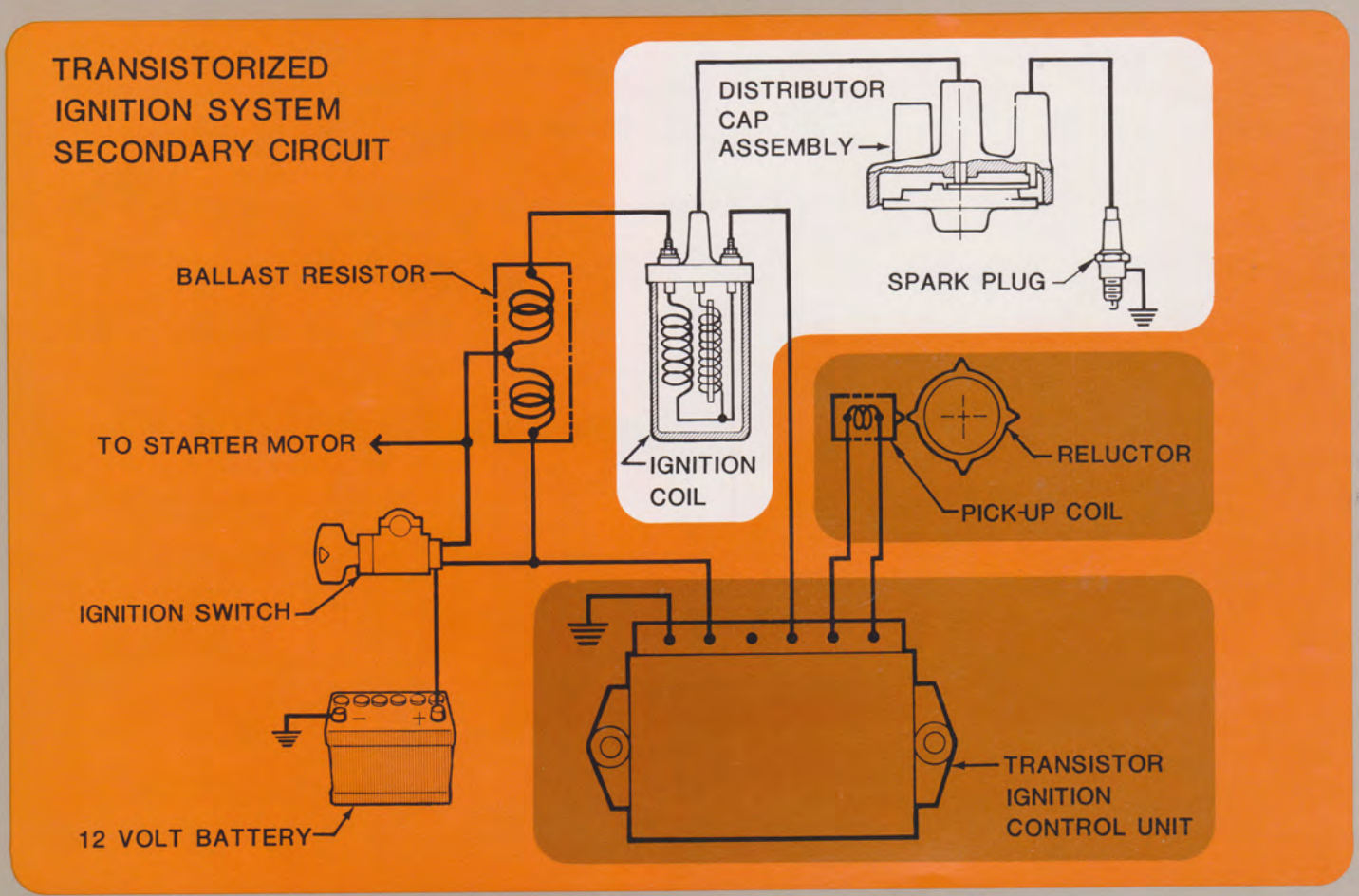
7. Except for spark plugs, no periodic parts replacement is required.

The secondary ignition circuit remains the same as in a conventional system.



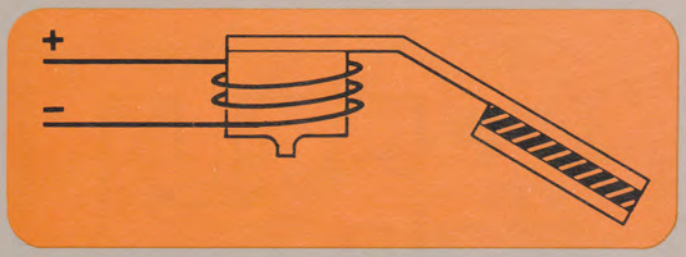
There is really only one major difference between transistor and conventional ignition - there are no breaker points in the Transistor Ignition System. The secondary circuit of the Transistor Ignition System remains identical to the secondary of the conventional system. Let's take a brief look at how the primary circuit ground is controlled in the Transistor Ignition System.

Instead of using breaker points pushed open mechanically by a distributor cam, the Transistor Ignition System uses a special pick-up coil assembly and a special wheel, called a reluctor, which is attached to the distributor cam. Together these parts produce a signal which is sent to the Transistor Ignition Control Unit. It is this unit, often called the "Trig Box" for short, which opens and closes the primary ground.

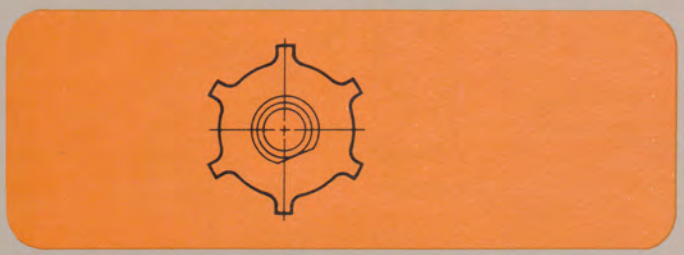


THE PRIMARY IGNITION CIRCUIT
differs slightly from the conventional systems

The pick-up coil assembly contains a permanent magnet, placed near a tooth called the pole piece. A coil of many turns of fine wire is wrapped around the pole piece. Two leads from this winding go to the "trig box".

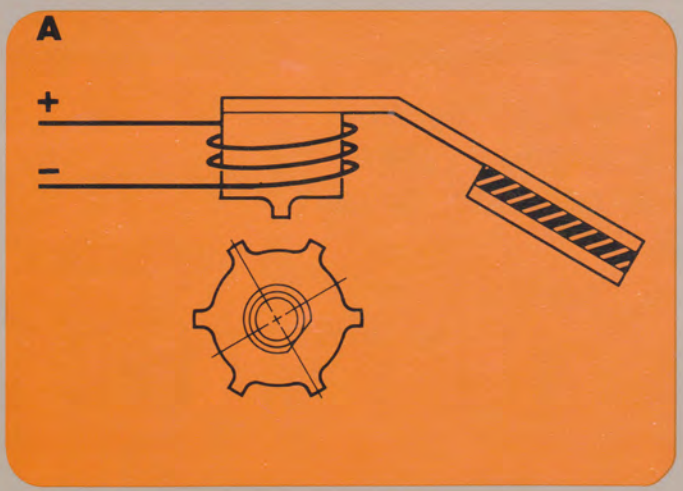


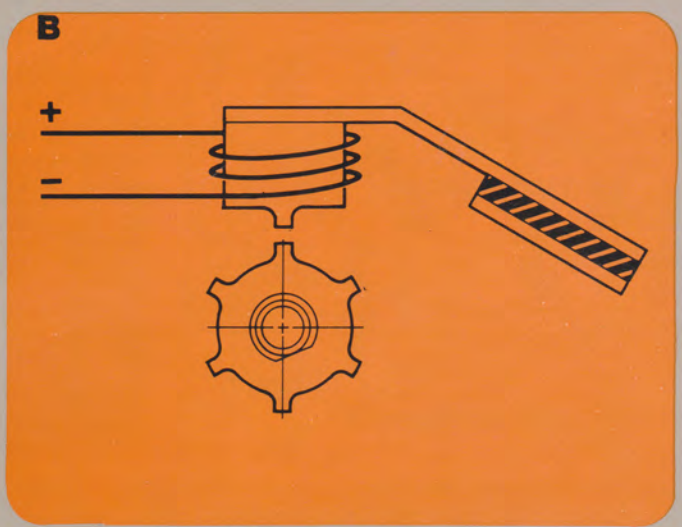
The reluctor is made of soft iron, and has the same number of "teeth" that the distributor cam would have if breaker points were used. Together, the reluctor and the pick-up coil assembly function as a generator.



The magnet creates a magnetic field which is carried by the reluctor. In view A, the metal of the reluctor is far from the pick-up coil pole piece, and has little effect on the pick-up coil.

In view B, as the distributor shaft turns, a tooth passes near the pole piece, bringing the magnetic field close enough to the pole piece to induce a small current in the pick-up coil windings. When the "trig box" receives this signal current, it uses a transistor to electronically break the coil's primary circuit ground. Then, just as with a conventional ignition system, the magnetic field collapses across the secondary coil windings and induces the high voltage spark which is sent to the distributor.

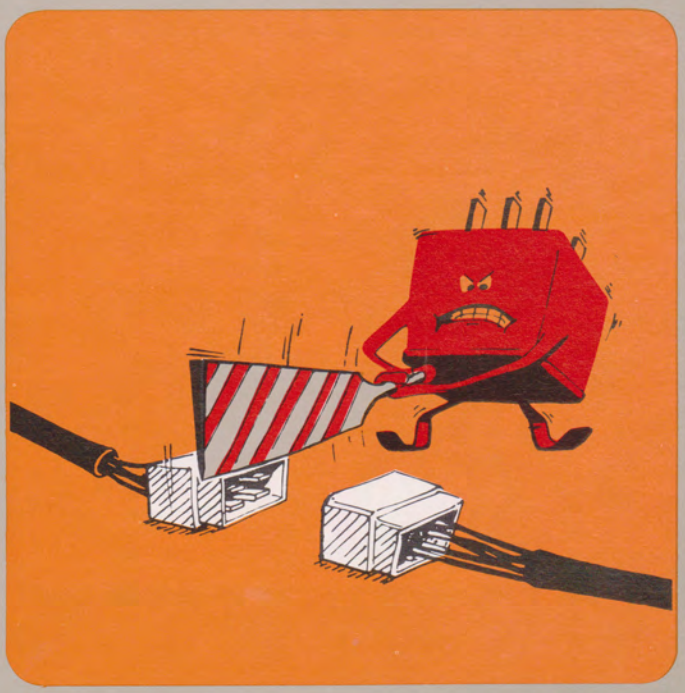




As you may have guessed, the clearance between the reluctor teeth and the pole piece is very important. If the clearance is too large, the signal to the "trig box" may be too weak to trigger the unit. And, if the clearance is too small, the reluctor teeth might butt the pole piece, damaging both components.

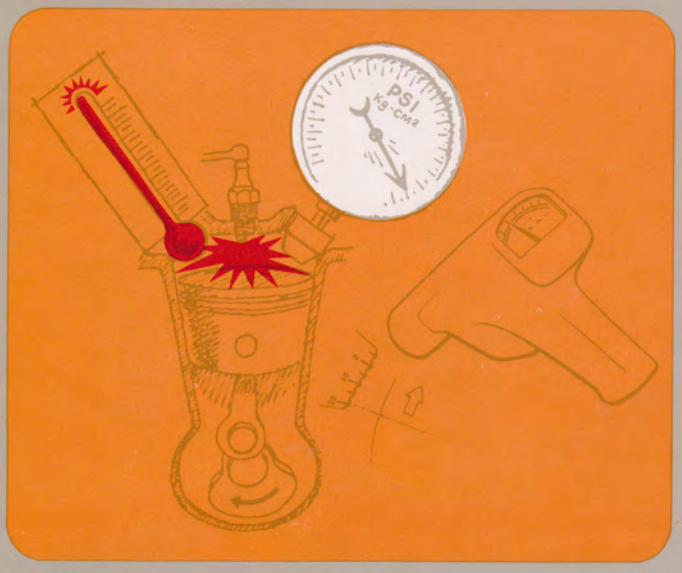
TRIG BOX
opens and closes primary ignition circuit electronically

Since the "trig box" opens and closes the primary ignition circuit electronically, there are no points to oxidize, burn, or otherwise deteriorate. The primary circuit can operate with a higher current flow, permitting the higher secondary voltages needed by modern engines. Also, the "trig box" can electronically lengthen "dwell time", assuring adequate coil saturation even at high speed. So, assuming that the rest of the secondary circuit (rotor, distributor cap, wires, plugs) is in good condition, ignition misfire is virtually eliminated as a source of performance and emission problems. Finally, transistor ignition protects the catalytic converter, since misfire could cause the catalyst to overheat (more about catalytic converters later).



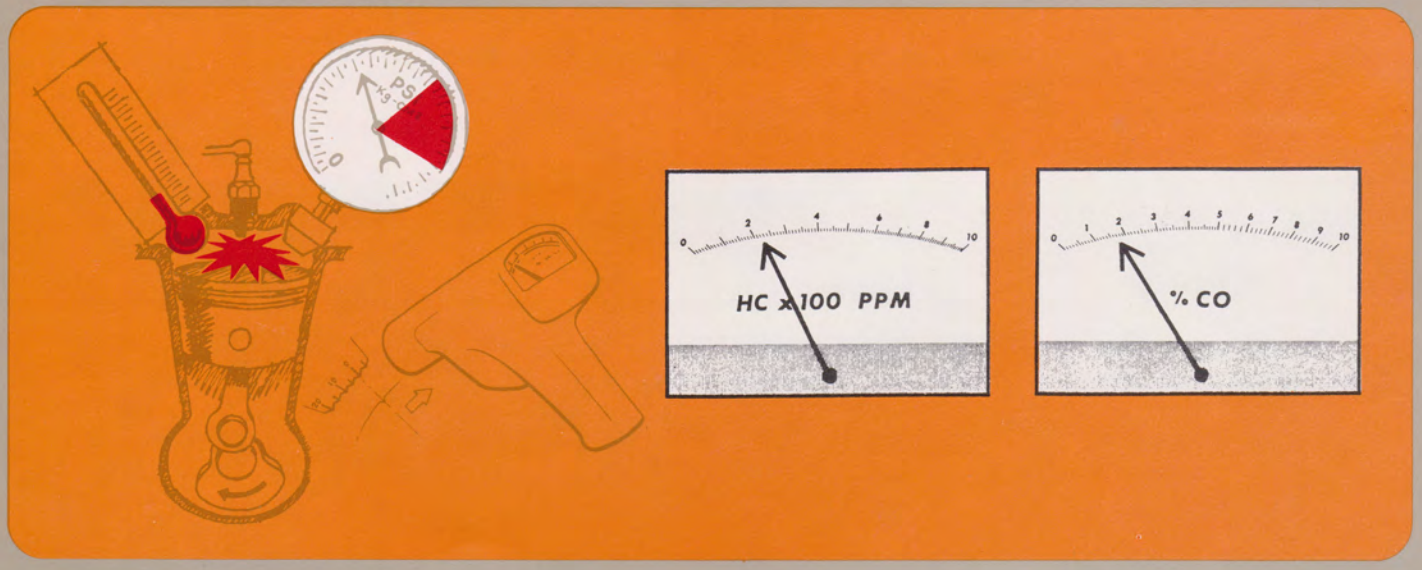
So, as you can see, transistorized ignition system means a modification of the primary ignition system and is not all that hard to understand.

RETARDING IGNITION TIMING



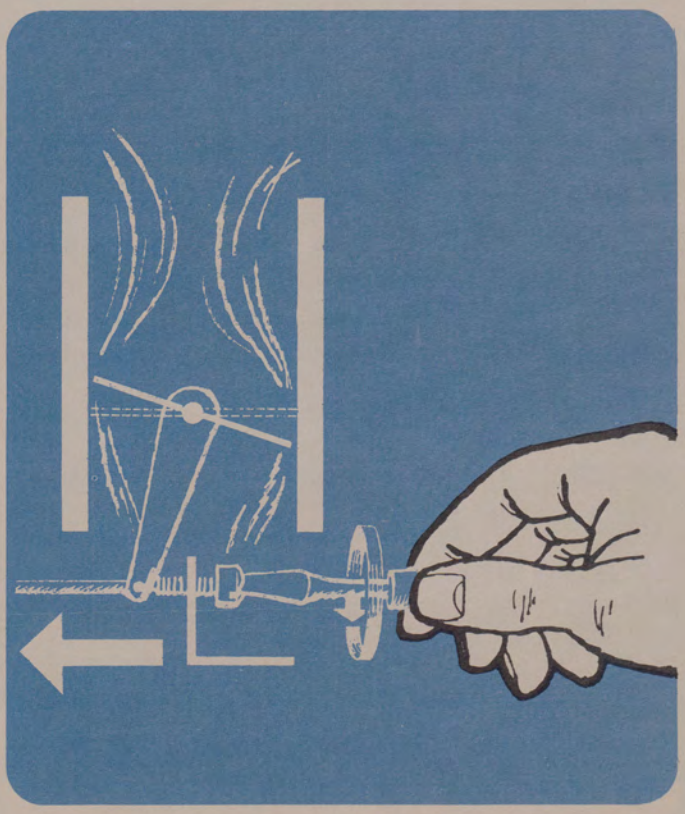
When engine speed increases, ignition timing must be advanced so that the spark occurs well before the piston reaches TDC. This assures maximum temperature and pressure from the combustion process. However, the fuel charge tends to burn very quickly and incompletely, burning less gasoline and forming more CO. HC and CO emissions increase, and the high temperature and pressure rise of the combustion contribute to NO_x formation.

By limiting ignition advance, combustion proceeds more slowly and completely, and continues for a longer period of time. Together, these reduce HC and CO emissions. The slower, longer burning allows more of the fuel to burn, while the longer burn time raises the exhaust temperature allowing burning to continue during and after completion of the exhaust stroke. Also, the higher exhaust temperature increases the efficiency of afterburning systems, which we'll talk about later.



RETARD TIMING AND OPEN THROTTLE PLATE





There's another benefit we can get if we retard the ignition timing at idle. As you know, the idle speed will drop as we retard the timing. To raise the idle speed back to an acceptable level, we must open the throttle plate further using the idle speed screw - and this means increased air flow through the carburetor venturi. This means that the leaner and more efficient main metering circuit will be activated sooner, further lowering HC and CO output.

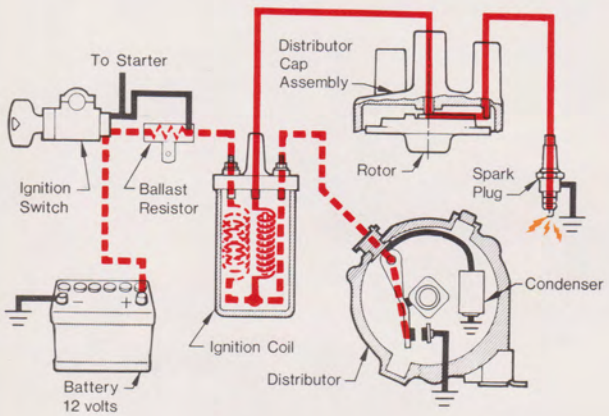
Now that you know the benefits of retarding ignition timing, let's take a look at the ways this has been done on a variety of Datsuns.

DUAL POINT AND DUAL PICK-UP DISTRIBUTORS

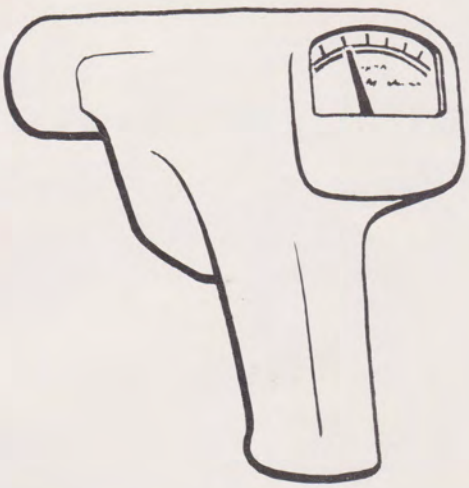
The function of dual point and dual pick-up distributors is to provide either advanced or retarded initial timing only during specific operating modes, such as during engine warm-up, full throttle operation, and a couple of other special conditions. First, let's take a look at how dual point distributors work.



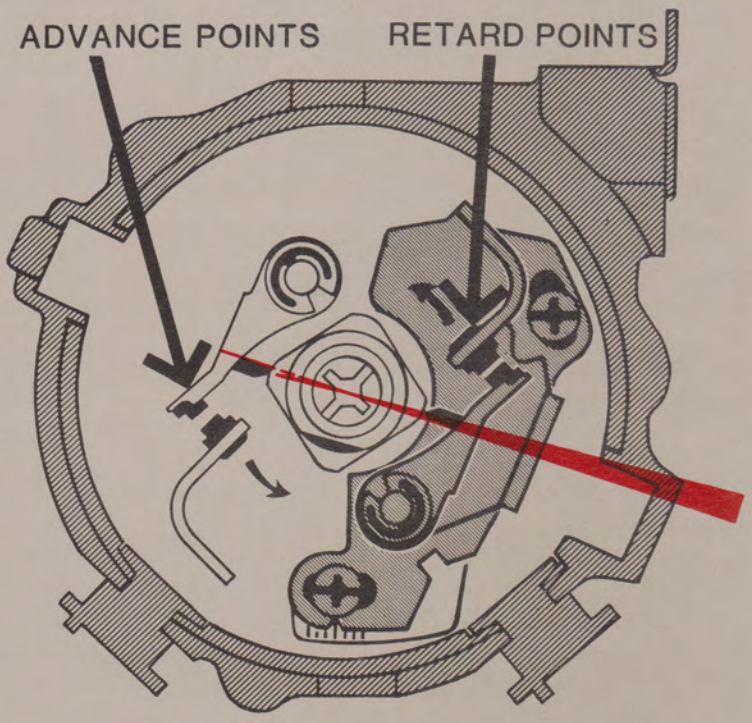
You'll recall that the ignition coil produces a high voltage spark when its ground circuit is broken by the points' opening. The moment at which the points open, of course, is controlled by the position of the points in relation to the lobes on the distributor cam. This position determines the INITIAL TIMING, and can be varied simply by rotating the distributor.





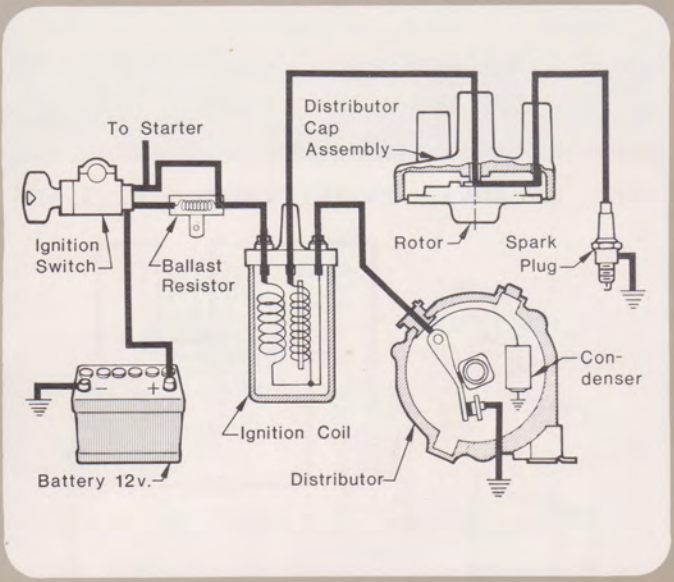


Now, let's say we want to advance the timing only when the engine is cold, to ensure smoother running during warm-up. One way would be to rotate the distributor a few degrees. As you might guess, this could cause all kinds of problems. So, instead, we install a second set of points almost directly across from the first set, like this.

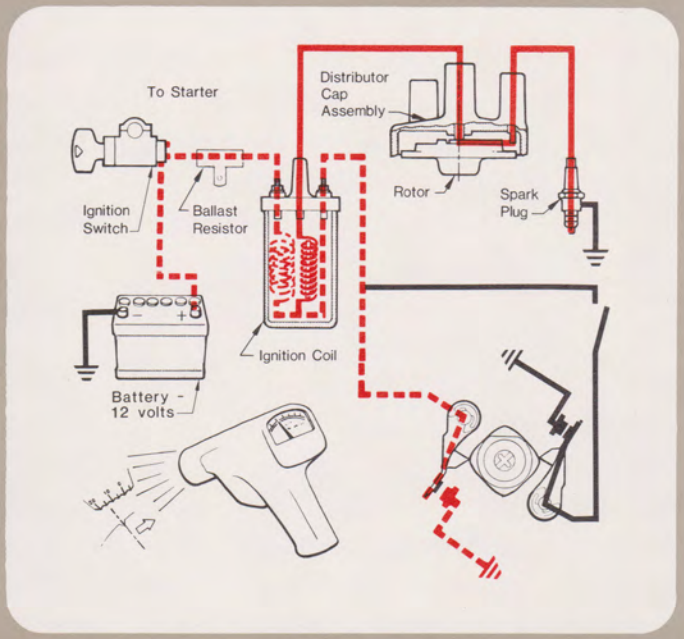


If the second set were placed exactly opposite the first set, the two sets would open and close at exactly the same time. However, if the second set is just a few degrees away from being directly opposite, then the two sets will open at slightly different times.

Now, we could use the "advance points" during warm-up, and switch to the "retard points" after the engine reached operating temperature. But the engine might stumble during the switchover, and might not run at all if the switch became defective. So instead, we wire the two point sets so that they can both work at the same time and use an ON/OFF switch to control the extra set.

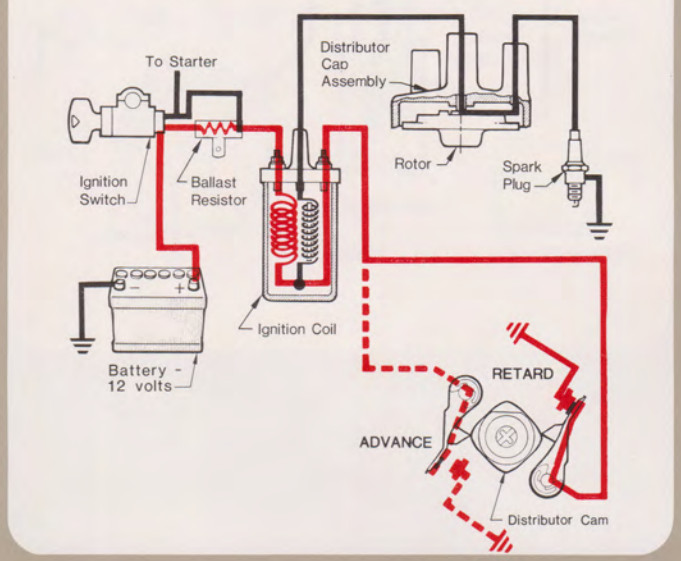


You can see that if we open the control switch, the current flow through the coil will stop when the advance points open, and a spark will occur at, say, 15 degrees BTDC.

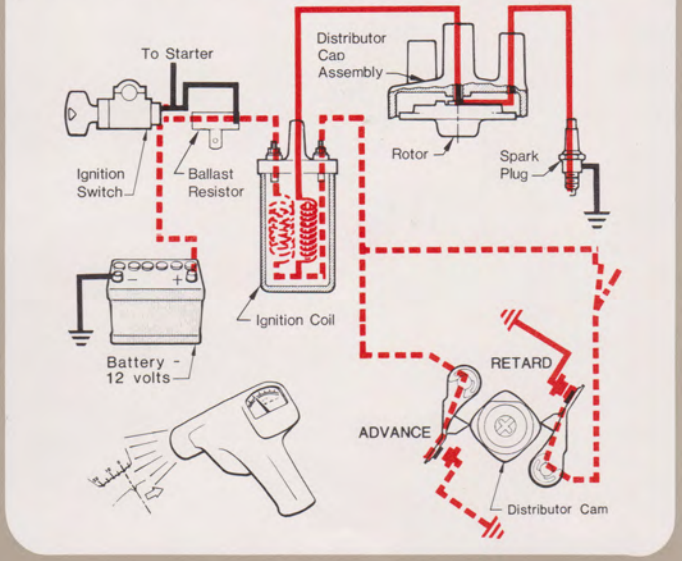


However, if we close the control switch, then current can continue to flow through the coil primary even though the first point set has opened - a ground is still provided by the second, or retard set. Now, when the retard points finally open, both sets of points will be open, the coil ground will be lost, and a spark will occur. Thus, the spark will occur later, say, at 5 degrees BTDC.

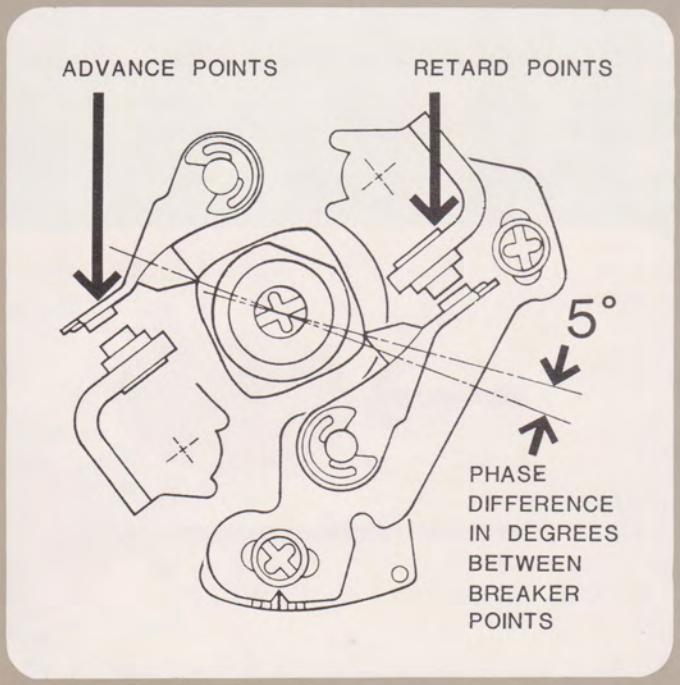
FIRST OR ADVANCED SET OPENS - NO SPARK



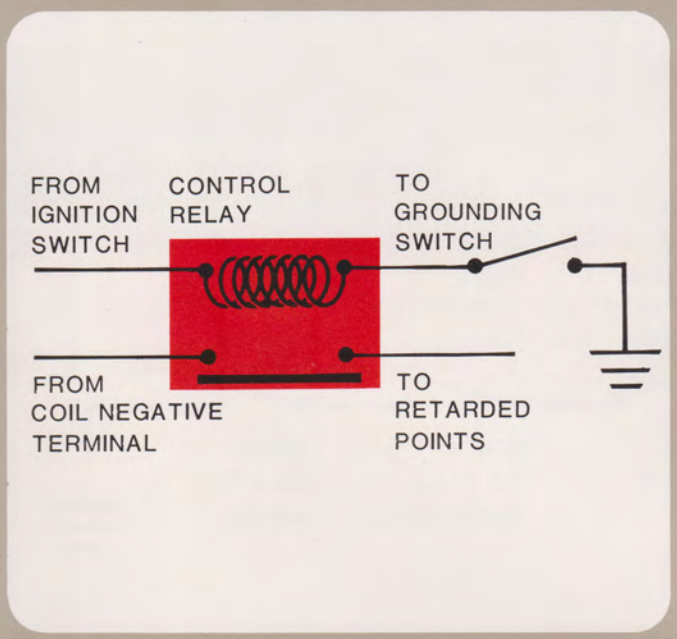
SECOND OR RETARDED SET OPENS - SPARK

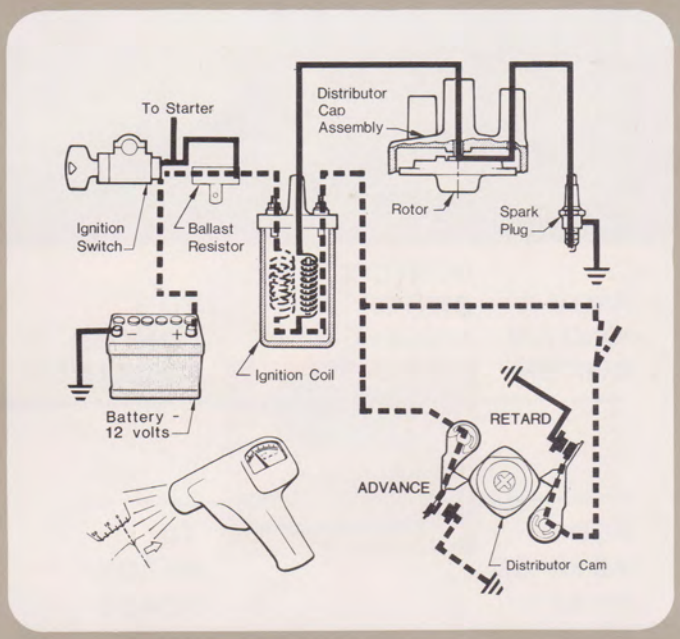


The difference in the point open position of the two point open position of the two point sets is referred to as "Phase Difference". It is expressed as the number of degrees (like dwell) through which the distributor cam must rotate, once the first point set has opened, before the second set opens. THE IMPORTANT THING TO REMEMBER IS THAT A PHASE DIFFERENCE OF 5 DEGREES WILL GIVE AN IGNITION TIMING CHANGE OF 10 DEGREES.



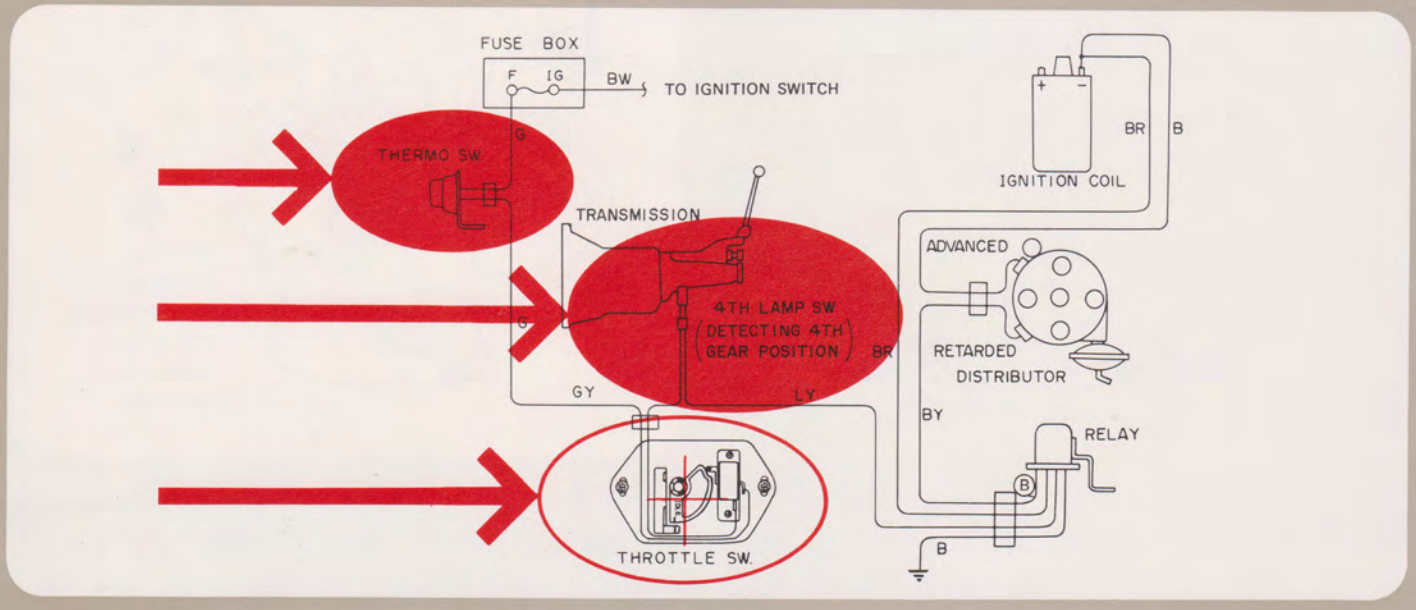
In a real car, the part we have called the control switch is actually a relay. The relay windings get current from the ignition switch whenever the key is in the ON or START position. When the windings are grounded, the relay closes and supplies current to the retard point set.





DIFFERENT GROUNDING SWITCHES
have been used throughtout the years

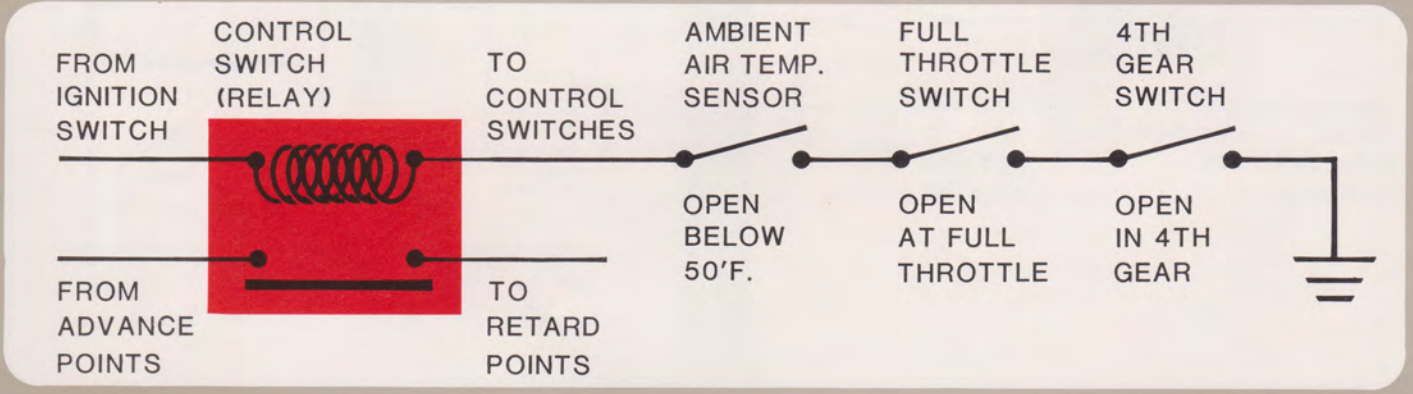
Through the years, different grounding switches have been used on various models. These have included ambient air temperature sensors, coolant temperature sensors, throttle position sensors, gear detector switches, and clutch position switches used singly, or in combination with one another. The illustration below shows the circuit diagram for the 1973 610 with Manual Transmission.



In the diagram below, to obtain retarded timing, all three switches have to be closed, which requires three conditions:

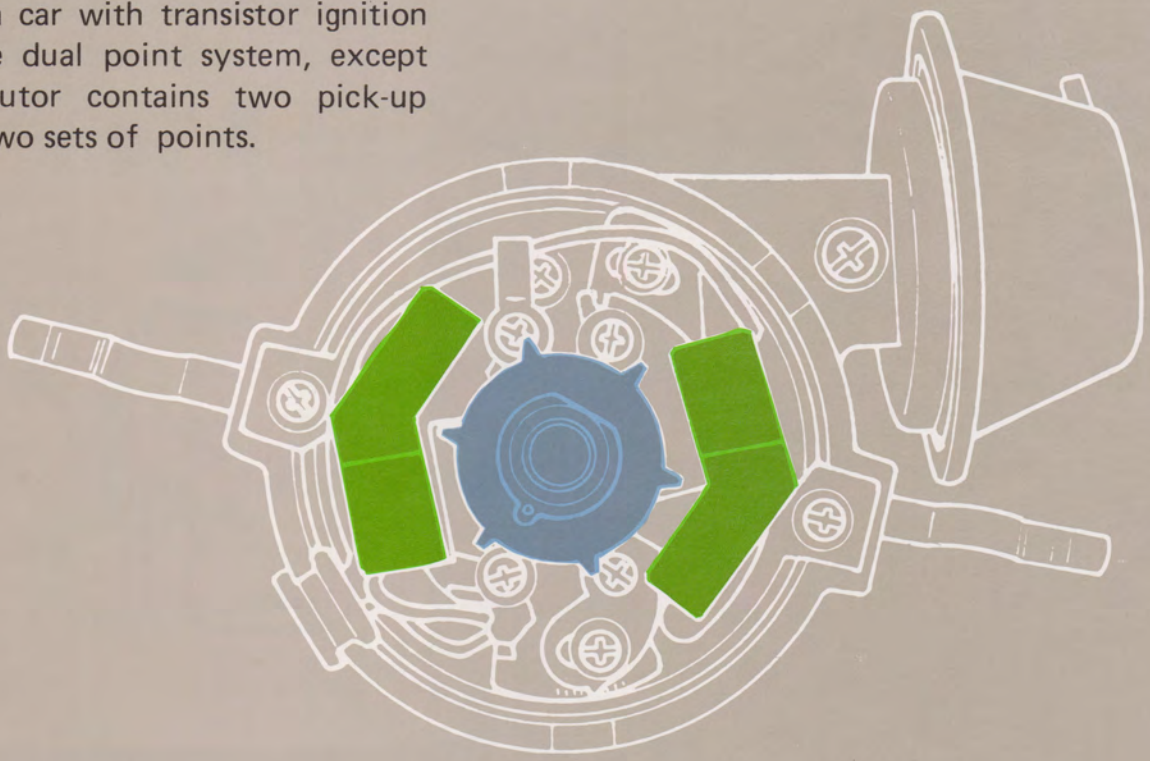
1. Ambient air temperature above 50 degrees Farenheit.
2. Throttle NOT wide open.
3. Transmission NOT in fourth gear.

If ANY one of these three conditions do not exist, the initial timing would be advanced.

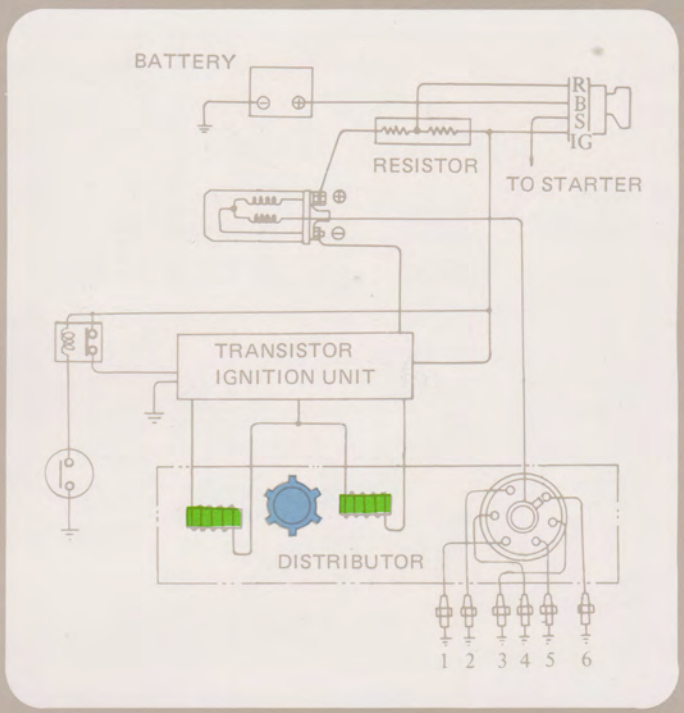


DUAL PICK-UP TRANSISTOR IGNITION SYSTEMS

The set-up for a car with transistor ignition is similar to the dual point system, except that the distributor contains two pick-up coils instead of two sets of points.



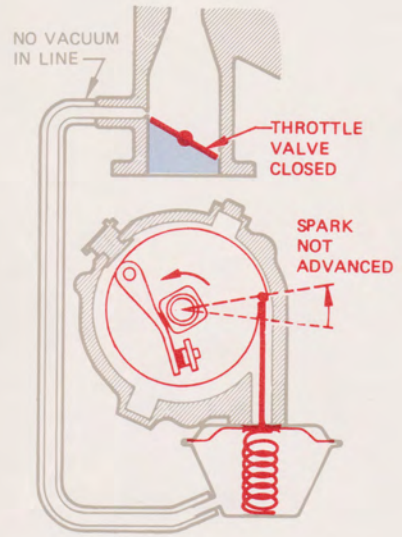
However, unlike the dual point system, only one pick-up coil functions at a time. When the grounding switch activates the relay, the Transistor Ignition Control Unit (trig box) automatically switches from one pick-up coil to the other. Engine performance isn't affected during the switchover, since the T.I. control unit is much faster and more reliable than a mechanical switch.



Dual point and dual pick-up distributors offer the advantage of retarded initial timing, for lower emissions, and advanced initial timing during periods of engine operation needing extra spark advance.

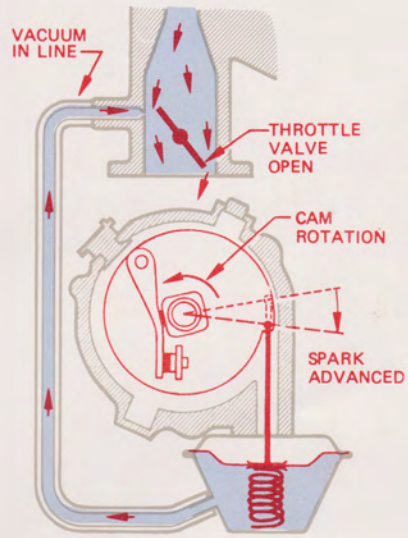
PORTED VACUUM FOR VACUUM ADVANCE

All Datsuns use vacuum-controlled ignition timing advance to improve engine efficiency during periods of part load, part throttle operation. However, if the vacuum line were connected to the intake manifold, the spark would also be advanced at idle, causing HC, CO, and NO_x emissions to increase.



AT IDLE, THROTTLE VALVE CLOSES- NO VACUUM ADVANCE

All late model Datsuns use "ported vacuum" to operate the vacuum advance. Ported vacuum is vacuum taken from a carburetor port positioned above the throttle plate's idle position. With the throttle plate in idle position, there is too little vacuum in the carburetor throat to advance spark. But, the port is gradually exposed to more and more vacuum, as the throttle plate opens, and the timing can advance as the engine load increases.



WITH INCREASE IN ENGINE LOAD, THROTTLE VALVE OPENS- VACUUM IN LINE INCREASES TO ADVANCE SPARK

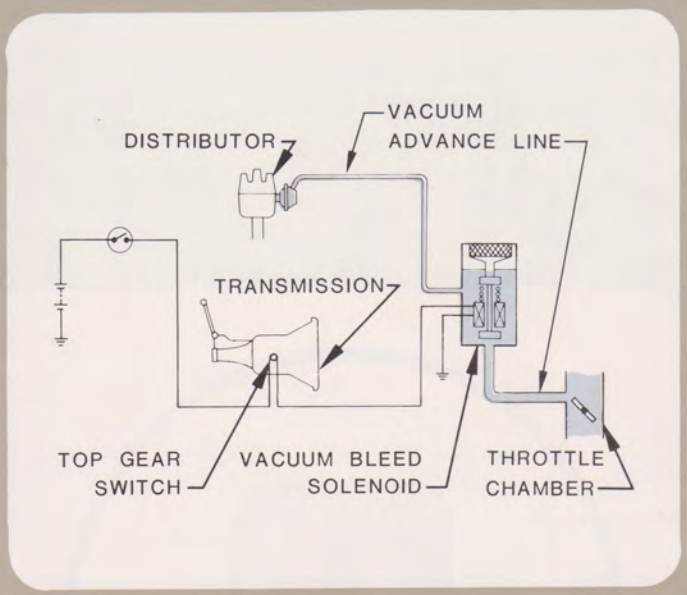
TRANSMISSION CONTROLLED VACUUM ADVANCE

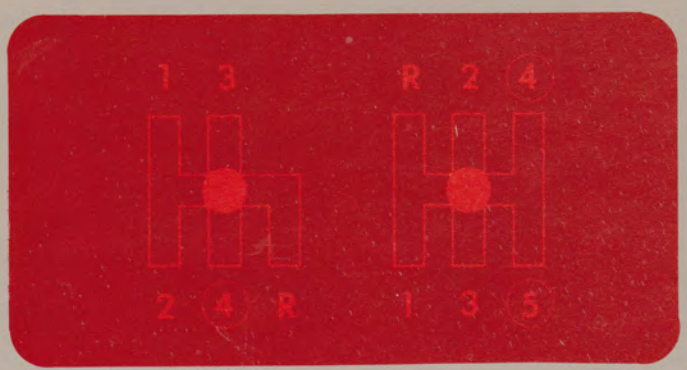
Ported vacuum allows elimination of vacuum advance at idle while still providing normal vacuum advance when engine load increases. However, since emissions are heaviest during acceleration, and spark advance contributes to emissions, we need a method of shutting off vacuum advance during periods of heaviest engine load, such as acceleration in first, second, and third, gears. On the other hand, we do little accelerating in fourth gear, and it is in this gear that we most often operate the car at part throttle - so we need vacuum advance in fourth gear.

Datsuns using Transmission Controlled Vacuum Advance, TCVA, employ an electrical switch and a solenoid which controls vacuum to the distributor.

The switch is mounted on the transmission. When the shift lever is in any position except fourth or fifth gear, the solenoid is energized, and vacuum from the carburetor port bleeds off to the air cleaner, preventing vacuum advance.

But when the shift lever is in fourth or fifth gear, the switch is turned off and the solenoid is de-energized. This allows the ported vacuum to reach the distributor, and the timing will be advanced.



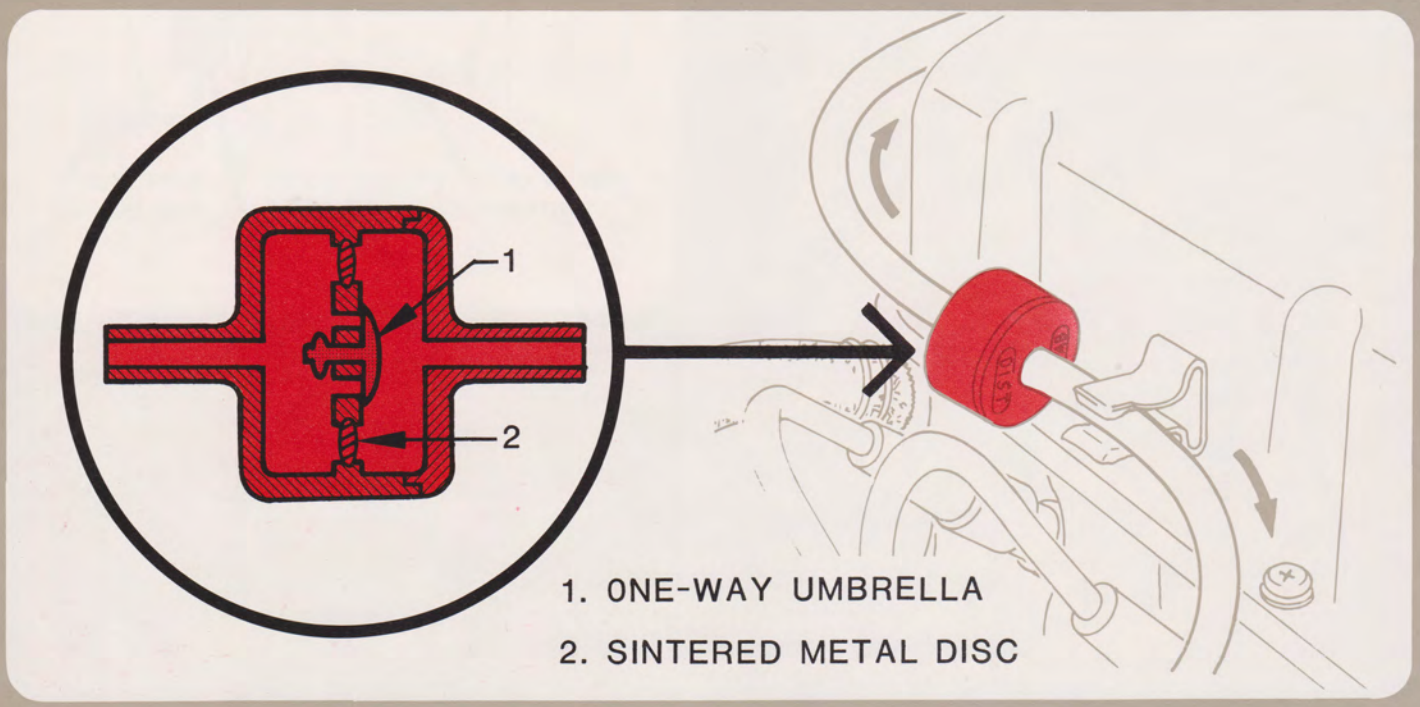


There are some variations to this system. For example, on the 1975 610, the solenoid does not bleed off the vacuum; instead, it just closes off the line to the distributor.

Through 1976, only manual transmission models had TCVA. However, beginning with 1977, some automatic transmission equipped models employ TCVA also. The system remains similar to that used on manual transmission models. The only difference is that instead of a mechanically operated switch being activated by the shift linkage, the switch used with the automatic is hydraulically activated by the oil pressure which gives us third gear (band release pressure).

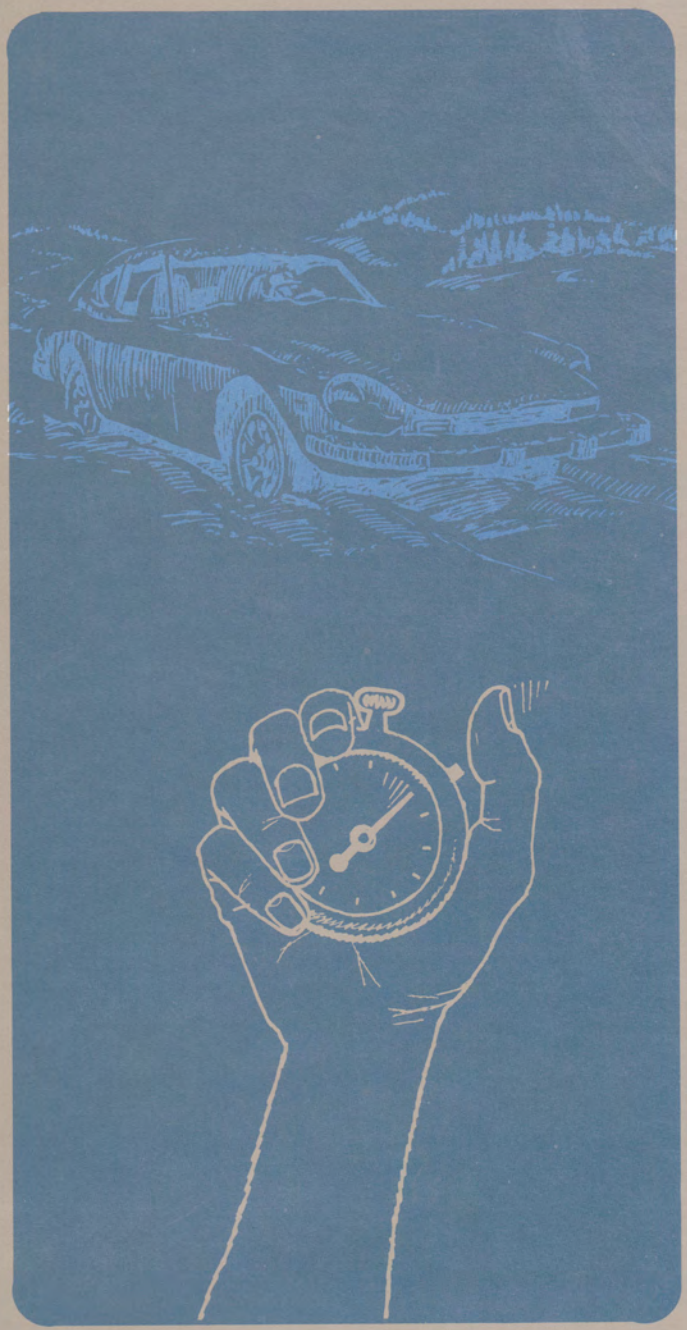
SPARK DELAY VALVE

The vacuum advance control used on some automatic transmission equipped models is much simpler than the TCVA system used on manual transmission models. It consisted only of a Spark Delay Valve.



This valve is nothing more than a device which temporarily restricts air flow in one direction but permits it in the other direction. During acceleration, when the ported vacuum increases, the valve offers a restriction to the air flow between the distributor and the carburetor. Thus, vacuum advance is delayed for about thirteen seconds, usually enough time to complete the acceleration. However, since air flow in the other direction is never impeded, the vacuum advance will be quickly released when the throttle is closed and ported vacuum disappears.

CHOKE SYSTEM IMPROVEMENTS

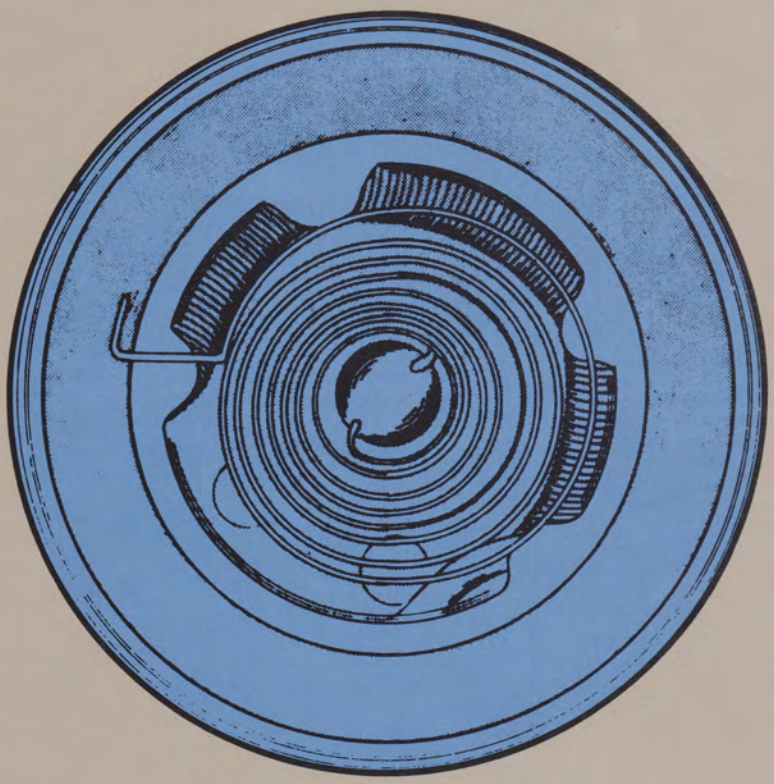


Whenever the choke system is operating, the carburetor supplies the engine with a very rich mixture needed to keep the engine from dying. During this period, the mixture is so rich that HC and CO emissions are very high.

Therefore, from the standpoint of emission control, it is desirable to open the choke as quickly as is practical. Let's take a look at how this has been accomplished on different Datsuns.

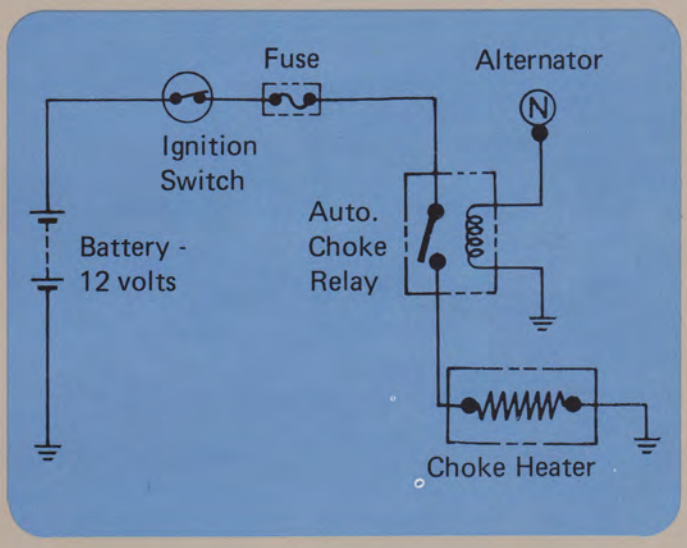
ELECTRIC AUTOMATIC CHOKE

You'll recall that the operation of the automatic choke is controlled by a bi-metallic spring. When the engine cools, the spring cools; and, as it cools, it coils up and closes the choke plate. Then, when the engine warms up, engine heat causes the bi-metallic spring to unwind and open the choke. However, to effectively control emissions during this period, the choke must open faster than is possible using only engine heat. Putting a small electric heater inside the bi-metal spring housing does the job.



The easiest way to control this heater would be to supply current to it whenever the ignition key is in the "run" position. But, consider the driver in a cold climate who starts his car in the morning, and returns to the house for that last cup of coffee while his car warms up. If the engine dies, the key would still be in the "run" position, operating the heater, causing the choke to open fully. The car might subsequently be hard to start. Therefore, the heater should work only while the engine is actually running.

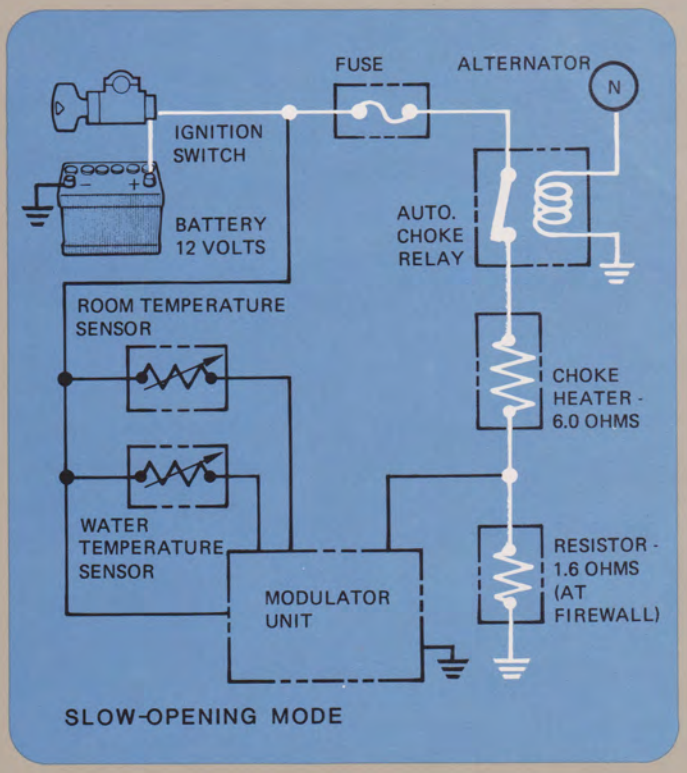
To do this, we simply use a relay to control the current to the heater. The circuit looks like this:



The current used to energize the relay comes from the N, or Neuter, terminal of the alternator. When the voltage at the N terminal reaches approximately 6 - 7 V, the current flow through the relay windings is sufficient to close the relay and energize the choke heater. If the engine stops, the alternator output will drop to 0, the relay will open, and the choke heater will stop working.

610 MODULATOR SYSTEM

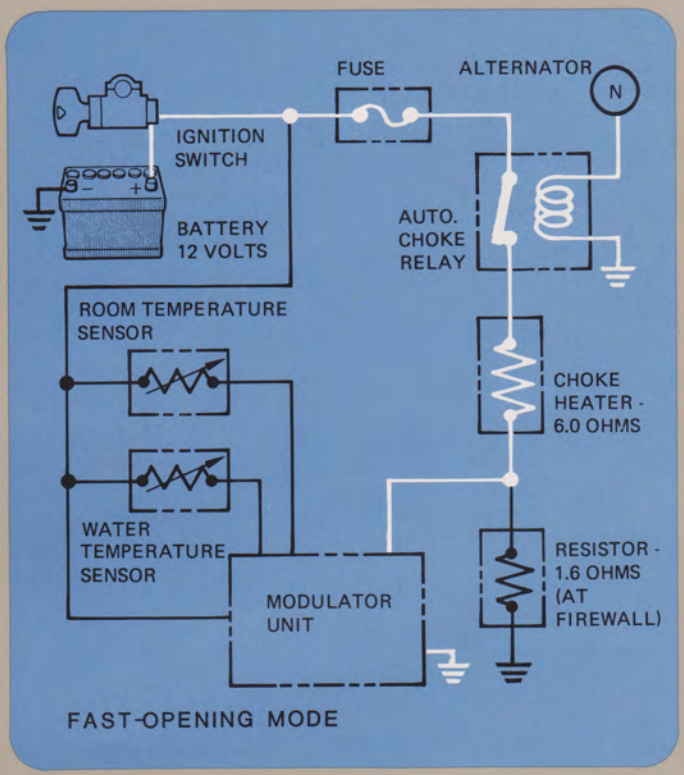
In the 1974 610, a so-called "modulator" system was used, which allowed the choke to open at two different speeds, depending on air and engine water temperature. In the slow-opening mode, the choke heater was grounded through a special resistor, mounted on the firewall. The resistor permitted less current to pass, and so less heat was developed.



SLOW-OPENING MODE

On the other hand, if the resistor were bypassed, more current could flow and the choke would open sooner. The resistor was bypassed using a transistorized switch, or modulator, mounted behind the left-hand kick panel. The switch was connected to temperature sensors in the passenger compartment and the engine water jacket. When conditions were right, the switch grounded the choke heater directly (bypassing the resistor), permitting more current to flow through the heater and opening the choke faster.

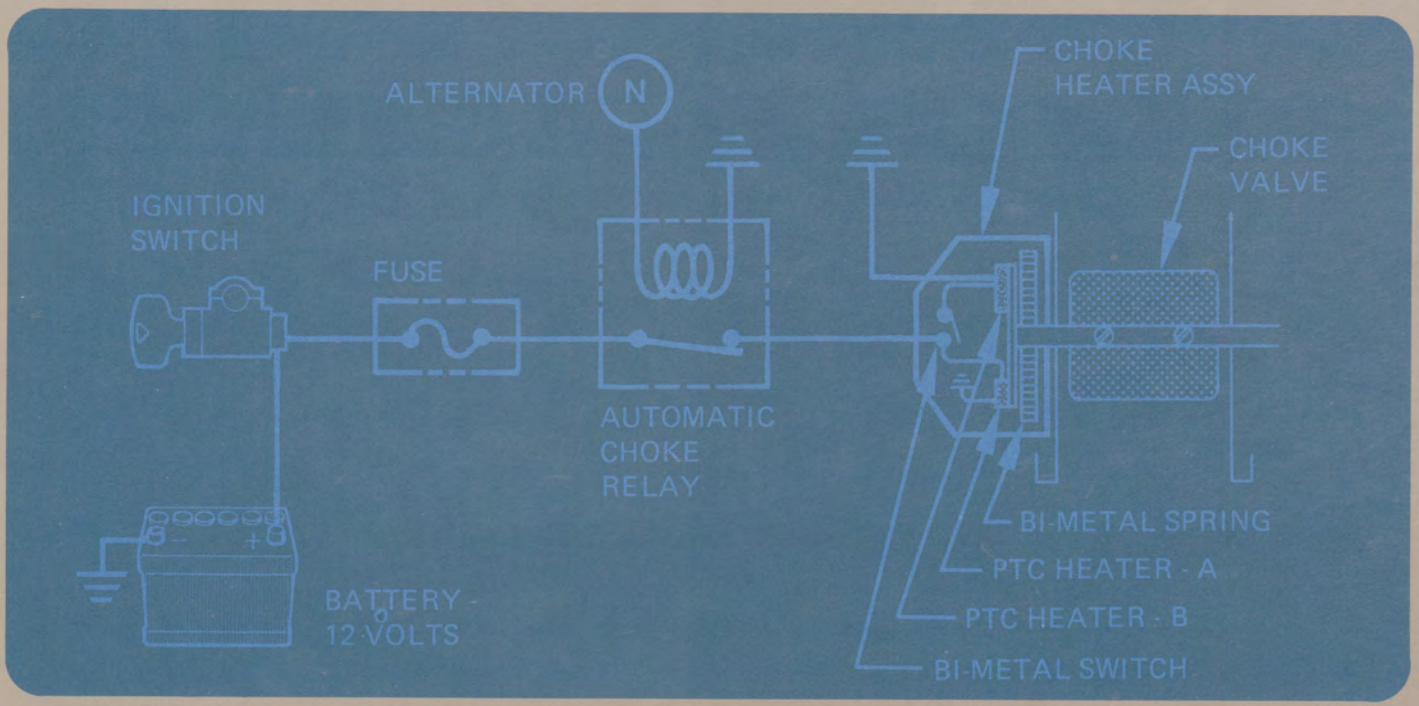
Although this system was pretty complicated, it's really not too hard to check if you follow the specific procedures outlined in your SERVICE GUIDE.



FAST-OPENING MODE

POSITIVE TEMPERATURE COEFFICIENT CHOKE SYSTEM

Beginning in 1975, all Datsuns using carburetors were equipped with a PTC ("Positive Temperature Coefficient") choke. The purpose of the PTC system was to open the choke slowly when the ambient air was cold, and to open it more rapidly when the ambient air was warm. Obviously, the idea was to improve driveability under cold conditions while still holding emissions to a minimum.



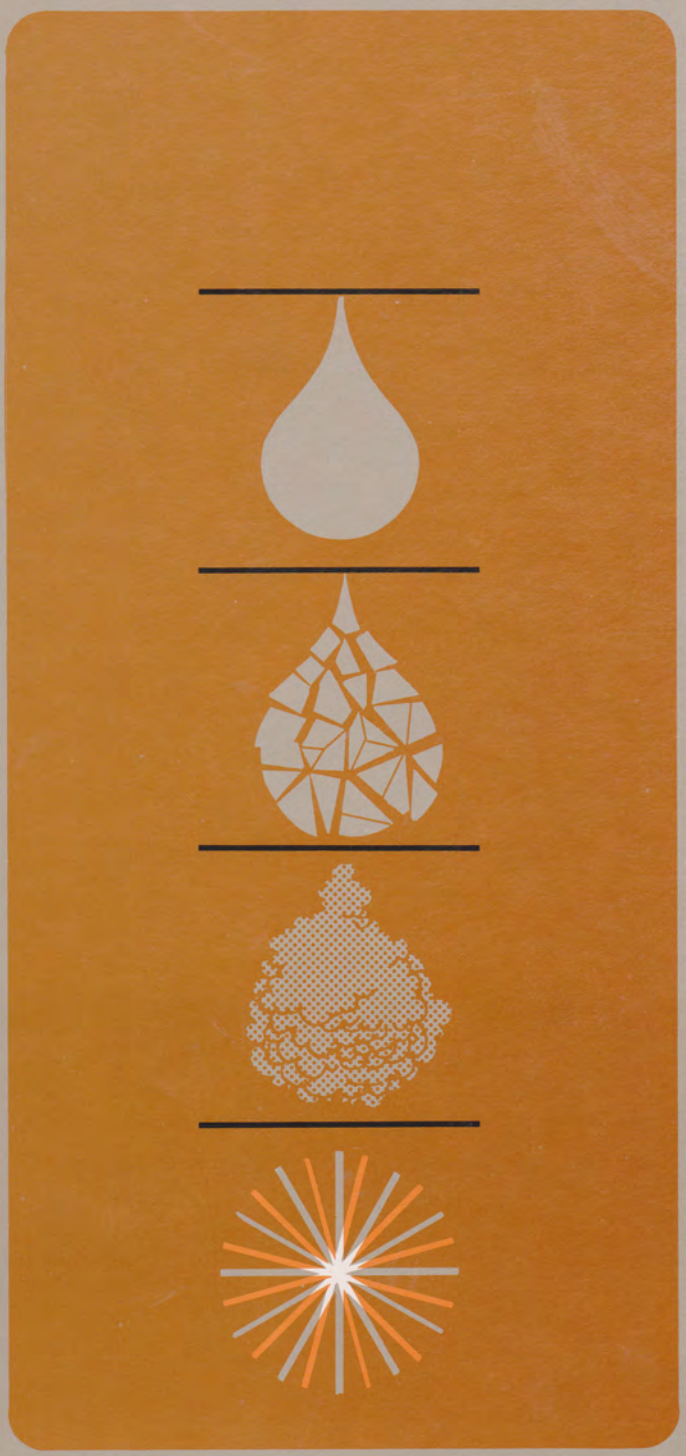
When the temperature of the air surrounding the choke housing is below a certain point, the bimetal switch is open. In this mode, current can flow only through heater A, and choke opening will be slow enough to provide good driveability in cold weather.

On the other hand, if the temperature of the air surrounding the housing is high enough to close the bimetal switch, then we won't need the choke for as long. With the bimetal switch closed, current can flow through both heater A and heater B, the choke will open somewhat faster, and HC and CO emissions will be lowered.

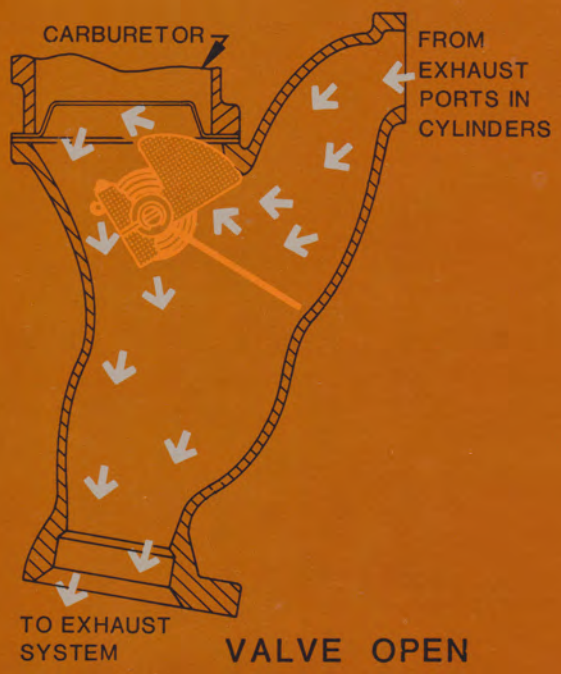
EARLY FUEL EVAPORATION SYSTEM

Surprising as it may seem, liquid gasoline DOESN'T BURN - it must first be vaporized (changed from a liquid to a gas) and mixed with air. Poor fuel vaporization results in rough running and high HC emissions, since a lot of liquid fuel is just blown out the tailpipe. Fuel vaporization occurs best when both air and fuel are warm, since it will be easier for the gasoline to evaporate. Now, this is no problem when an engine has reached operating temperature, since the carburetor will be warm enough to raise the fuel temperature and the intake manifold will heat the air.

On the other hand, fuel vaporization in a cold engine is relatively poor, since neither the carburetor nor the manifold will have warmed up to operating temperature. A means of temporarily heating them during warm-up is required. This need is taken care of by one of two "Early Fuel Evaporation" systems: (1) a water-heated intake manifold or (2) a "heat riser".



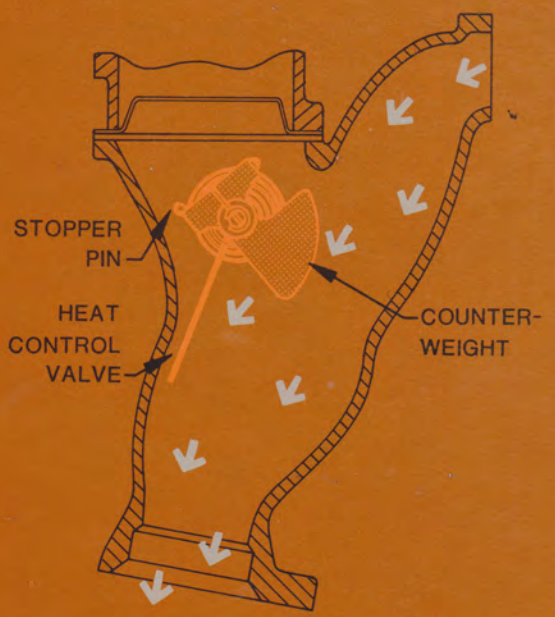
The heat riser is simply a flapper door, located inside the exhaust manifold, its position controlled by a bi-metal spring similar to the spring which controls the choke.



VALVE OPEN

On a cold engine, the bi-metal spring holds the flapper in this position. As you can see, the flapper diverts the flow of exhaust gases so that they must flow underneath the carburetor. The hot exhaust gases heat the carburetor and intake manifold, improving fuel vaporization.

As the engine warms up, the bi-metal spring is heated and begins to open the flapper. By the time the engine is at full operating temperature, the flapper will be fully open, and the exhaust gases can pass directly through the exhaust manifold.



VALVE CLOSE

By the way, under heavy acceleration, the back pressure of the exhaust can overcome the tension of the bi-metal spring so that the flapper won't "choke" the engine!

The water-heated intake manifold is much simpler, yet accomplishes the same thing. Engine coolant circulates through passages in the intake manifold heating it as the engine warms up. On some vehicles, a thermostat is built into the system to shut off the coolant flow once the temperature reaches a certain level.

CRANKCASE EMISSION CONTROLS

During engine operation, some of the fuel charge and exhaust gases find their way past the piston rings into the crankcase. These gases are commonly called "blow-by".

Blow-by gases and moisture condensation in the crankcase cause contamination of the motor oil, resulting in the formation of sludge in the oil. Sludge can block the oil pump screen and oil galleries, and the results are disasterous. Further, these contaminants are highly corrosive. Acid etching and rusting of highly polished internal engine surfaces will eventually result. Varnish and lacquer formation on critical engine parts, such as hydraulic lifters and cam lobes, seriously interfere with efficient engine operation. It is essential to properly ventilate the crankcase and remove these fumes, gases and condensed vapors, to prevent motor oil contamination and extend engine life.

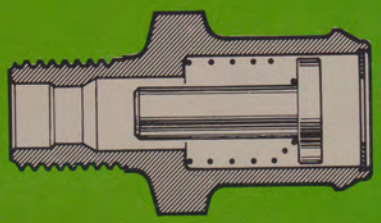
DRAFT TUBE

Ventilating the crankcase by passing air through it has been a standard practice for many years. Air entered the crankcase through the oil filler cap, or crankcase as it was frequently called, and as it passed through the crankcase, picked up fumes and gases, and then passed from the engine through a road draft tube.

The system had two disadvantages. First, the amount of air that passed through the crankcase was governed by the speed of the vehicle. The movement of air under the vehicle created a pressure differential at the end of the draft tube that was greater or less than the air pressure at the breather cap. At idle and low cruising speeds, the passage of air through the crankcase was inadequate for effective ventilation. Second, fumes ventilated from the crankcase go into the atmosphere contributing to air pollution.

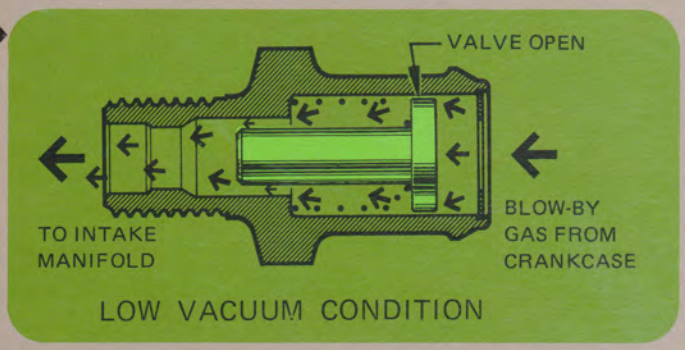
Positive Crankcase Ventilation

The Positive Crankcase Ventilating System, referred to as "PCV", helps reduce air pollution caused by automobile crankcase vapors. In the PCV system, the draft tube is eliminated. Vapors pass from the crankcase through tubing, into the intake manifold and finally into the engine's cylinders. The rate of air flow through the system is controlled by intake manifold vacuum and a valve that meters the air flow. This valve provides the proper degree of crankcase ventilation consistent with engine demands and vehicle speeds and is known as the PCV Valve.

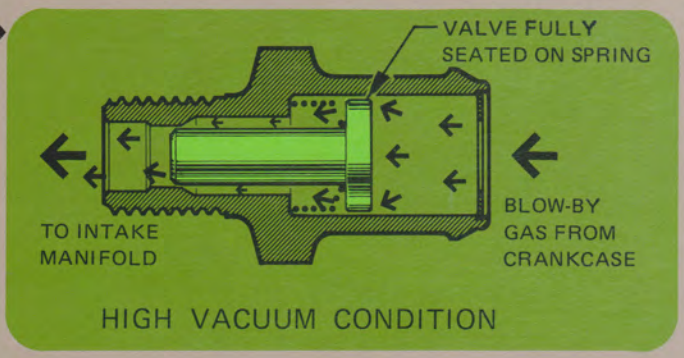


PCV VALVE

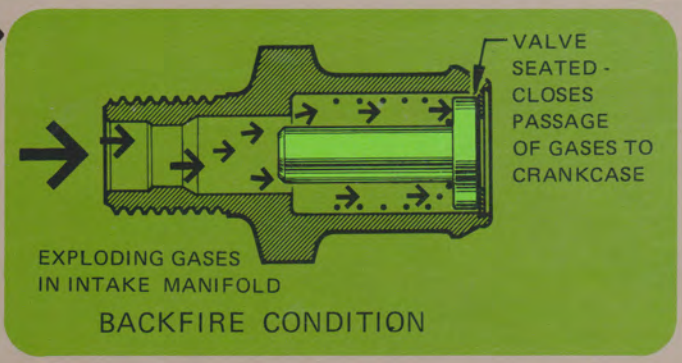
The PCV valve is specially designed to maintain a constant flow of blow-by gases into the manifold, even when manifold vacuum changes. During low vacuum conditions, the valve is opened fully so that the weak vacuum can still pull a sufficient quantity of vapors through it.



As manifold vacuum rises, however, the valve is pulled against the spring and the size of the passage is restricted. When vacuum is highest, the valve will be in the seated position, leaving only a very tiny passage for vapors. Since vacuum is so high, however, the amount of blow-by gases passing through it remains as great as during low vacuum and wide-open valve conditions.

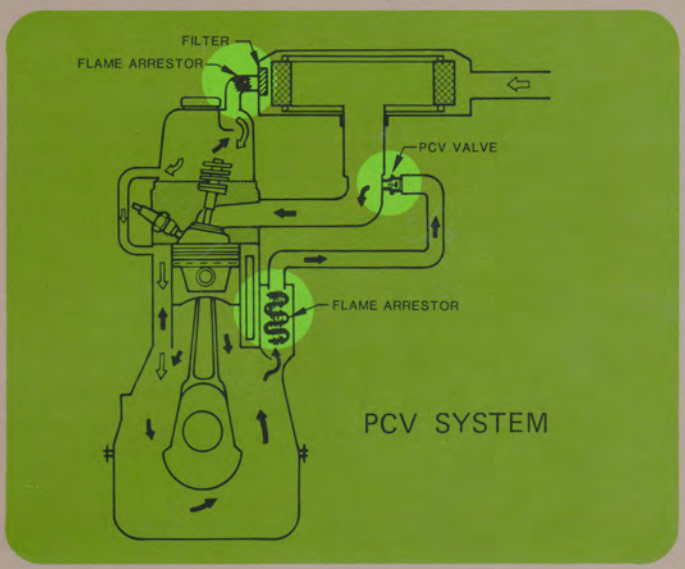


Since the crankcase gases may explode if they come in contact with flame, backfire in the intake manifold must be prevented from passing through the PCV system into the crankcase. Therefore, the PCV valve is designed so that a backfire will push the valve all the way back to the other end, where it will seat and close off the passage entirely.

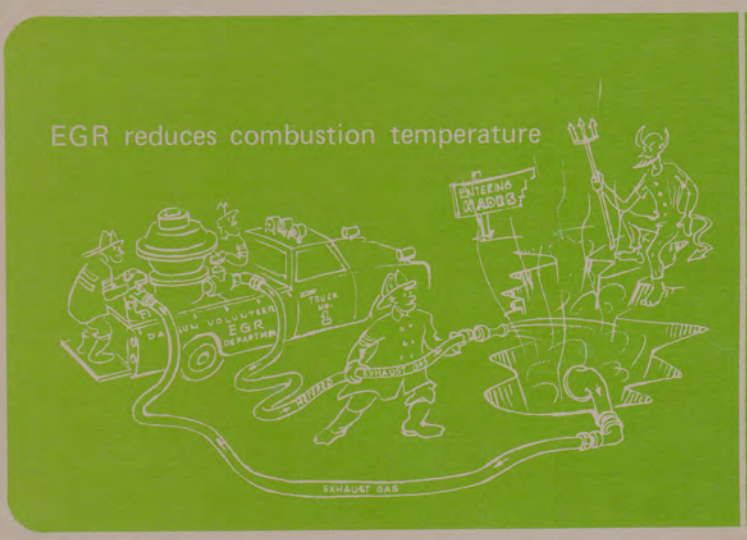


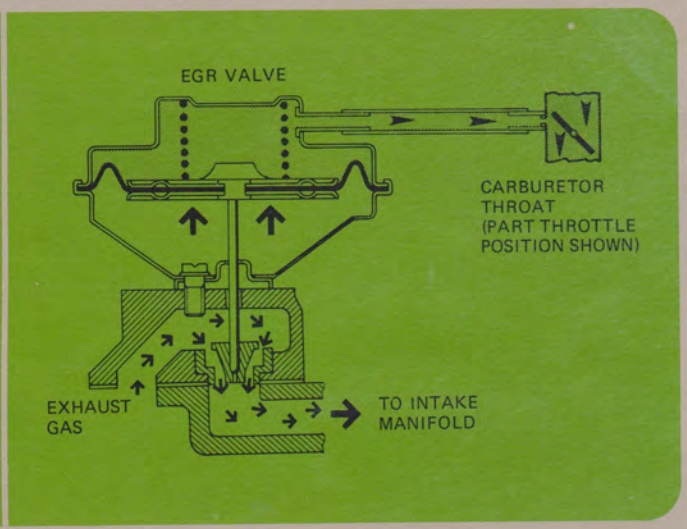
Also, to prevent the spread of flames from the carburetor to the rocker cover, a flame arrestor has been placed in the vent line. This is either a screen or a small device like a wire brush. You can see that it's important that this flame arrestor be properly installed.

With the elimination of the major portion of blow-by gases, engine oil contamination is reduced, water vapor, rust and corrosive acids are diminished, and engine life is materially extended. Most importantly, air pollution from the crankcase is totally eliminated on cars with PCV system.



EGR REDUCES COMBUSTION TEMPERATURE





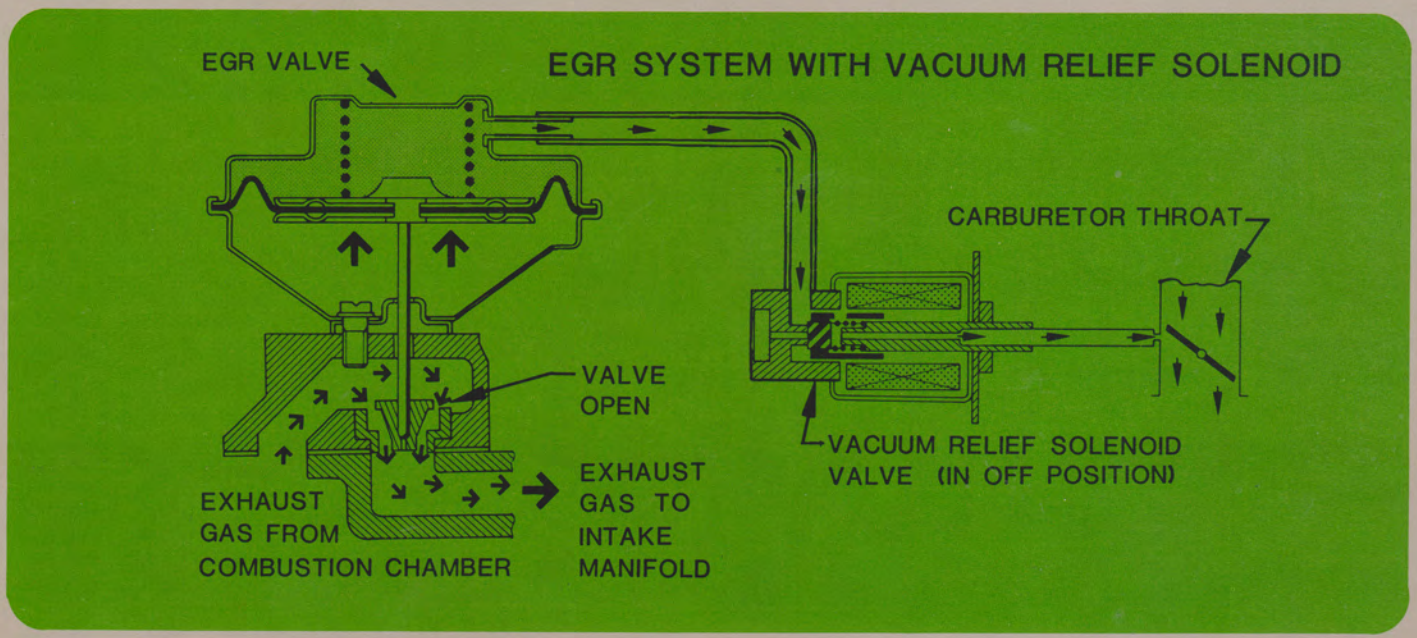
Why do we recirculate exhaust gas? It won't burn anymore, like crankcase vapors, so what good is it? Well, the reason for this system is exactly that - exhaust gas won't burn. Putting it back into the combustion chamber has the same effect as throwing water on a roaring fire. The temperature of combustion can't get as high, and, as you know, high temperatures are what create oxides of nitrogen. Therefore, the EGR system is designed to lower NO_x emissions. First, let's take a look at the refinements that tailor the system to different models.

As you can see, the EGR valve basically consists of a plunger attached to a diaphragm. When vacuum is applied to the top of the diaphragm, the plunger is raised, and allows hot exhaust gases to bleed into the intake manifold. The amount of exhaust gas which can flow is dependent on the position of the plunger/diaphragm, which in turn, is controlled by the strength of the vacuum signal.

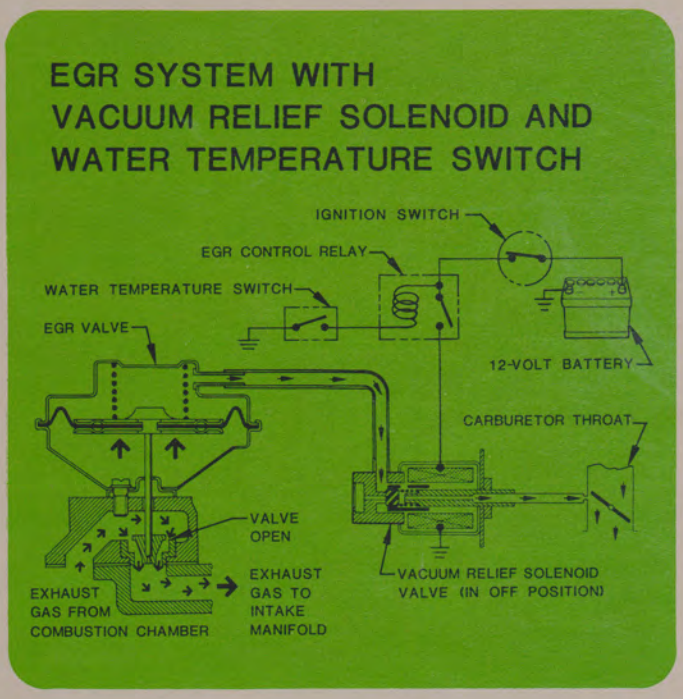
Like the vacuum advance for the ignition timing, the EGR valve gets ported vacuum, so the engine will get just the right amount of EGR under all operating conditions. EGR at idle is undesirable. Little NO_x is formed at idle, and EGR would make the engine run very rough. We don't want EGR during wide-open throttle acceleration either, since engine performance would be poor. Since the vacuum in the carburetor throat drops very low during WOT acceleration, there will be no EGR. However, the valve will get vacuum and provide EGR during most part-throttle operation, when NO_x formation is the greatest.

EGR SYSTEM allows a certain amount of exhaust gas to pass into the intake manifold

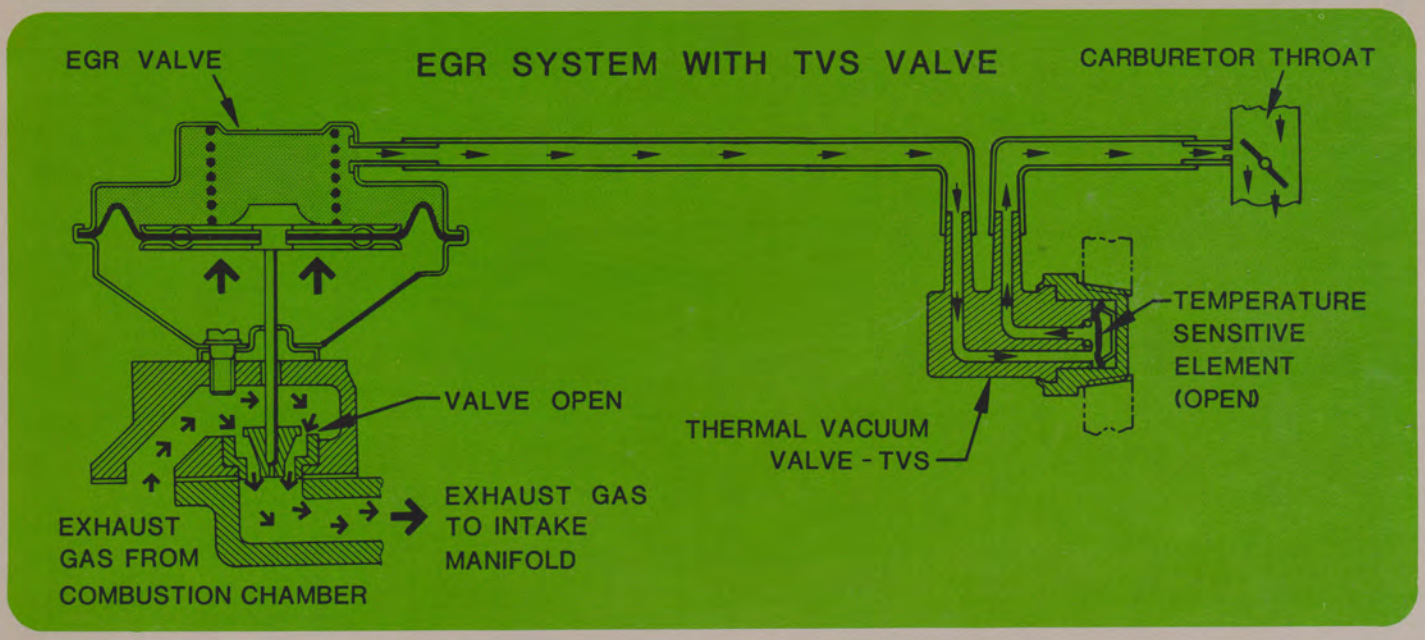
Other components have been installed on some Datsuns to improve the EGR system. The first one was a vacuum relief solenoid, installed in the vacuum line ahead of the EGR valve. It bleeds off the EGR valve signal vacuum until the engine reaches a certain temperature, eliminating EGR during cold operation. This improves cold engine response and smoothness.



Although the solenoid received current from the ignition switch, the ground was controlled by a water temperature switch. When the water temperature was below about one-hundred degrees Farenheit, the switch closed, energizing the solenoid, and bled off EGR. When water temperature was about one-hundred degrees Farenheit, the sensor switch opened, the solenoid ground was interrupted, and the solenoid closed, thereby allowing vacuum to pass to the EGR valve. Some models which used this system had a relay which energized the solenoid, and the relay was energized by the water temperature sensor switch (which controlled the relay ground) thus allowing EGR only in certain temperatures.

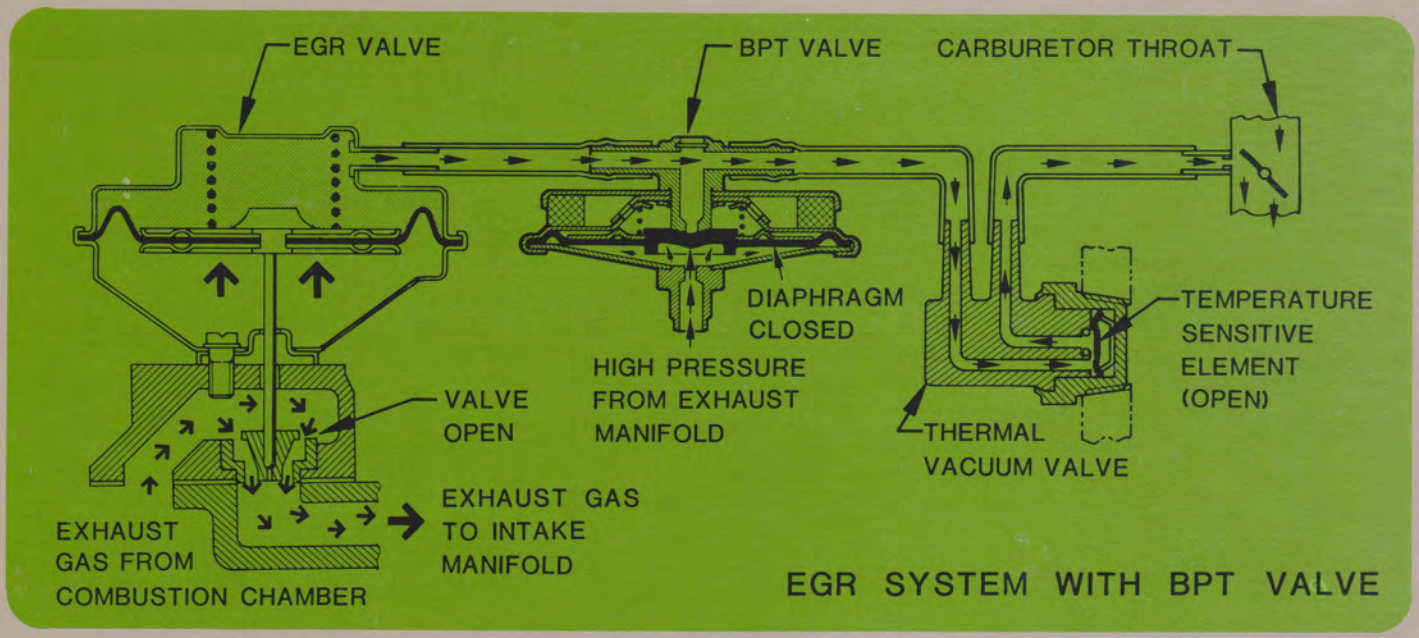


Beginning in 1975, a simpler type of vacuum control device, called the Thermostatic Vacuum Switch, or TVS, was used. This valve was mounted in the water jacket. When the water temperature was below a certain point, the temperature sensitive element contracted (shortened) and blocked off the vacuum port. When the water was heated to a certain temperature, the temperature sensitive element expanded, uncovering the vacuum port and allowing the vacuum signal to activate the EGR valve. Some models which utilized this TVS also used a vacuum bleed-off solenoid controlled by a transmission switch, allowing EGR only after warm-up and then only if the transmission was in a particular gear.



BACK PRESSURE TRANSDUCER **EGR** SYSTEM

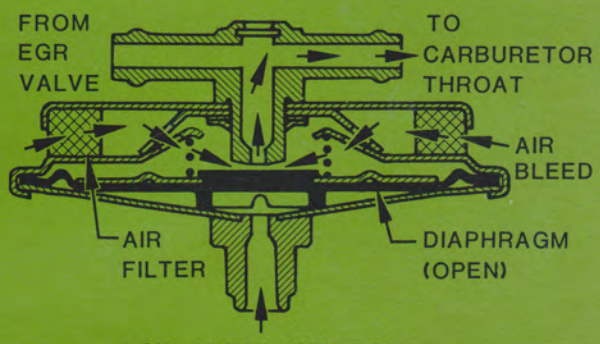
In 1977, a new type of EGR control, called the Back Pressure Transducer, or BPT, was introduced. It allowed more precise tailoring of the EGR volume to engine speed and load. Here's how it works.



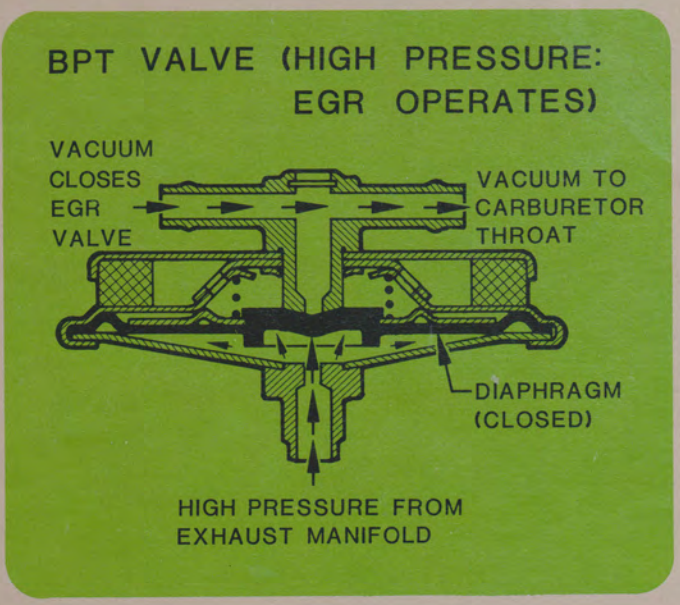
EGR SYSTEM WITH BPT VALVE

The BPT valve functions as an air bleed in the EGR valve vacuum line. The valve is connected to the exhaust manifold and exhaust pressure pushes against the underside of the valve diaphragm. When exhaust manifold pressure is low, that is, during light acceleration and part throttle, the pressure in the exhaust manifold will not be strong enough to push the diaphragm upward. At this time, fresh air will enter through the special air filter and bleed off the vacuum which is being supplied to the EGR valve. This means that during part throttle, light acceleration, there will be very little, if any, EGR.

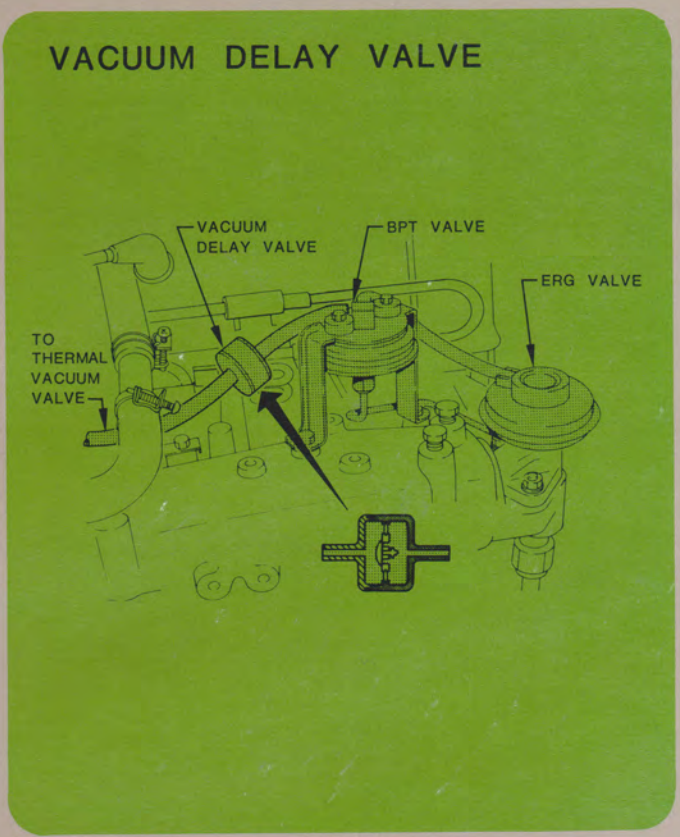
BPT VALVE (LOW PRESSURE: EGR CANCELLED)



However, during high speed cruising, when combustion chamber temperatures are highest and emissions are greatest, the exhaust manifold pressure will be high, and the diaphragm will be pushed upward until it seals off the fresh air bleed. Now a full strength vacuum signal can be sent to the EGR valve to open it and allow EGR.



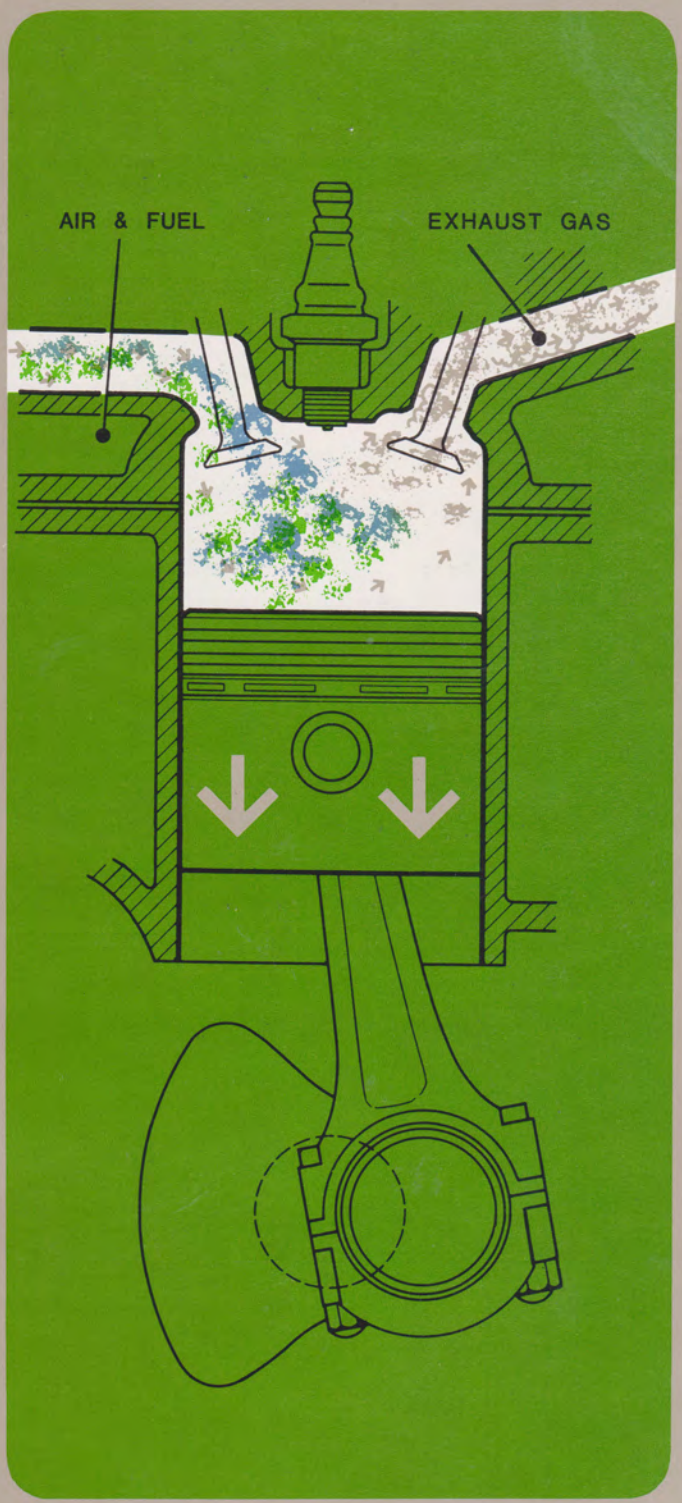
On some California models, an additional valve is installed in the EGR system. This is a vacuum delay valve similar to the spark delay valve you studied earlier. However, the valve installed in the EGR system delays the RELEASE of vacuum from the EGR control valve, while the SDV delayed the BUILD UP of vacuum at the distributor vacuum advance diaphragm. The purpose of this valve is to prevent the rapid release of EGR in response to transient manifold vacuum changes, thus providing greater and more consistent EGR flow. On the other hand, this delay valve freely passes vacuum to the EGR control valve, assuring rapid actuation.



THERE'S A BUILT-IN **EGR** SYSTEM in the camshaft valve overlap

By the way, there's another EGR system in the engine - one that's built in. You may have noticed that camshaft overlap has increased in the past few years. That is, there's been an increase in the length of time during which both the intake and exhaust valves are open on the intake stroke. This creates what might be called "internal EGR" since the piston, starting down on the intake stroke while the exhaust valve is still open, draws some exhaust gas back into the cylinder. However, this method of EGR causes a rough idle, so in 1975, Datsun engineers began to rely more heavily on the EGR valve and less on camshaft NO_x control. For instance, on the 1975 280Z, camshaft valve overlap was reduced by more than twenty-five percent.

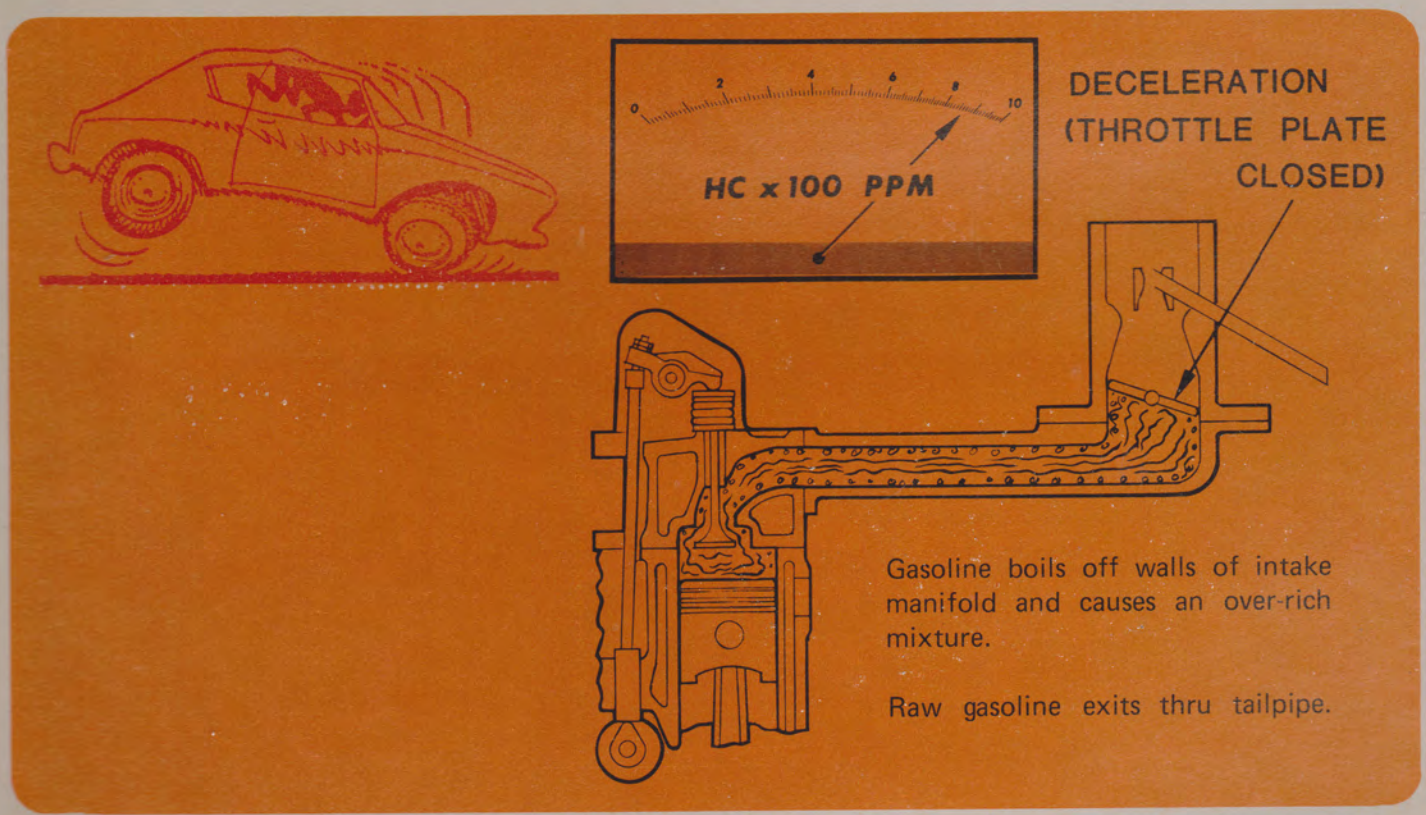
Of course, all engines must have SOME valve overlap to insure good performance at high speeds.



OVER-RICH MIXTURE OCCURS DURING DECELERATION

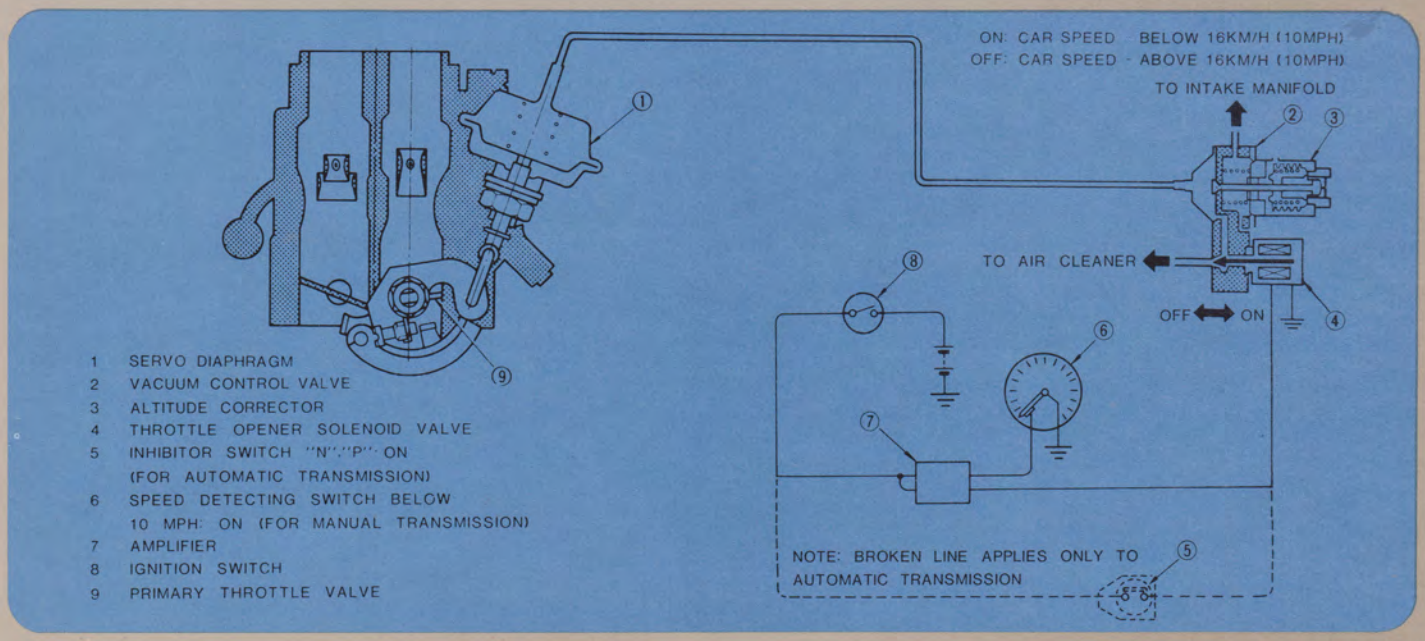
During deceleration, HC emissions increase markedly due to the phenomena of "flash vaporization" - any liquid gasoline in the intake manifold boils off, or vaporizes, when the throttle plate snaps shut. (Refer to page 14 for a more detailed explanation of "flash vaporization".) In addition, since the rich idle circuit outlet is below the throttle plate, even more fuel comes from the carburetor and is vaporized in the intake manifold. By the time the mixture gets to the cylinders, it is far too rich to burn, and leaves the tailpipe as HC emissions.

Datsun engineers have developed effective ways to control HC emissions during deceleration. Let's take a look at how they've done this.



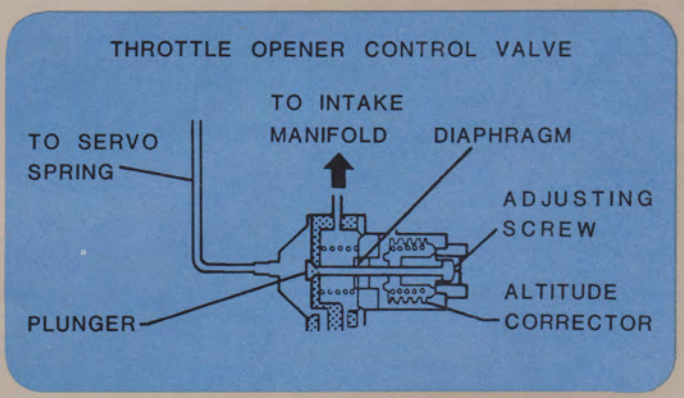
THROTTLE OPENER SYSTEM

Some Datsuns use a Throttle Opener Control System (T.O.C.S.) to limit HC on deceleration. This device is simply a vacuum servo connected to the throttle linkage. Vacuum applied to the servo diaphragm pulls the throttle linkage open a specific amount. The throttle opening prevents intake manifold vacuum from rising beyond a certain point, usually about nineteen in. Hg. This is not enough vacuum to cause flash vaporization.

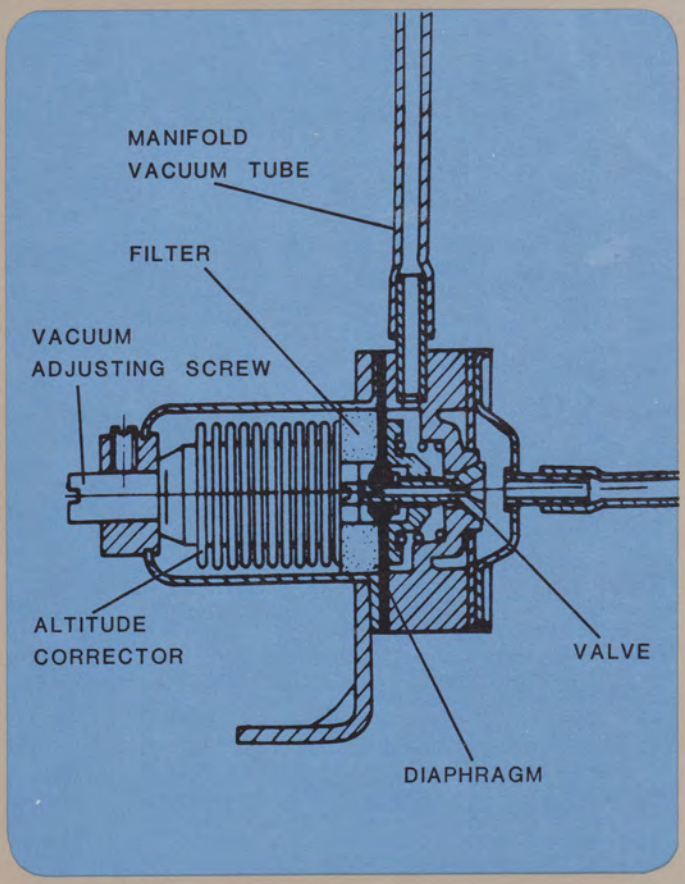


Connecting the Actuating Vacuum Line directly to the intake manifold would cause the servo to be activated all the time. Therefore, vacuum to the servo is controlled by an adjustable Vacuum Control Valve.

Here's a diagram of the Vacuum Control Valve. It consists basically of a plunger attached to a spring-loaded diaphragm. When manifold vacuum exceeds the "set pressure", spring tension is overcome, the plunger moves to the left and allows vacuum to be applied to the servo. The system is adjustable - turning the adjusting screw changes the tension of the diaphragm's spring and the strength of the vacuum required to open the plunger.

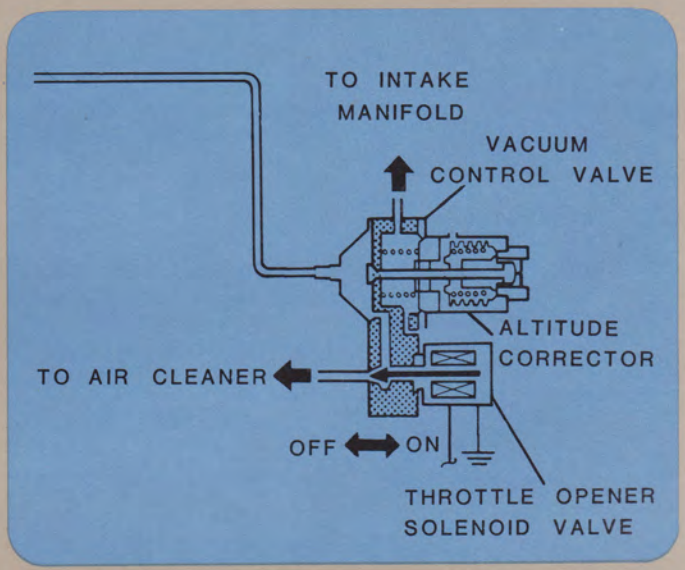


The valve also incorporates a so-called "altitude corrector". When altitude changes, manifold vacuum also changes. When you drive into the mountains, manifold vacuum may not rise high enough to open the valve. However, since atmospheric pressure drops at high altitudes, the vehicle tends to run richer at all times, so a deceleration control is still needed. Also, if the valve were adjusted to operate properly in the mountains, idle vacuum at sea level would keep the valve open all the time. A device that automatically corrects "set pressure" for changes in altitude is necessary.

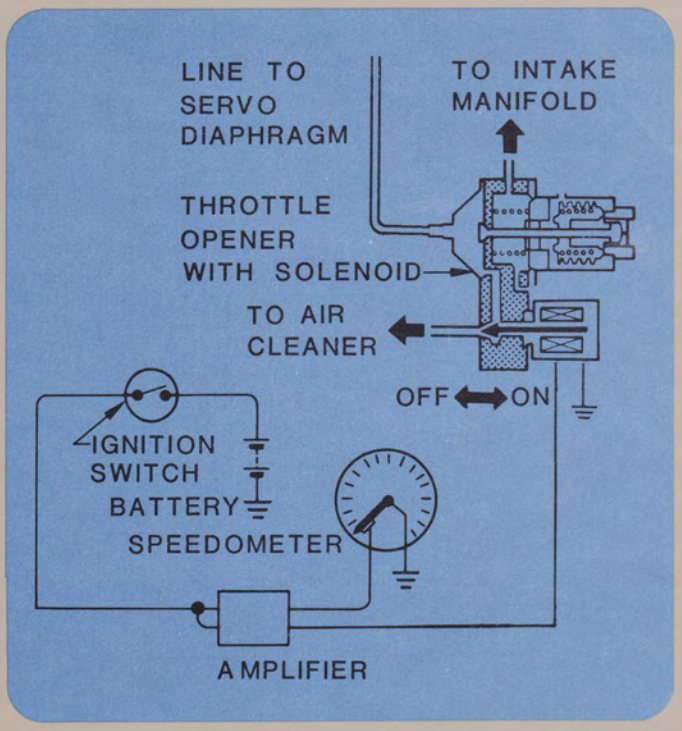


The device uses a sealed bellows containing a fixed amount of gas. As atmospheric pressure decreases at higher altitude, the pressure in the bellows causes it to expand and counteract the diaphragm spring pressure. This has the effect of lowering the set pressure.

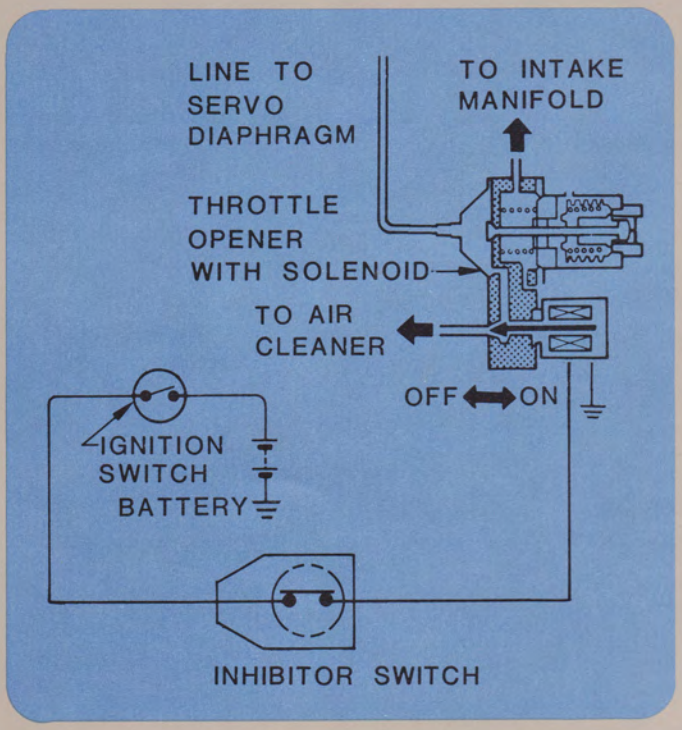
1973 or later models, using a throttle opener, also incorporate a relief solenoid in the Vacuum Control Valve. Energizing the solenoid relieves, or bleeds off, the vacuum which would go to the servo, preventing the servo from operating. The relief device keeps the throttle opener from holding the throttle open and keeping engine RPM too high, when the vehicle is stopped. If the control valve isn't adjusted properly, idle vacuum might be high enough to cause the system to operate, creating a safety hazard when the car was stopping, or it might cause the engine to "diesel" when the driver tried to turn it off.



On manual transmission models, the solenoid is energized when the speedometer needle comes to rest at its stop at ten miles per hour. When this happens, the amplifier is grounded, and current flows to the solenoid, thus bleeding off the servo vacuum.

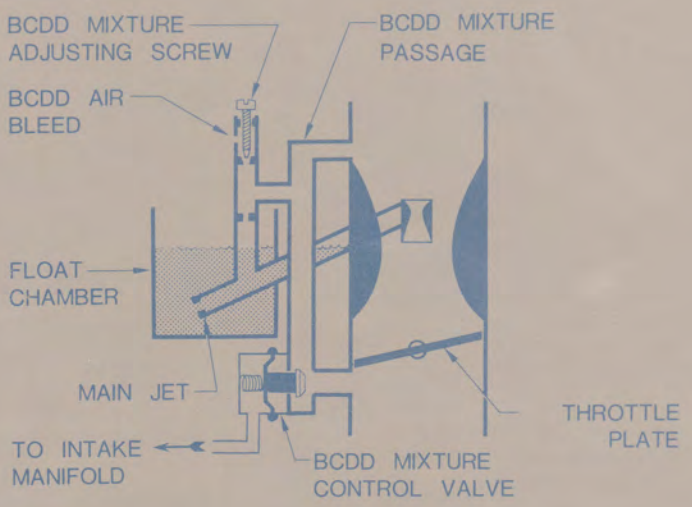


On automatic transmission models, the solenoid circuit is completed by the inhibitor switch whenever the gear selector is in either "Park" or "Neutral".

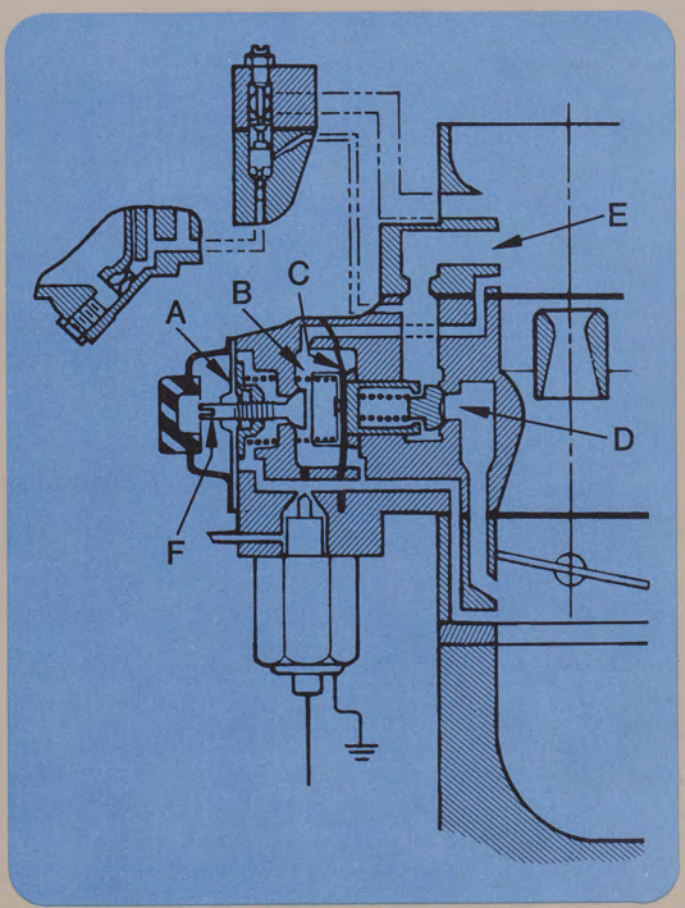


BOOST CONTROLLED DECELERATION DEVICE

Another type of deceleration emission control is the Boost Controlled Deceleration Device, or BCDD. "Boost" is a British term for vacuum, so the system can be called a Vacuum Controlled Deceleration Device. All this device does is open a passage which allows a special air fuel mixture to be by-passed around the secondary throttle plate.

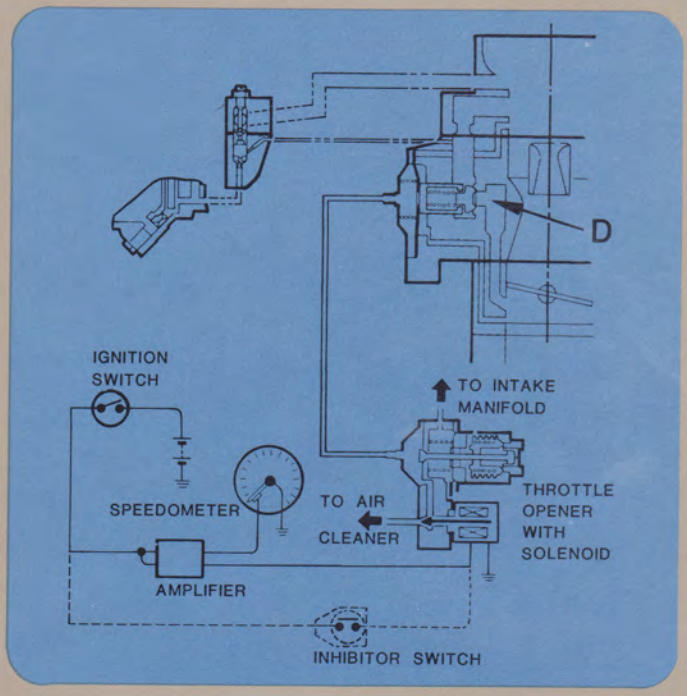


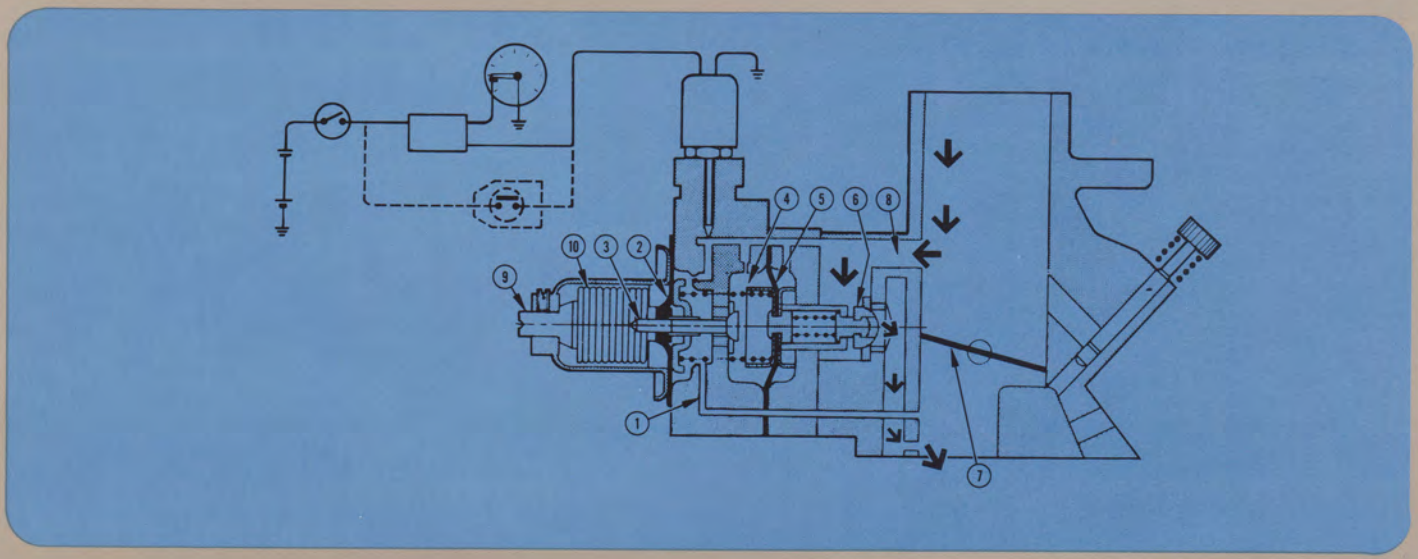
Special fuel and air coasting jets built into the carburetor supply the special mixture. As with the Throttle Opener, manifold vacuum cannot rise to the point where flash vaporization could occur. There are three different types of BCDD. Let's take a look at each.



The first type is an assembly located on the side of the carburetor. When manifold vacuum rises high enough, it moves diaphragm A, which in turn opens the port at B. Vacuum passes into a second diaphragm chamber, where it moves the secondary, or servo, diaphragm, C. When this happens, the large port at D is opened. Air then flows through passage E, where it mixes with an air/fuel mixture supplied by the coasting fuel and air jets. This mixture is preset at the factory by calibrating the size of the air bleed. The reason for using two diaphragms instead of one is to assure better control over the exact set pressure, which is adjustable at point F. Also, notice that the vacuum relief system is actuated in the same manner as on the T.O.C.S.

This type of BCDD was first used on California cars since 1975. It functions in exactly the same manner as the other type: that is, when manifold vacuum rises high enough, carburetor passage **D** is opened. However, only the servo diaphragm is mounted on the side of the carburetor; this system uses the same Vacuum Control Valve as used on the TOCS. The major difference between the two types of BCDD's is that this later design incorporates an altitude corrector, whereas the other type does not. Also, notice that the vacuum relief system is, once again, actuated in the same way.





This is the BCDD used on the fuel injected 280Z and 810 models. It's operation is similar to other BCDD's, except that this one passes only air around the throttle plate. This is because the Electronic Fuel Injection System can add any necessary fuel. Here's how the device works: manifold vacuum is sensed at passage (1). When the vacuum rises beyond the "set pressure", diaphragm (2) moves plunger (3) to the left, admitting vacuum to chamber (4).

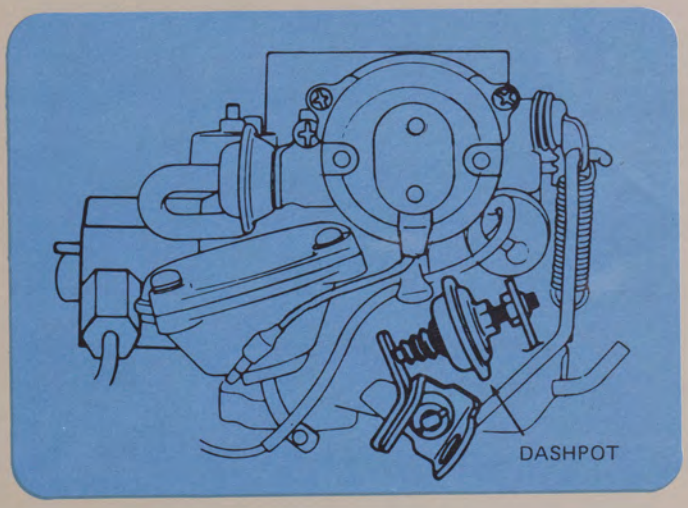
Here the vacuum acts on the secondary servo diaphragm (5), which opens the air control valve (6). Air can now flow around the throttle plate (7) through air passage (8). The set pressure is adjustable at point (9), and the valve assembly includes a built in altitude corrector (10) which functions the same way as with other deceleration devices. Finally, notice that the vacuum relief system works the same way as with other deceleration devices.

DASHPOT

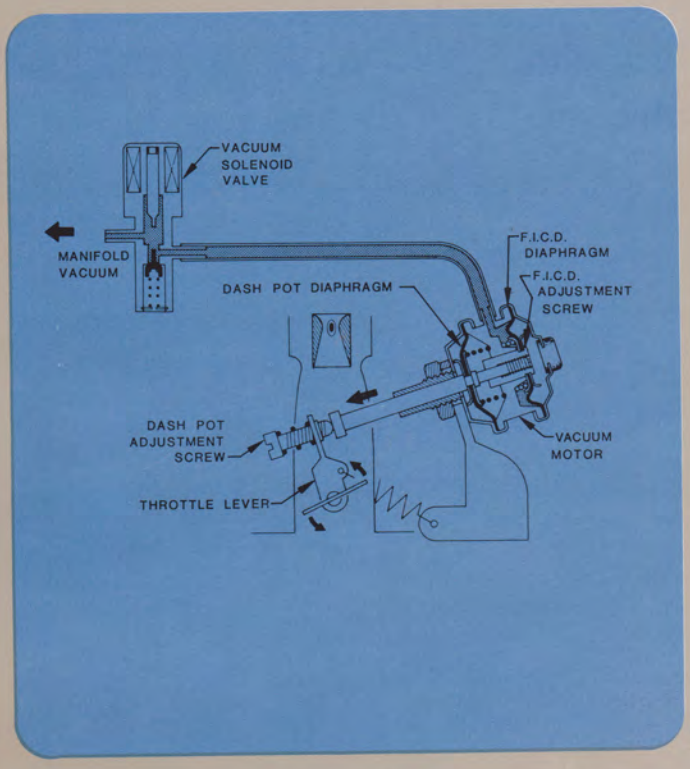
The simplest type of deceleration emission control device is the dashpot. As you probably know, this device has been used for many years on automatic transmission cars to prevent the throttle from closing too rapidly, which could cause the engine to die.

As far as emission control is concerned, the dashpot still does the same thing, but for a different reason. That is, the dashpot slows down the closing of the throttle, thus helping to prevent the manifold vacuum from rising high enough to cause flash vaporization.

Some Datsun models employ both a BCDD and a dashpot. This dual system provides extra insurance against both high HC emissions and engine dying during deceleration.


DASHPOT

Some newer Datsuns equipped with air conditioning employ a combined dash pot and Fast Idle Control Device (F.I.C.D.). This system insures against high emissions and fast idle speed while the air conditioner is in operation. As long as the air conditioner compressor is operating, the vacuum solenoid valve is energized and passes intake manifold vacuum to the vacuum servo. Vacuum pulls down on the F.I.C.D. diaphragm and plunger. Since the plunger is in direct contact with the throttle linkage, idle speed is increased. This small increase in idle speed is needed for proper engine operation while the air conditioner is on. The second or lower part of this dual device consists of a dash pot plunger supported by the dash pot diaphragm. This prevents the throttle from closing too rapidly during deceleration.

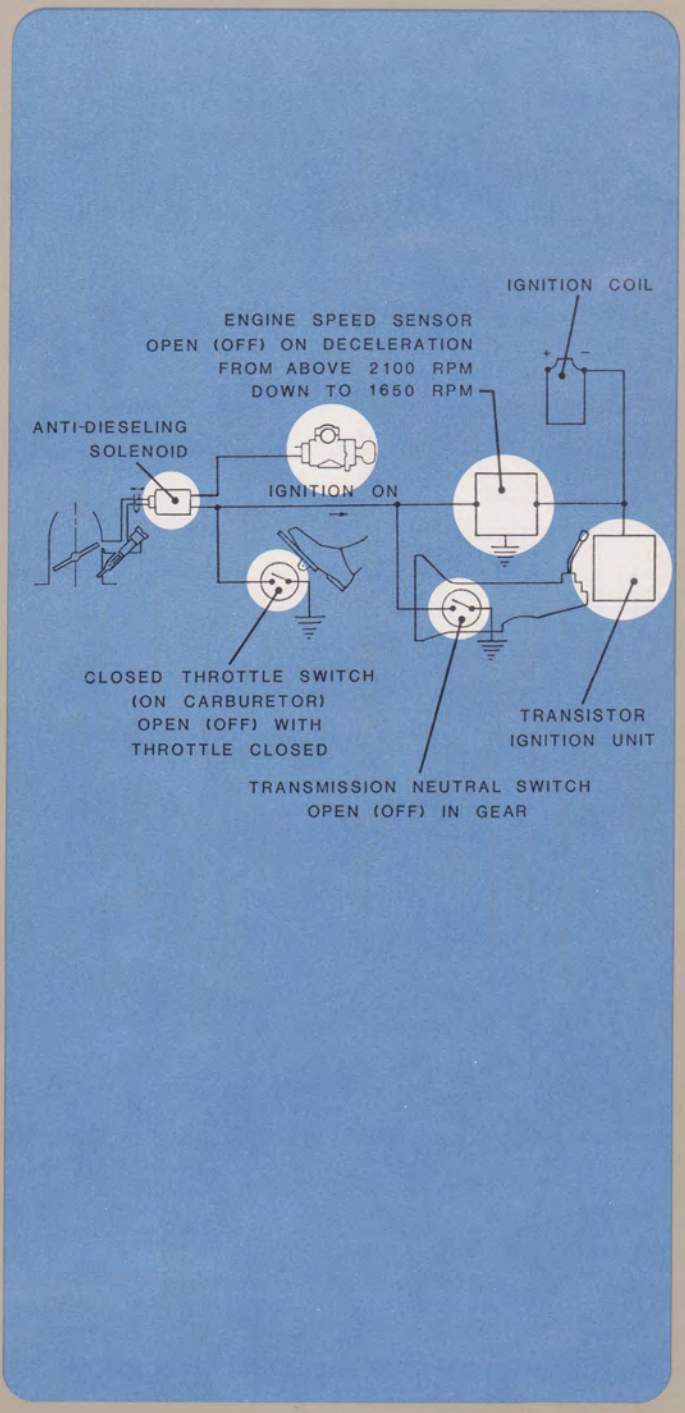


DECELERATION FUEL SHUT-OFF SYSTEM

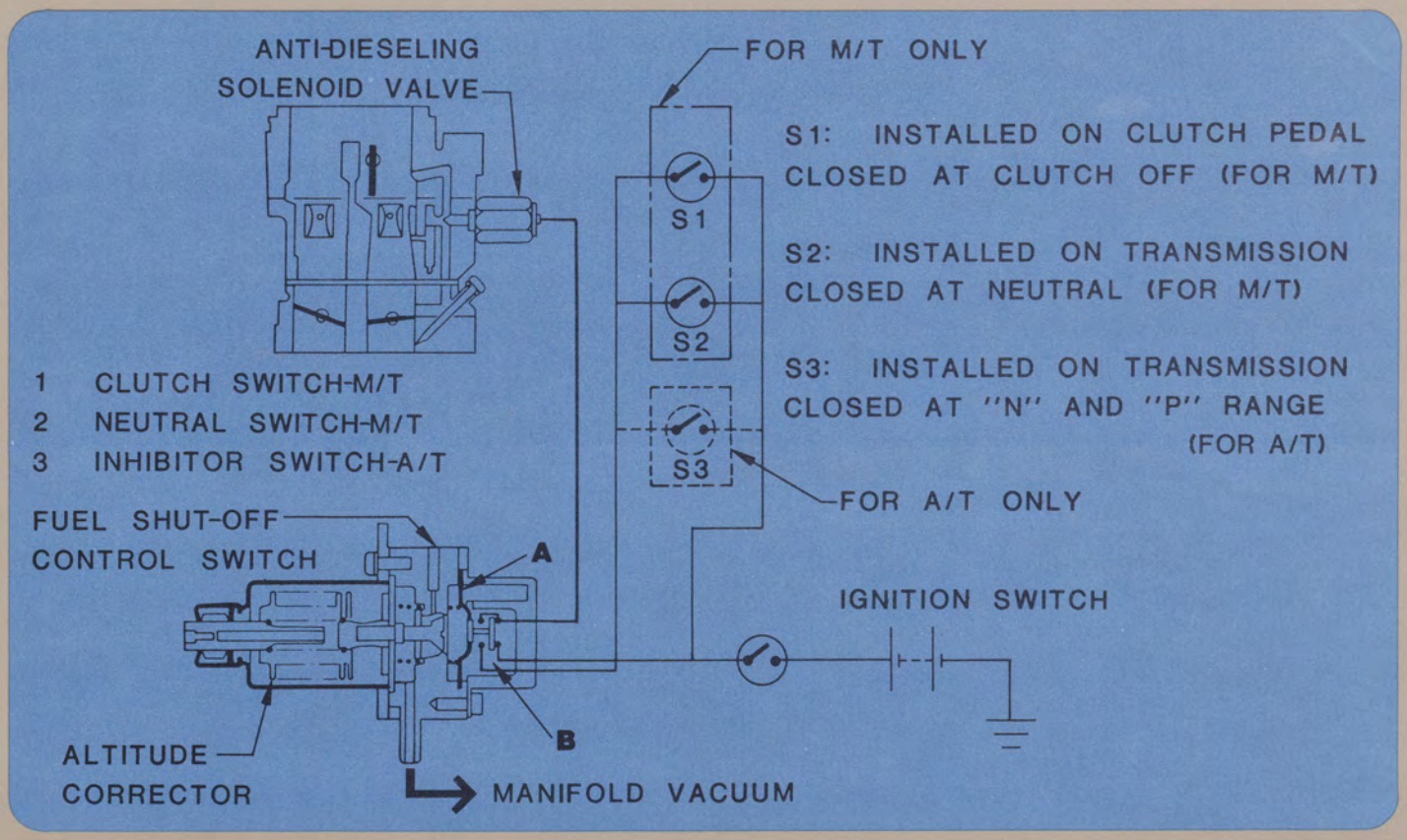
The third type of deceleration system is the fuel shut-off system, used in the Federal B210 Plus. The anti-dieseling solenoid, installed on many Datsuns for a number of years, receives current directly from the ignition switch. On deceleration, however, the solenoid ground circuit can be interrupted by any of three switches, causing the anti-dieseling solenoid plunger to close off the idle current fuel passage.

During all normal cruising and part-throttle operation, the anti-dieseling solenoid is grounded at a throttle switch located on the carburetor. When the accelerator pedal is released, the throttle switch opens and the fuel flow through the anti-dieseling solenoid will be shut off. However, in neutral, the anti-dieseling solenoid can also be grounded at a second switch, located on the transmission. This allows the engine to idle normally in neutral.

The third switch for the anti-dieseling solenoid is located in a transistorized engine speed sensor, inside the passenger compartment. The speed sensor is connected to the transistor ignition unit and senses the speed of the engine. During deceleration, from above 2100 rpm down to 1650 rpm, the sensor opens the ground circuit for the anti-dieseling solenoid, turning it off. Once the engine speed drops down below 1650 rpm, the switch again makes contact and the anti-dieseling solenoid allows fuel to flow for normal idle operation.



620 CALIFORNIA, FUEL SHUT-OFF SYSTEM



A slightly different fuel shut off system is used on some California pick-up trucks starting in 1978. On these trucks, the transistorized speed sensor is replaced by a fuel shut-off control switch. This switch turns the anti-dieseling solenoid off during deceleration, according to throttle position and manifold vacuum conditions. The switch also contains a built-in altitude compensator to provide automatic adjustments to changes in altitude.

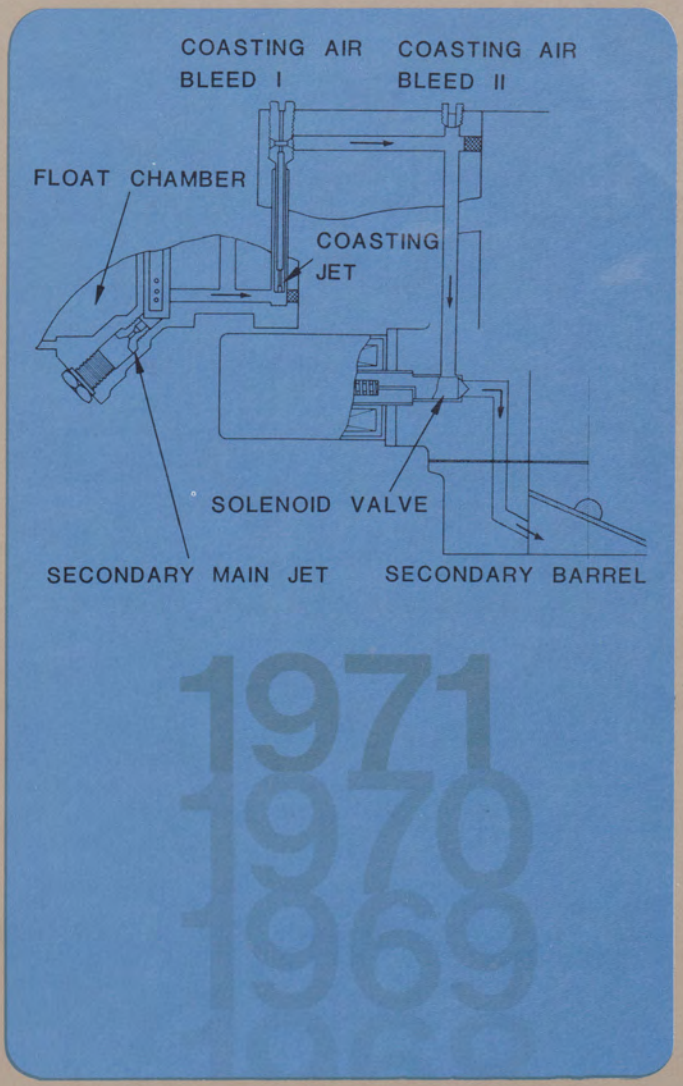
To assure proper engine operation while shifting through gears or stopping for a traffic light, the engineers have installed switches on the clutch and transmission. The clutch switch supplies current to the anti-dieseling solenoid while the clutch pedal is depressed, and the neutral switch supplies current while the shift lever is in neutral.

On automatic transmission models, current to the anti-dieseling solenoid is controlled by the inhibitor switch, as long as the shift lever is in park or neutral.

THERE ARE TWO OTHER DEVICES

There are two other devices used in the past, but discontinued before 1972, that we'll mention briefly so you'll recognize them if you see them in the shop. You'll find information on these systems in your Engine Analysis Service Guide. The first, a forerunner of the BCDD valve, was a solenoid mounted on the side of the carburetor. This opened a passage around the throttle plate, allowing an air-fuel mixture to pass into the manifold. This solenoid, installed on 1970 and 1971 model L16 engines, was energized by a series of switches which sensed when the throttle was released with the engine in gear. It was replaced by a simpler, vacuum-operated BCDD valve.

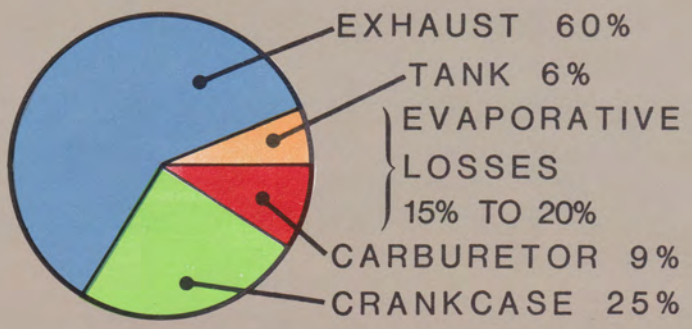
An even earlier solenoid valve served to cut off the idle fuel entirely during deceleration. This solenoid was built into the carburetor on early pick up trucks, and performed the same job as an anti-dieseling solenoid, except that it was activated only during deceleration in gear. During idle conditions, the idle circuit operated normally. The system is described in the appendix of your Engine Analysis Guide.



EVAPORATIVE EMISSIONS CONTROL

In 1972, Nissan Motor Company began installing systems on Datsuns to control the amount of fuel vapors which could escape to the atmosphere, since fuel vapors are actually hydrocarbons, and about 15 to 20% of the total hydrocarbons from a vehicle come from losses by evaporation. It's important to prevent these emissions.

1. CARBURETOR VENTING
2. FLOW GUIDE VALVE
3. CHARCOAL CANISTER STORAGE



CARBURETOR VENTING

Two sources of these emissions have been eliminated. First, before the days of emission controls, the carburetor float bowl was often vented directly to the atmosphere. Now, however, the vents are located inside the air cleaner. Any gasoline which evaporates passes through the air filter before reacting to the outside air.

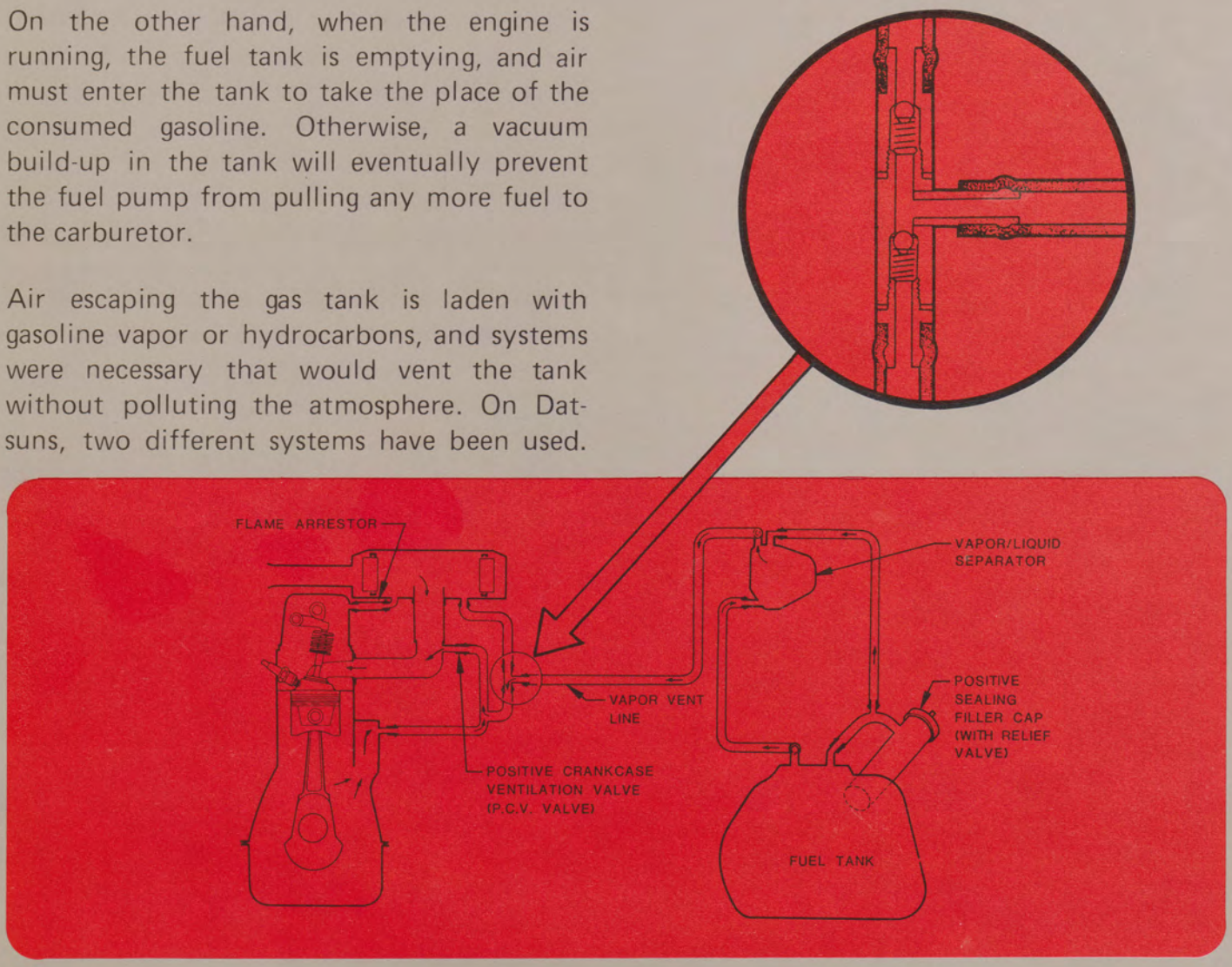
GAS TANK VENTING

The greatest source of evaporative emissions is the gas tank. Before emission controls, the gas tank vented through the gas cap directly to the outside air. On a hot day, gasoline inside the tank expands, creating fuel vapor, and building pressure in the tank. Some way must be developed to let the pressure bleed off. Otherwise this pressure will force gasoline through the fuel line into the carburetor, and the carburetor will eventually flood. Therefore, the gas cap used to be designed so that when pressure built up in the tank, it would be bled off to the outside air through the cap.



On the other hand, when the engine is running, the fuel tank is emptying, and air must enter the tank to take the place of the consumed gasoline. Otherwise, a vacuum build-up in the tank will eventually prevent the fuel pump from pulling any more fuel to the carburetor.

Air escaping the gas tank is laden with gasoline vapor or hydrocarbons, and systems were necessary that would vent the tank without polluting the atmosphere. On Datsuns, two different systems have been used.



FLOW GUIDE VALVE SYSTEM

The first system used a "flow guide valve" to direct fuel vapors in or out of the fuel tank and out of the air cleaner or into the crankcase. The flow guide valve let the tank draw in fresh air from the air cleaner, while directing fuel vapors from the tank into the PCV valve line. Let's take a closer look at how this system operates.

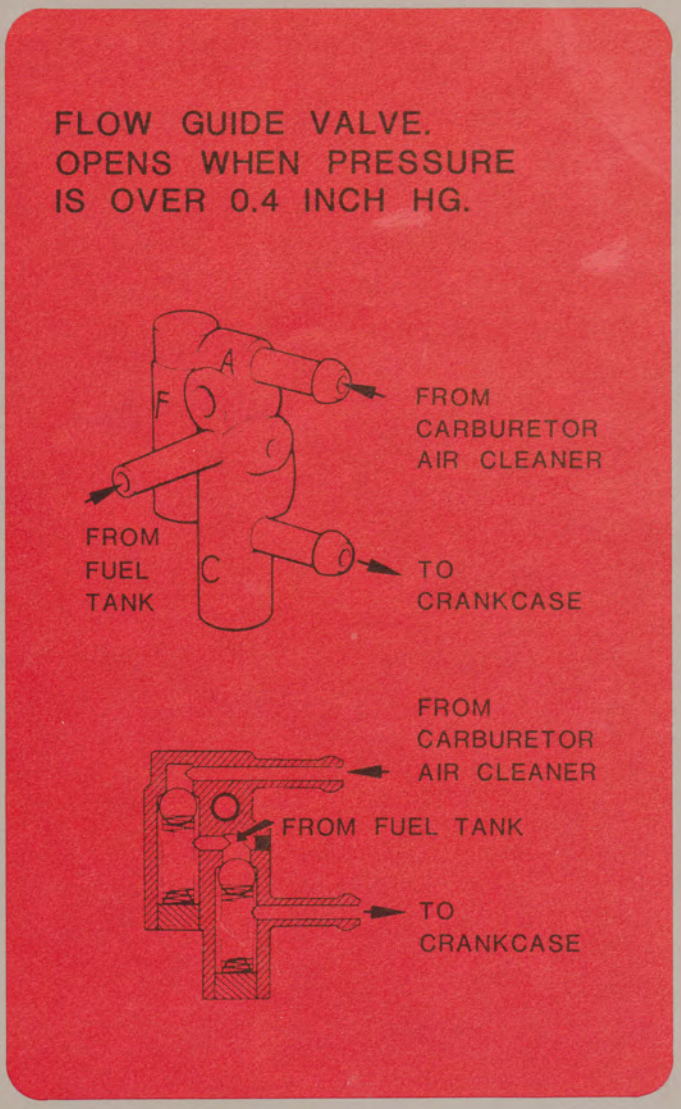
Fuel vapors leaving the tank travel through vent lines to a liquid-vapor separator, above the tank, in a relatively cool location. Since the separator is cooler than the tank, fuel vapors tend to condense, and drop back into the tank through the vent lines. The remaining fuel vapor passes from the separator through a single line to the flow guide valve, mounted in the engine compartment.

The flow guide valve lets pressure, built up in the tank, bleed off into the crankcase, where the vapors are stored. The flow guide valve is connected to the PCV line, and once the engine starts, the vapors are pulled through the PCV valve and into the intake manifold.

As the fuel level in the tank drops, it is necessary to add or vent air to prevent a vacuum from building up. When pressure in the tank drops, the flow guide valve opens a passage between the air cleaner and the tank vent line. At the same time, it closes the line between the tank and the crankcase, preventing blow-by vapors from passing back into the gas tank.

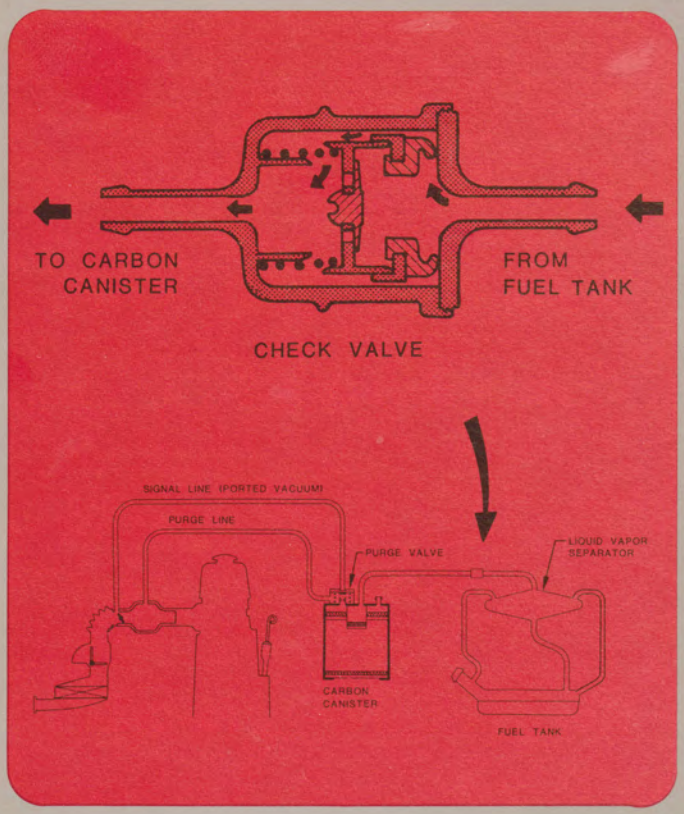
Therefore, the flow guide valve really contains two one-way valves, which let fresh air pass from the air cleaner to the tank, and fuel vapors pass from the tank to the PCV valve.

While it shouldn't be necessary to check this system during every analysis, we have covered it because a sticky valve causes the engine to run too rich or too lean. You should also be aware that, later in the production run, the gas cap was changed from a completely sealed type to one which vents inward only if the flow guide valve failed and a vacuum built up in the fuel tank.

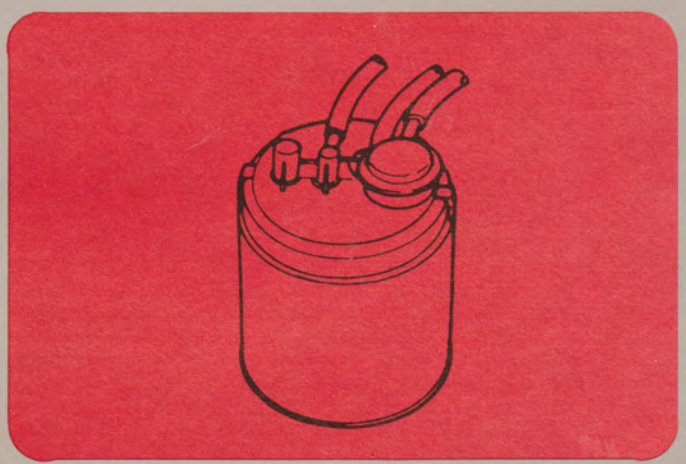


IMPROVEMENTS ON THE EVAPORATIVE EMISSION CONTROL SYSTEM

A later type of evaporative control system was installed on the 240-Z in 1973, and on all Datsuns in 1974. The newer system did away with the flow guide valve, and also with the use of the crankcase for vapor storage. Instead, this new system uses a carbon canister to store the vapors until the engine starts. Let's look at how the system operates.



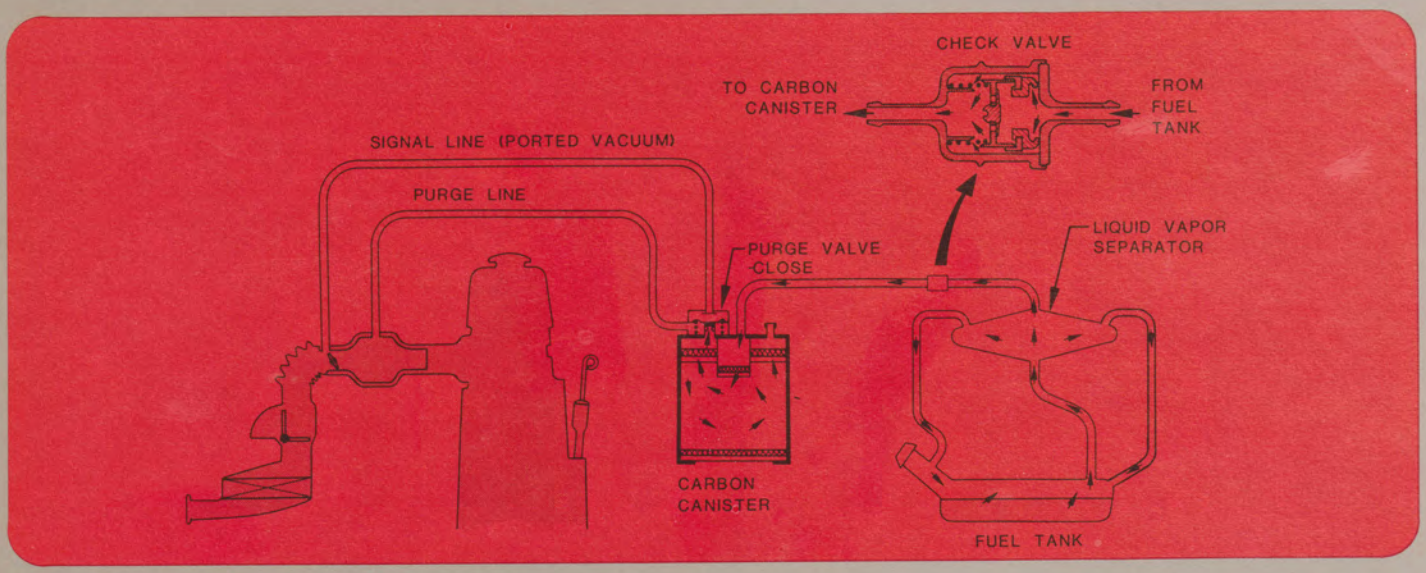
The system is basically the same on all Datsun vehicles. It consists of the liquid vapor separator located above the fuel tank; a check valve, to prevent fuel from flowing from the tank to the engine compartment in the event of an accident; a carbon canister, to store fuel vapors; a purge valve, located on the canister, which controls the flow of fuel vapors into the manifold; a ported vacuum signal line; and finally a purge line.



The carbon canister is filled with activated carbon, a substance which attracts hydrocarbons and holds them until they are purged by fresh air. A filter in the bottom of the canister prevents dirt from entering and contaminating the carbon. There are three lines located on the top of the canister. From left to right, they are the vapor line from the fuel tank, the purge line to the intake manifold, and the vacuum signal line which leads to ported vacuum.

ENGINE OFF OR IDLING

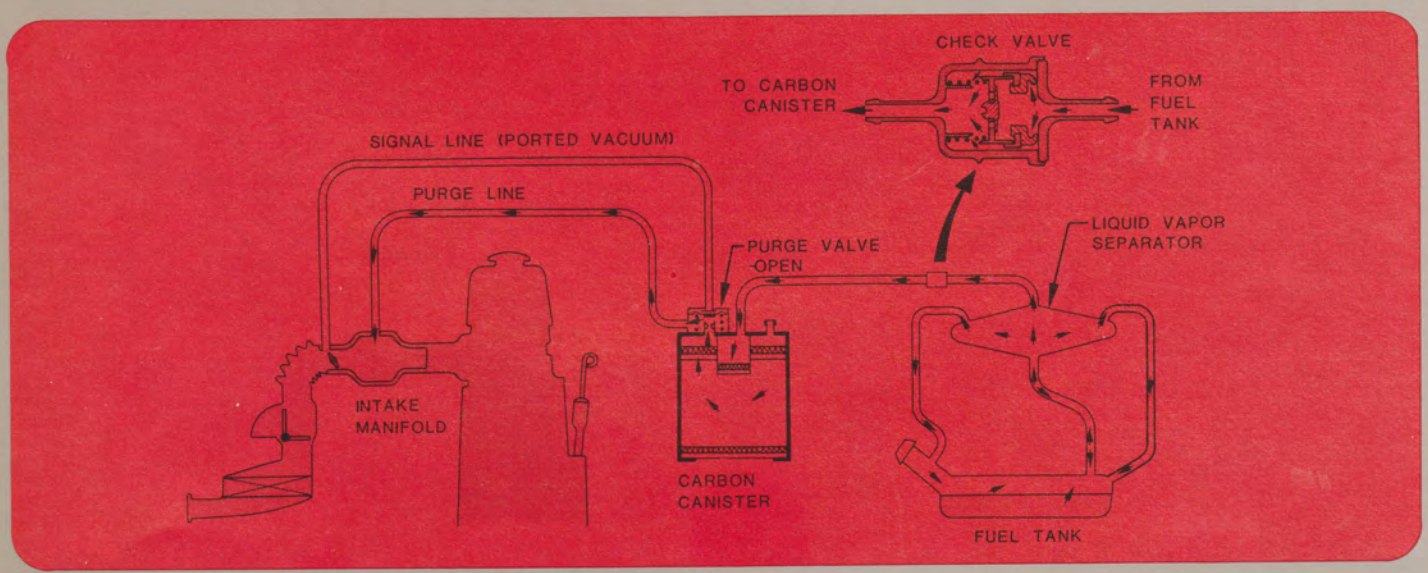
When the engine is off or idling, there is no ported vacuum available at the signal line. Fuel vapor from the fuel tank rises into the liquid vapor separator where it condenses and goes back into the tank as a liquid. The remaining vapor passes through the check valve and into a carbon canister, where it is trapped.



CRUISING

During cruising, the vacuum in the signal line rises, and the purge valve opens. Fresh air is drawn through the bottom of the canister to clean the hydrocarbons off the charcoal. This air, along with the fuel vapor, is drawn into the intake manifold, where it is burned.

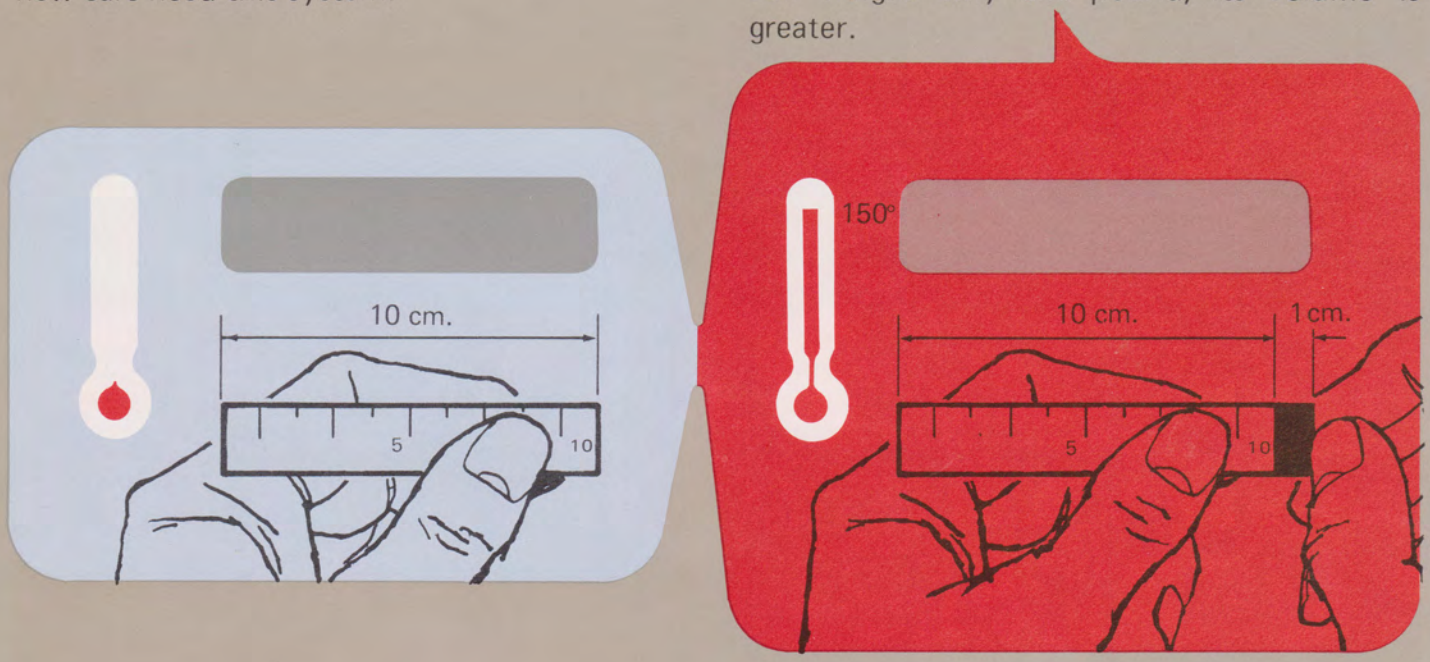
On the 1974 260-Z, the purge valve was also open to the manifold at idle. The size of the opening was very small, and the flow of vapors to the manifold through the bleed line was either small, at idle, or large, once the throttle plate was opened.



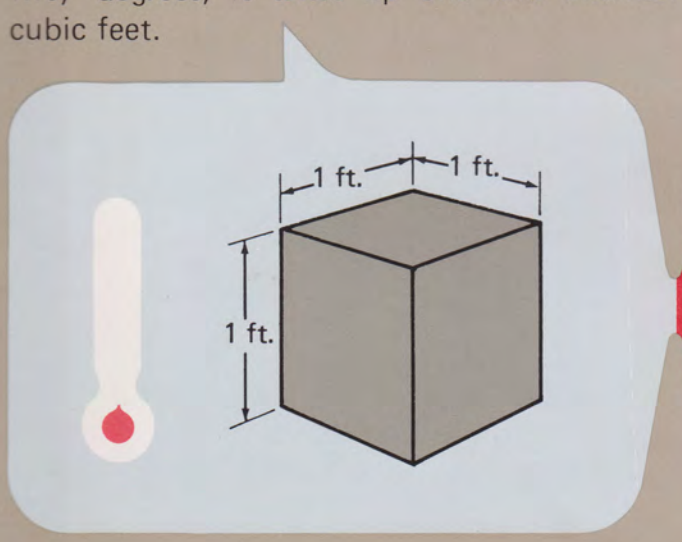
AUTOMATIC TEMPERATURE CONTROL AIR CLEANER

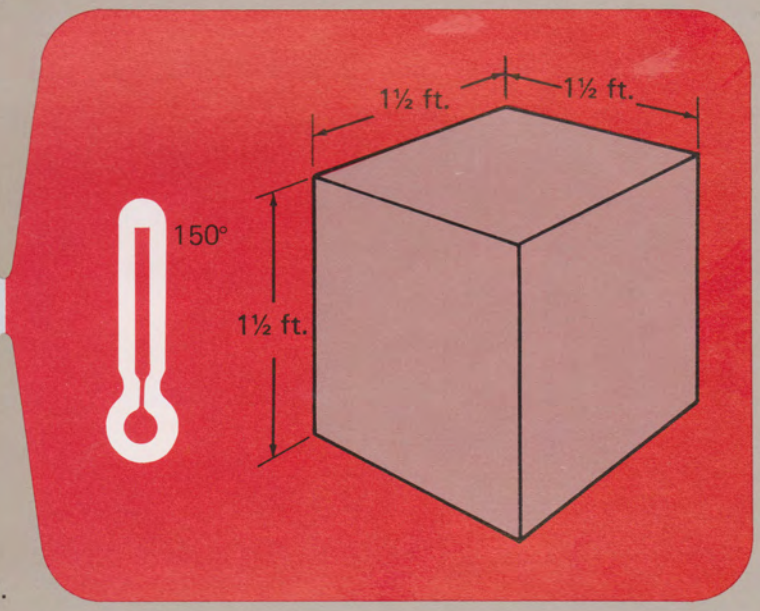
The Automatic Temperature Control Air Cleaner (ATC) plays a very important role in engine performance and emissions control by helping the engine receive the proper air/fuel mixture under all operating temperatures. Pre-emission control cars didn't have A.T.C. air cleaner, and you may wonder why new cars need this system.

Whenever something is heated, it expands. The weight of the substance remains the same, but it takes up more space, or volume. A one pound metal bar which is ten inches long at fifty degrees may expand to eleven inches when its temperature is raised to one-hundred and fifty degrees. Although it still weighs only one pound, its volume is greater.

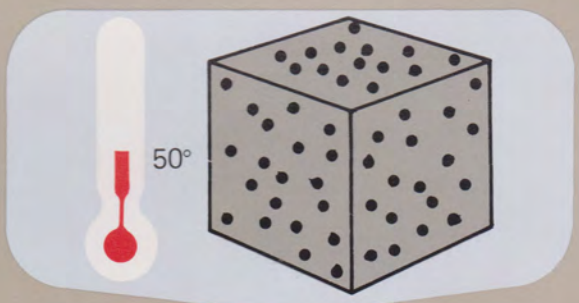


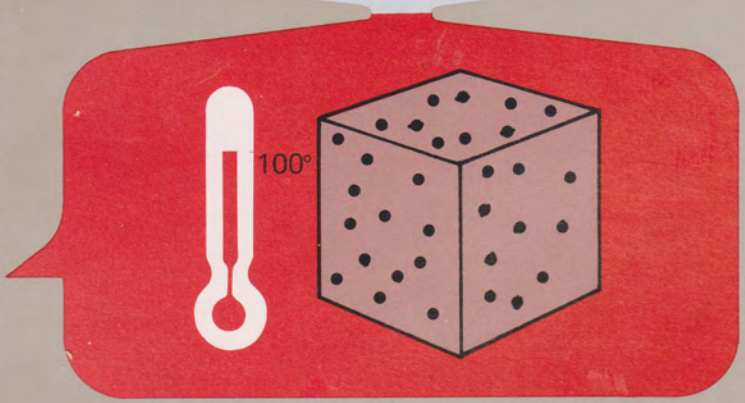
Air expands and contracts with temperature change, just like any other substance. A pound of air might take up one cubic foot of space at fifty degrees. But at one-hundred fifty degrees, it takes up one and one-half cubic feet.





Density refers to the weight of a substance. While a cubic foot of air might weigh one pound, a cubic foot of steel might weigh one-hundred pounds, since steel is much denser than air. But density changes with temperature. Remember, all substances are made up of molecules. A box holding one cubic foot of air will contain a certain number of molecules of air at fifty degrees. But the same box at one hundred fifty degrees will contain fewer molecules of air, since some of the air will have expanded and moved outside the box.





Thus, air expands as temperature rises. That is, the density of air inside the box drops, because there are fewer molecules. What does this have to do with emission control?

THE CARBURETOR MIXES CERTAIN PORTIONS OF GASOLINE AND AIR



Carburetors mix a certain volume of gasoline with a certain volume of air, but cannot take into consideration the density of air.

Let's say the carburetor is designed to mix one cubic foot of gasoline with ten cubic feet of air. At fifty degrees, there would be a great many molecules of air in the ten cubic feet. But at one-hundred fifty degrees, there would be fewer air molecules in that same ten cubic feet. With the air at fifty degrees, the actual air/fuel ratio will be somewhat leaner (because there are more air molecules) than with one-hundred fifth degree air. In pre-emission controlled cars, this was unimportant. The carburetor simply provided enough fuel to mix with the dense, cold air. Of course, this meant the mixture was overly rich when the intake air was very hot. There wasn't enough oxygen to fully combine with all the fuel, so the result was higher HC and CO emissions. However, on emission-controlled cars, the carburetors are designed to provide a much leaner mixture under normal operating conditions, thus limiting HC and CO.

COLDER AIR MEANS LEANER MIXTURE



COLD CU.FT. OF AIR HAS MORE AIR PARTICLES

+



ONE PARTICLE OF GASOLINE

= 10 to 1

LEANER MIXTURE



HOT CU.FT. OF AIR HAS FEWER AIR PARTICLES

+

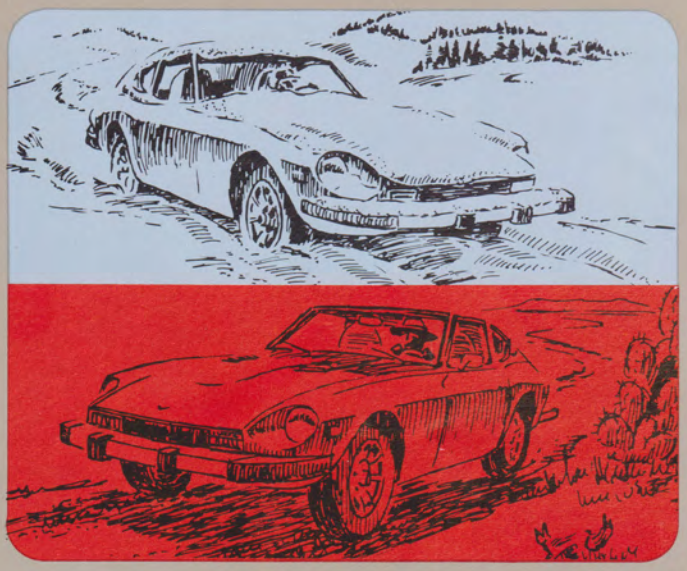


ONE PARTICLE OF GASOLINE

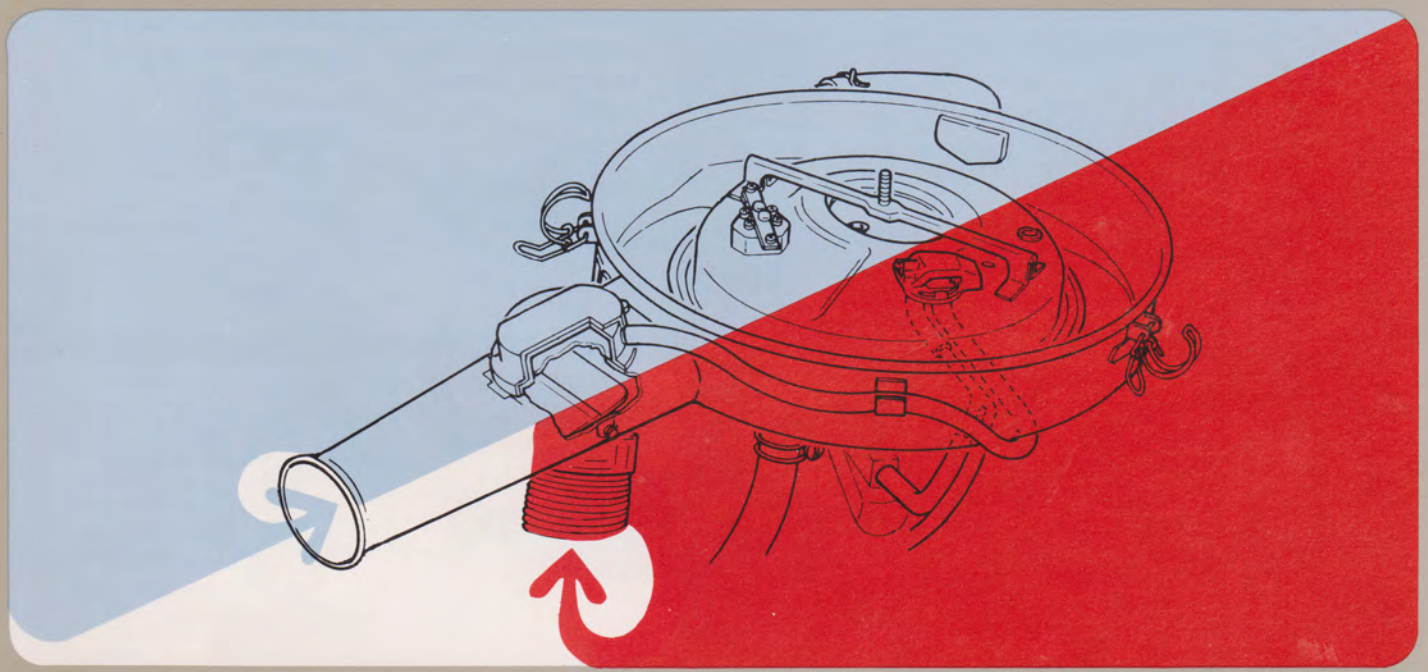
= 5 to 1

RICHER MIXTURE

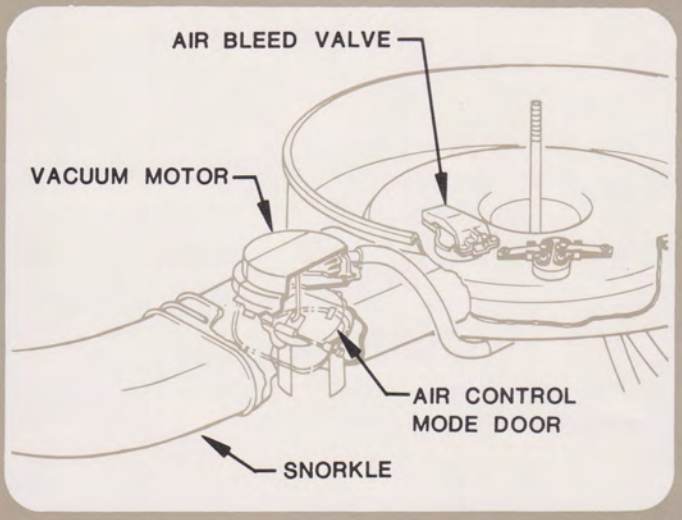
If the intake air temperature varies greatly, as it does during different seasons, the car would run too lean during cold weather and too rich during hot weather. The results could be surging during cold operation and high emissions during the summer. So, ATC comes to the rescue, keeping the intake air temperature nearly the same under all operating conditions.

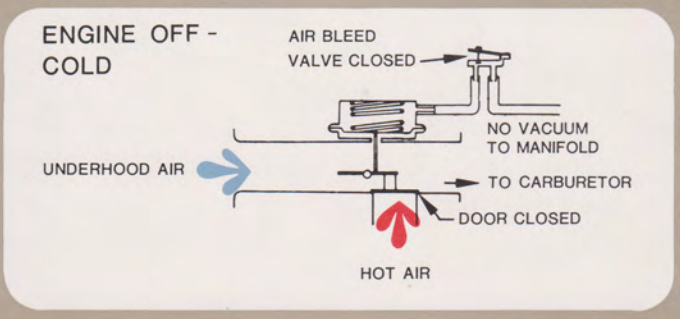


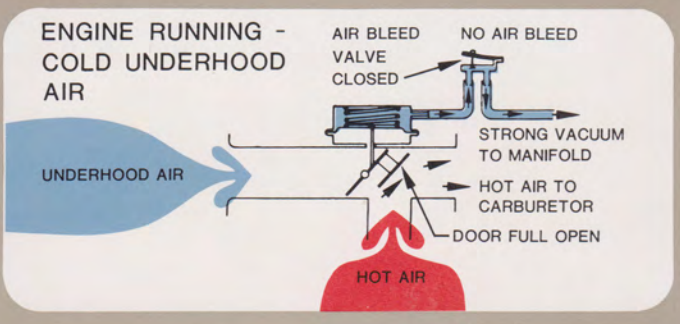
Air enters the air cleaner through two different passages. These are the fresh or cold air snout, and the hot air pipe, which draws air from around the hot exhaust manifold. A special door in the air cleaner intake controls which passage the intake air will come from.

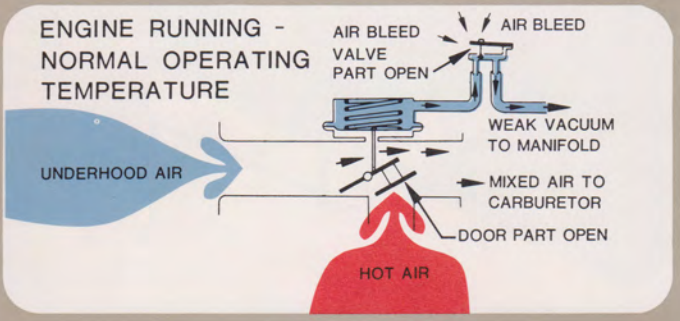


The system consists of an air control mode door mounted in the air breather inlet. The mode door is controlled by a diaphragm and a diaphragm spring. The intake manifold supplies vacuum to the diaphragm. The strength of the vacuum is controlled by an air bleed valve inside the air cleaner. The valve responds to changes in air temperature by opening or closing the bleed to allow a stronger or weaker vacuum to act against the air control mode door. During cold weather operation, the air bleed valve is fully closed, and full vacuum is applied to the diaphragm. The air control mode door is pulled all the way up and hot air, heated by the exhaust manifold, is pulled into the carburetor. As the temperature of air coming into the air cleaner warms up, the air bleed valve begins to open; the vacuum acting on the diaphragm weakens; the air control mode door closes off the hot air opening and allows outside air to enter. During normal operation, a constant balance is maintained between hot and cold air, keeping the temperature inside the air cleaner at a constant 110°.





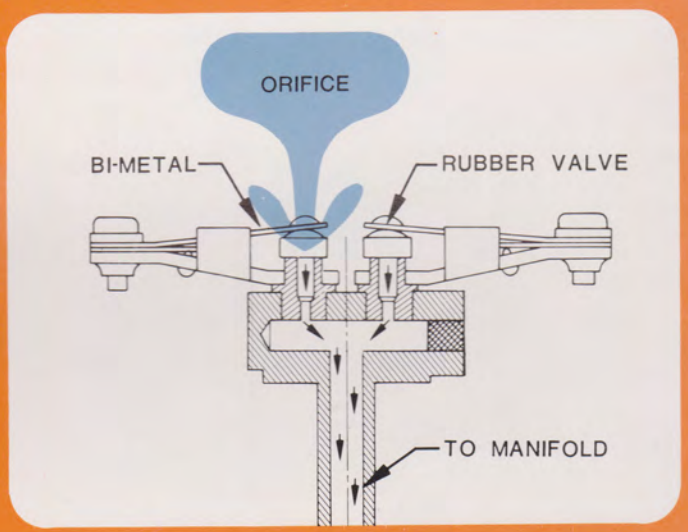




IDLE COMPENSATOR

Before leaving the subject of temperature and mixture ratio, let's look at one more device you'll find in the air cleaner. This is the Hot Idle Compensator. At idle, there is very little air flow through the engine compartment. Even if the ATC air cleaner is functioning properly, the temperature inside the air cleaner can cause the air to be very thin. The result is a rich idle mixture, which in turn causes a rough idle and high emissions. To prevent this, the idle compensator opens a special air bleed into the manifold to add extra air, leaning out the mixture.

The idle compensator is a bi-metallic valve. When it's cold, the valve is closed. When the bi-metal heats up, however, it bends upward, creating a vacuum leak. Extra air bleeds directly into the intake manifold, leaning the fuel mixture.



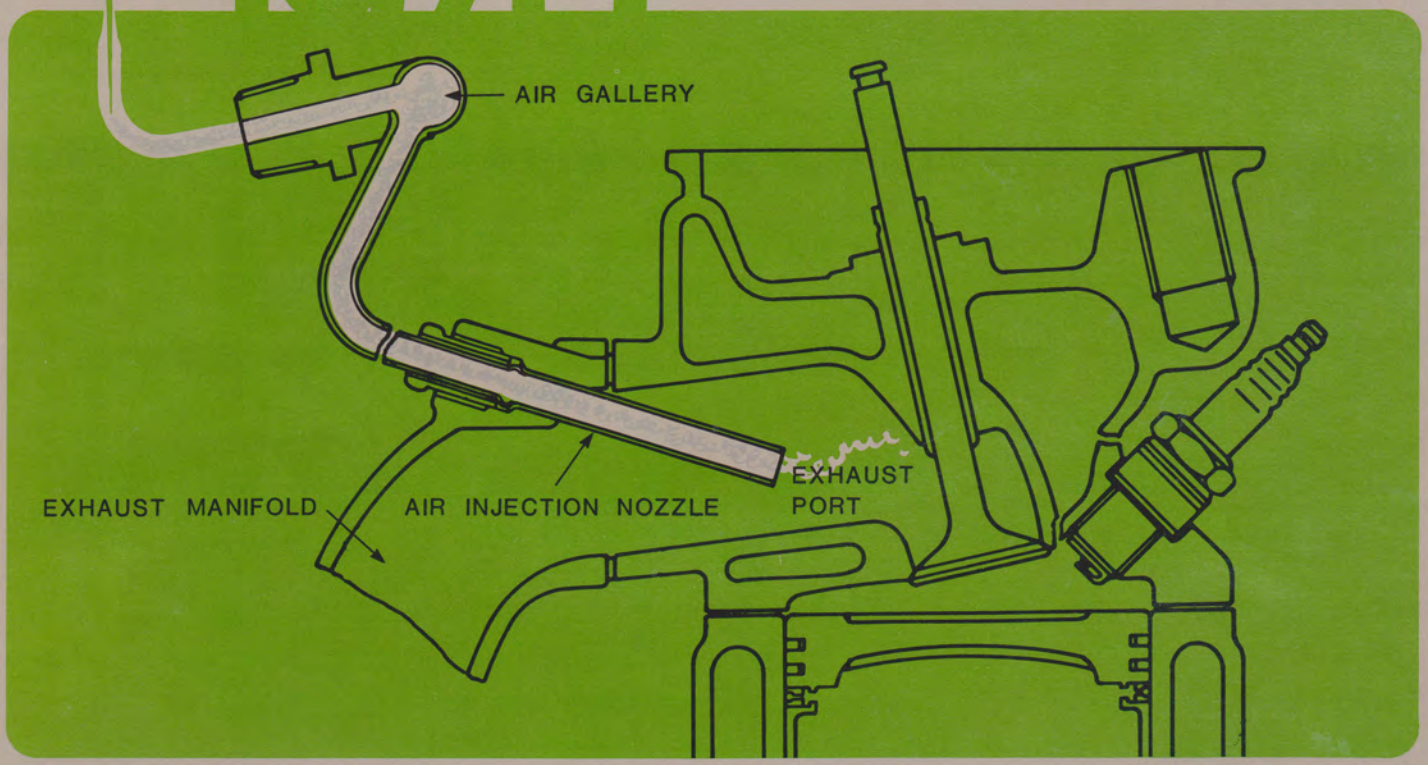
Some vehicles use dual idle compensators. On these vehicles, one compensator opens at around one-hundred thirty degrees. If the temperature continues to rise, the second compensator will open, allowing still more air to enter the manifold.

THE AIR INJECTION SYSTEM

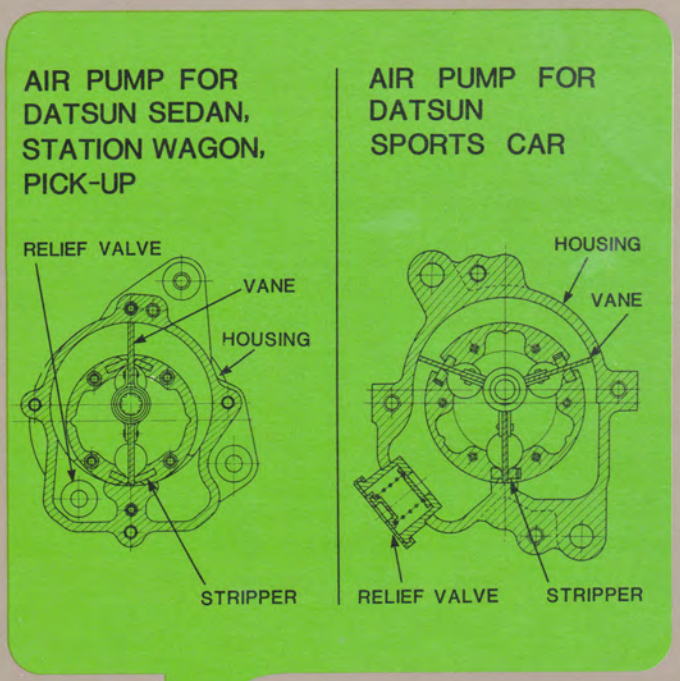
1968
1969
1970

The Air Injection System is among the oldest of emission control systems. In fact, it was first used on Datsun vehicles in 1968. The operation of the system is very simple. During normal combustion, many particles of unburned gasoline, or hydrocarbons, leave the combustion chamber and pass into the exhaust system. These pollutants are formed because there isn't enough oxygen to go around during normal combustion, and some of the gasoline is only partly burned or isn't burned at all. However, when the pollutants enter the exhaust system, they are already hot enough to burn.

The engineers took advantage of this by injecting fresh air into the exhaust manifold right behind the exhaust valve, supplying additional oxygen to combine with the unburned gases. By the time the exhaust reaches the tailpipe, it is much cleaner. In other words, the exhaust system has been turned into an "afterburner".

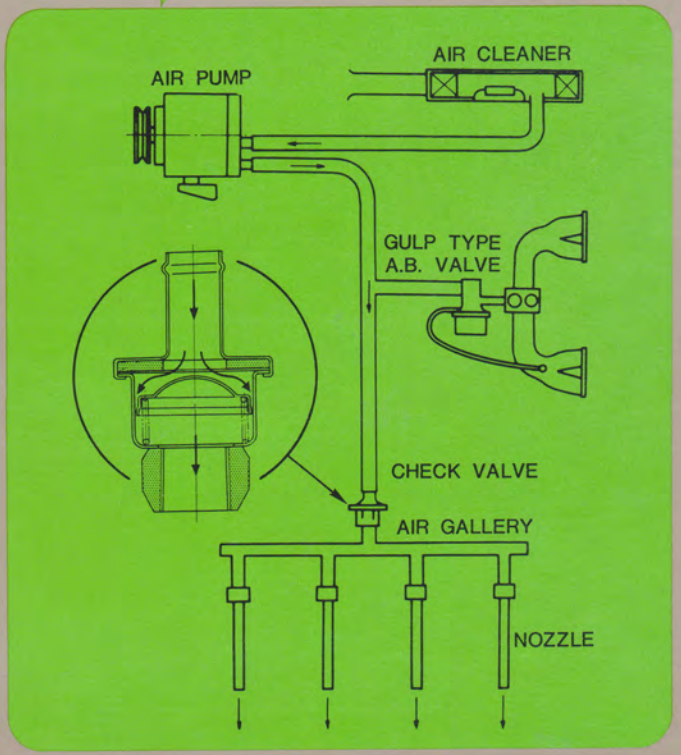


To supply air, an air pump turned by a belt-driven pulley, is mounted on the front of the engine. The pump uses either two or three vanes (depending on the model year) to create air pressure. The pressure is low, seldom exceeding five or six pounds per square inch. Air is supplied to the pump through the engine air cleaner or a special air filter provided for the pump.



Air pressure passes from the pump into each exhaust port through an air injection nozzle which directs air supply to the proper point.

Since air pump pressure is low, you may imagine exhaust gas backing up through the injection nozzle, into the air pump, and possibly damaging the vanes in the pump. To prevent this, a one-way check valve has been installed in the line between the air pump and the injection nozzles. The check valve allows air to pass from the pump into the exhaust manifold, but will not allow exhaust gas to pass in the other direction.

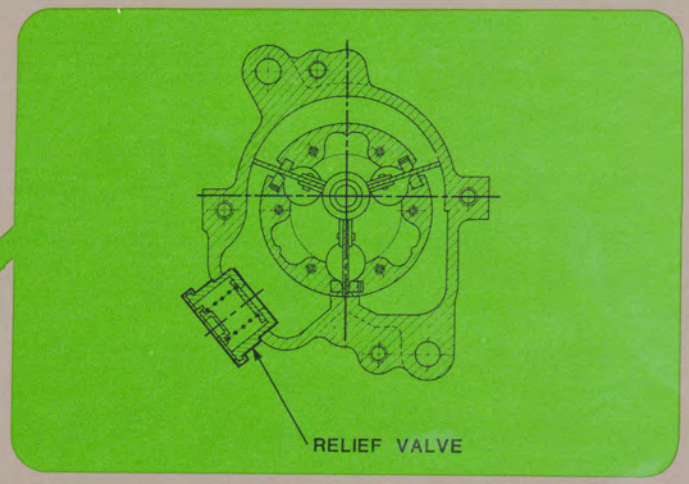


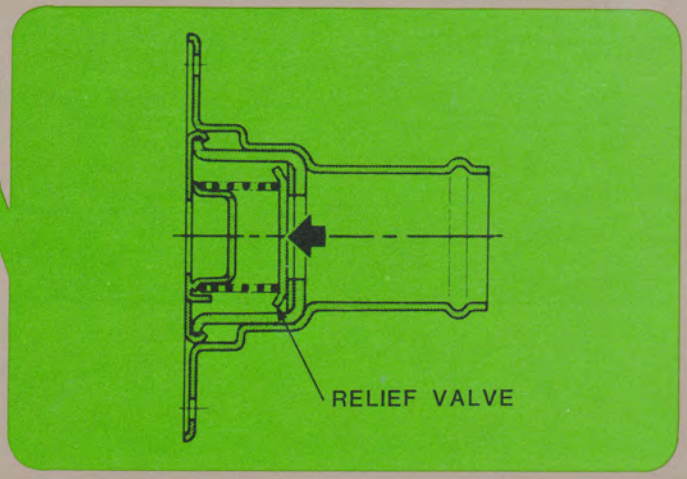
PRESSURE RELIEF VALVE

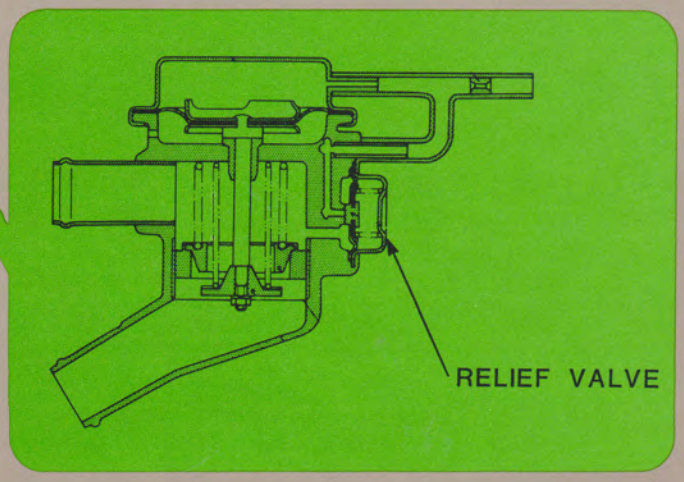
To prevent pressures within the pump from building up too high at high engine rpm's, the engineers have installed a relief valve in the system. The valve is built into the pump, or mounted in the carburetor air cleaner, or, on some models, replaced by the Combined Air Control or C.A.C. Valve. By allowing pressure to bleed off, the relief valve keeps pump pressure from going above three to eight pounds per square inch, depending on the model and year.

Although the basic air injection system is simple, injecting fresh air into the exhaust manifold creates a problem. Large amounts of hydrocarbons are emitted during deceleration, when high manifold vacuum causes flash vaporization and an especially rich mixture. Due to air injection, these hydrocarbons burn in the exhaust manifold; but because there are so many of them, too much burning takes place, and the driver can hear explosions, or backfiring in the exhaust.

The solution to the problem was to develop a way to lean out the mixture during deceleration so that more burning would take place in the combustion chamber and fewer hydrocarbons would be emitted. The anti-backfire valve takes care of this job.



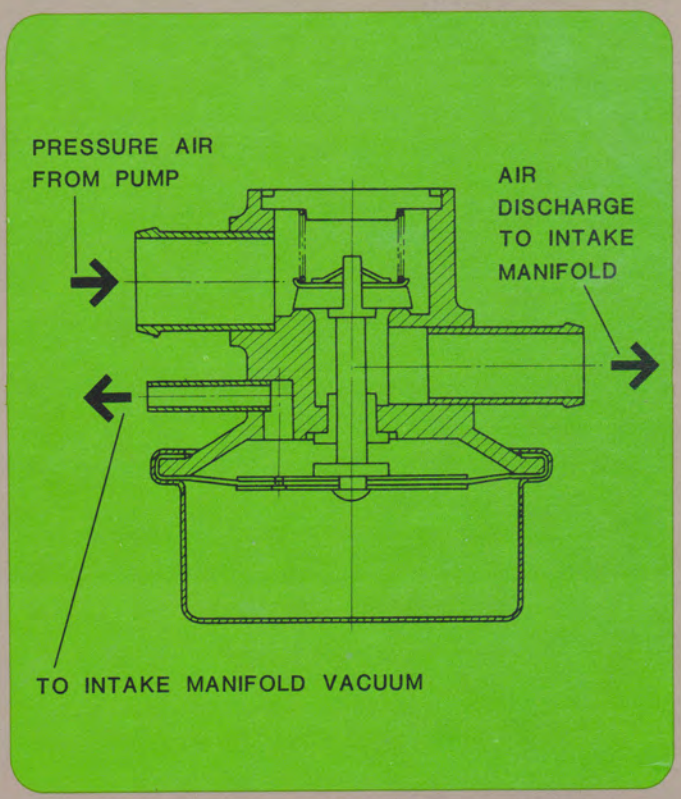




ANTI-BACKFIRE VALVE

The anti-backfire valve, or A-B valve for short, is connected between the intake manifold and the air cleaner or the air pump itself. The valve operates by a vacuum diaphragm, connected to intake manifold vacuum. During normal driving, the A-B valve is closed to keep air from passing into the manifold.

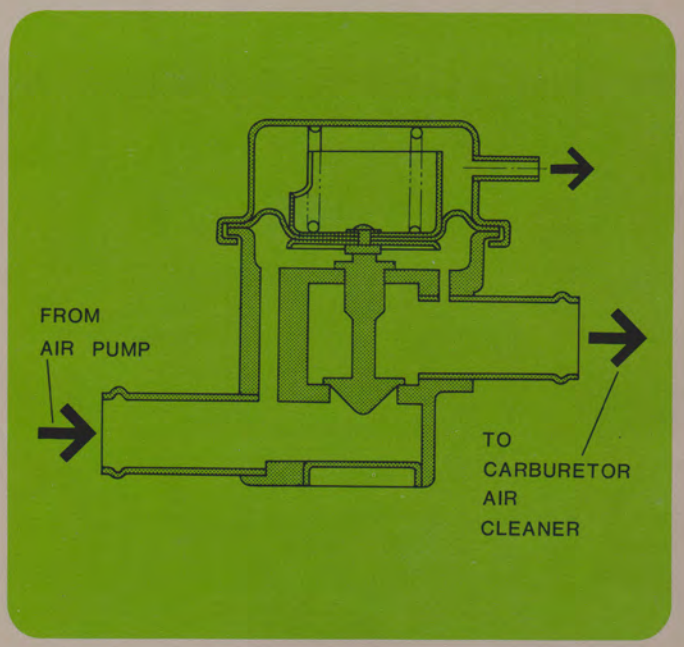
However, during deceleration, manifold vacuum is high enough to pull against the diaphragm and open the valve. Air passes through the valve from the air pump line or from the air cleaner, and dumps directly into the intake manifold. This leans out the rich mixture, and more complete burning takes place in the combustion chamber. The A-B valve behaves like an extra deceleration device, leaning out the mixture on deceleration. Another common name for this A-B valve is "gulp valve".



On most Datsuns, that's the complete Air Injection System. However, if the vehicle you're working on is equipped with a Catalytic Converter, then you'll find a couple of extra valves, which have been installed to protect the converter from overheating. When we look at catalytic converters, we'll see that the converter acts like the air injection system to make more of the hydrocarbons and carbon monoxide burn in the exhaust system. Actually, the converter works with the air pump system, using the air which the pump provides to complete this burning. But the more burning, the hotter the converter. If enough gas and air reach the converter, it might heat up enough to damage itself. To prevent excessive burning in the converter, two devices were installed to stop or limit air injection at different times.

AIR CONTROL VALVE

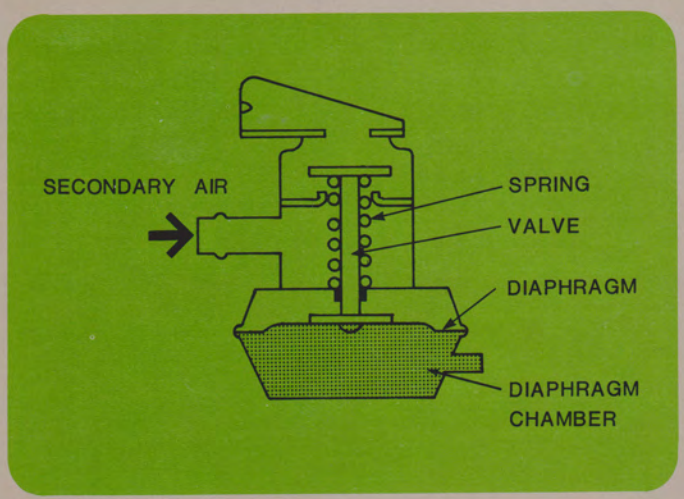
During deceleration and light throttle cruising at high speeds, when manifold vacuum is high but not high enough to open the A-B valve, air pump pressure is limited by an Air Control Valve, which dumps air pump output into the air cleaner. This is similar to the so-called diverter valves used on some domestic makes. The valve is connected between the pump pressure line and the air cleaner, and has a diaphragm, connected to the intake manifold. When vacuum rises, the valve opens, allowing pump pressure to dump into the air cleaner. Since less pump air will be injected, less burning takes place in the converter, and the converter runs cooler. It's important to note that the air control valve cuts down air injection to the exhaust manifold. The A-B valve, on the other hand, dumps air into the intake manifold, cutting down the number of hydrocarbons reaching the exhaust.



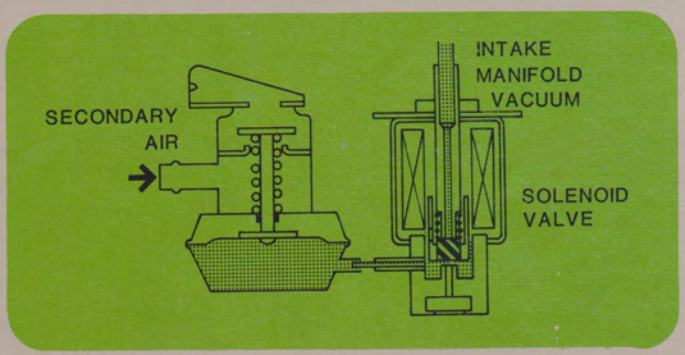
EMERGENCY AIR RELIEF VALVE

Air injection is also prevented during heavy acceleration. During full throttle operation, the charge reaching the combustion chamber is at its fullest, and the quantity of exhaust gases is great. The number of hydrocarbons reaching the converter will also be great. To prevent the converter from being overloaded, the air pump pressure is relieved by an Emergency Air Relief Valve, or "air relief valve". This simple valve operates just like the air control valve. It is connected to the pump pressure line, and when it opens, like the air control valve, it dumps the air pump's output. However, instead of dumping pressure into the air cleaner, it vents it to the outside through a small muffler. Like the air control valve and the A-B valve, the emergency air relief valve is operated by a diaphragm, connected to the manifold vacuum. However, unlike the other valves, it is closed when vacuum is normal or high. When vacuum

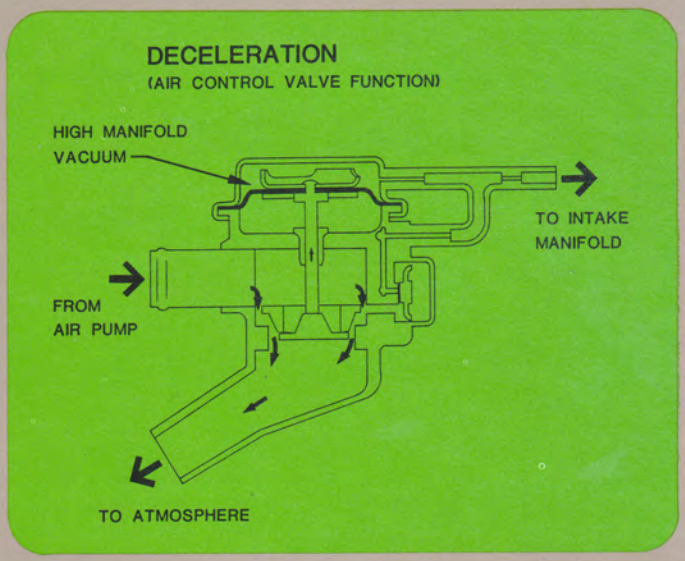
drops, the spring on top of the diaphragm pushes the diaphragm down, opening the valve. This is exactly what happens during heavy acceleration, when manifold vacuum drops. The pump no longer injects into the exhaust system, and the converter is not overloaded.



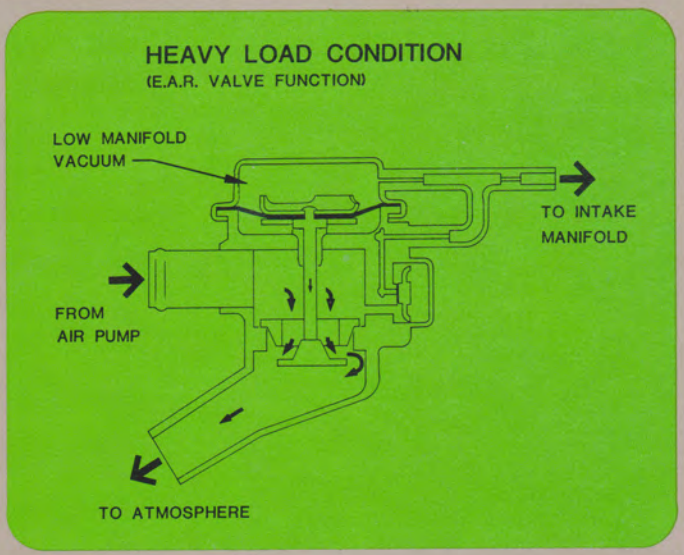
On early 1975 model vehicles, the emergency air relief valve was also actuated by a vacuum cutoff solenoid which blocked the vacuum line leading to the diaphragm. The solenoid was energized by a transistor switching unit whenever converter temperatures rose above a certain limit. Later, however, the solenoid was eliminated. There is more information concerning this system and the electrical system in the appendix section of your Analysis Guide.



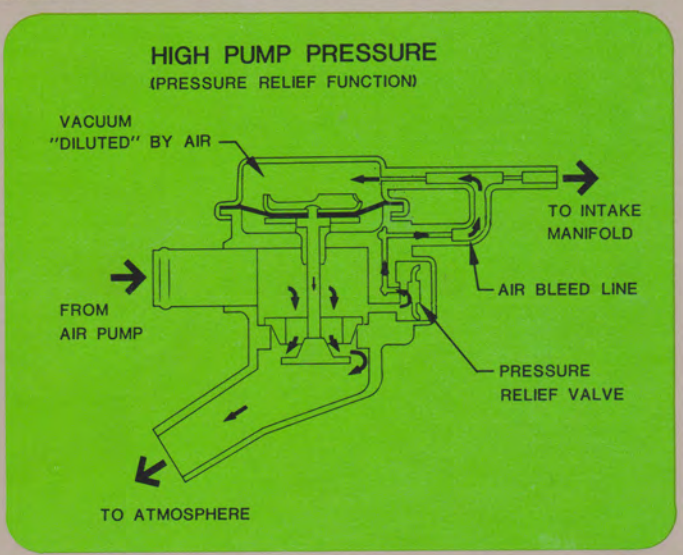
During deceleration, when manifold vacuum rises, the diaphragm is pulled upward against the combined force of the two springs. The large valve opens and air pump pressure is vented to the atmosphere.



On the other hand, during heavy load conditions, when manifold vacuum drops, the spring, acting on the smaller of the two valves, opens the valve and vents air pressure to the atmosphere. In this mode, the valve is acting as an emergency air relief valve. During low manifold vacuum, the valve will vent air pump pressure.

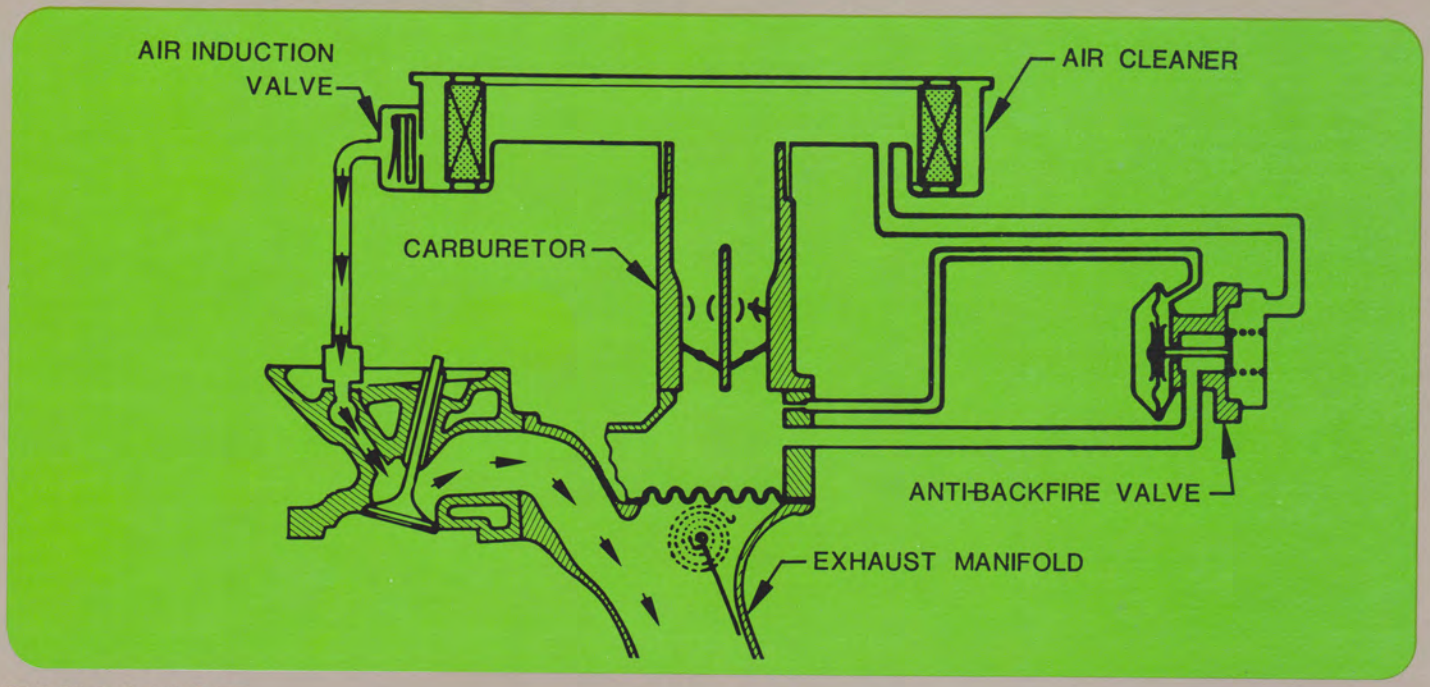


The third valve is the pressure relief valve. When air pump pressure is high enough, it pushes the diaphragm of the pressure relief valve to the right, against spring pressure. An air bleed line opens, which allows air pump pressure to pass into the vacuum line to the vacuum diaphragm. This bleeds off the vacuum which is acting on the diaphragm, and the spring pushes the valve downward, opening the smaller of the two valves to allow air pump pressure to be vented to the atmosphere.



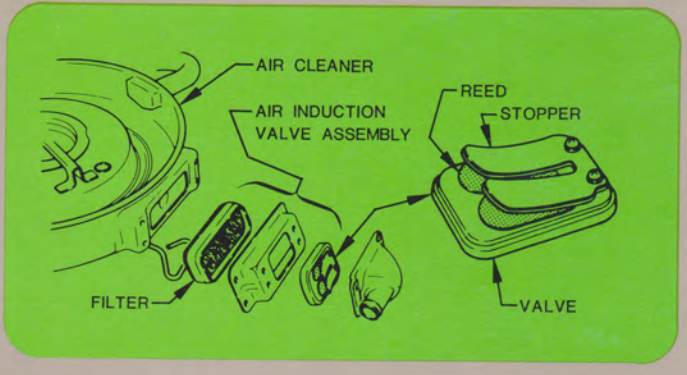
EXHAUST AIR INDUCTION SYSTEM

Let's take a look at a system which draws fresh air into the exhaust system. The air induction or E.A.I. System was used for the first time in 1977 on the B210 Plus model. It replaces the air pump. The system consists of an air induction valve, a filter, an AB valve (or anti-backfire valve), and hoses. The system utilizes a tuned exhaust manifold to produce exhaust pulsations which draws fresh air directly from the air cleaner into the exhaust manifold. The check valve, used with an air pump system, has been eliminated.



EXHAUST AIR INDUCTION SYSTEM

The air induction valve itself is nothing more than a reed valve which allows air flow in one direction only. The air filter is a replacement part and should be replaced every 25,000 miles.

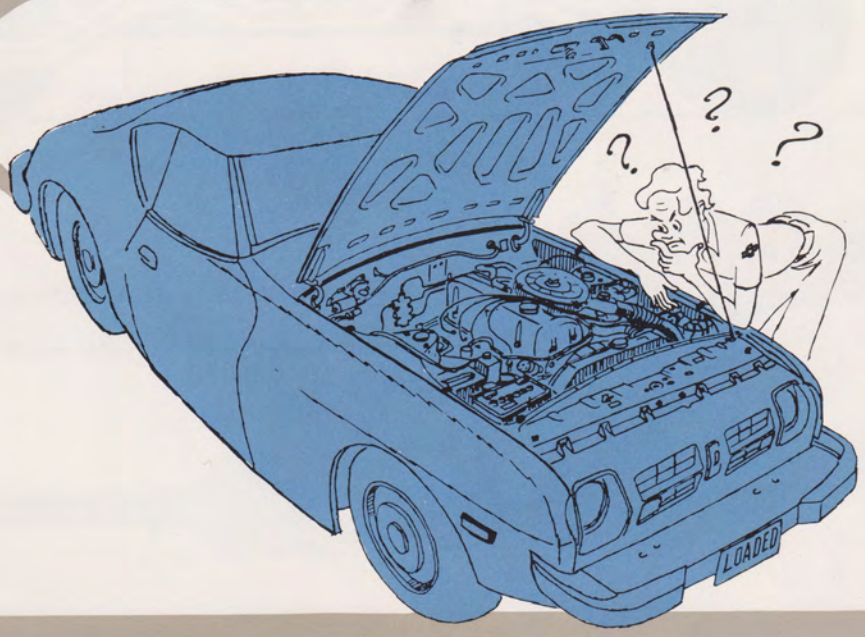


THE CATALYTIC CONVERTER

The catalytic converter actually continues the job that air injection started. It allows combustion to continue in the exhaust system, reducing hydrocarbon and carbon monoxide emissions.

If the expensive converter does the same job as the air pump, why not just inject more air?

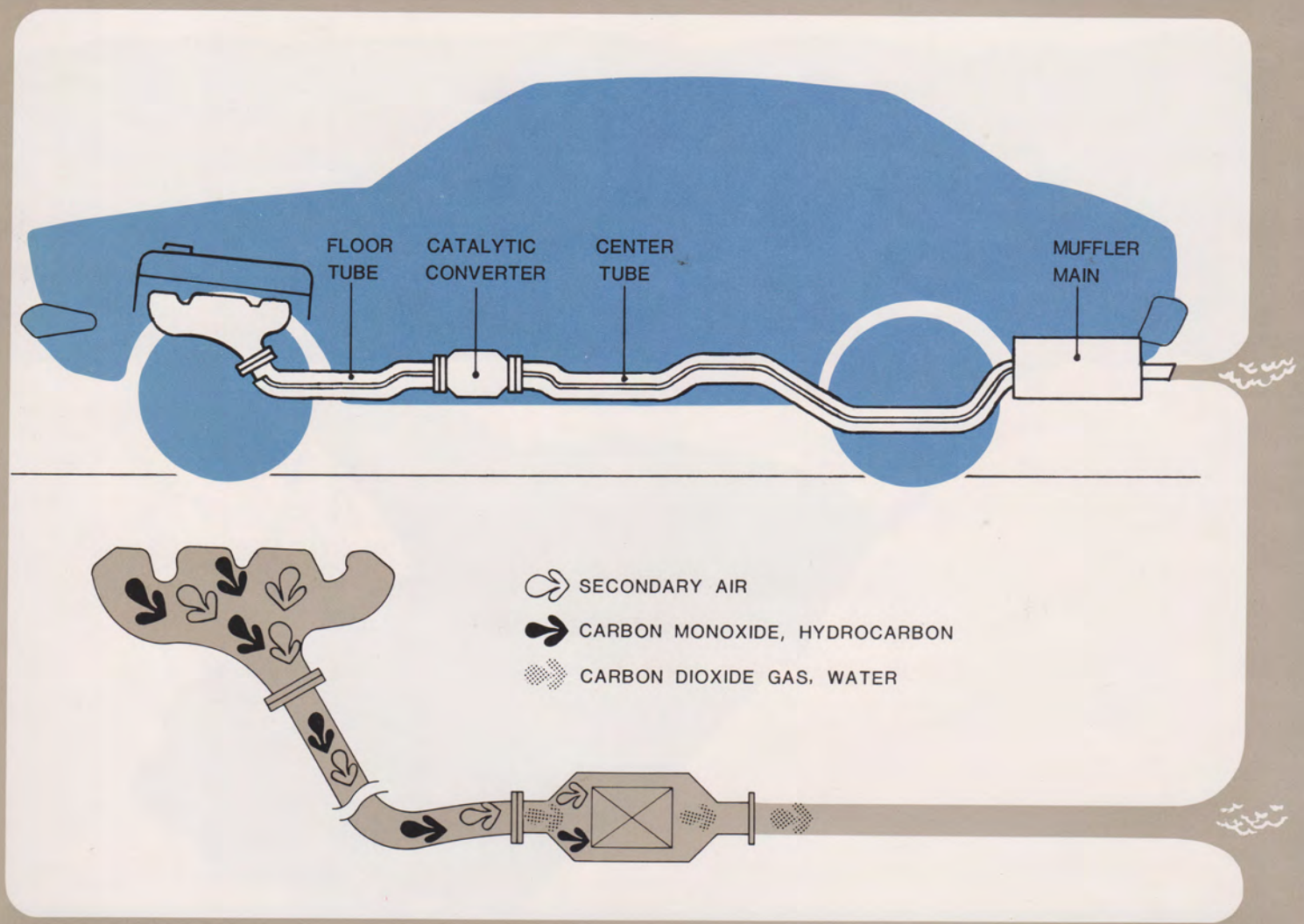
Well, the answer is that once the exhaust gases leave the exhaust manifold, they cool down very quickly - and once they cool past a certain point, they're not hot enough to burn. The converter is a special device which allows the burning to continue even at a lower temperature. Let's see how it works.



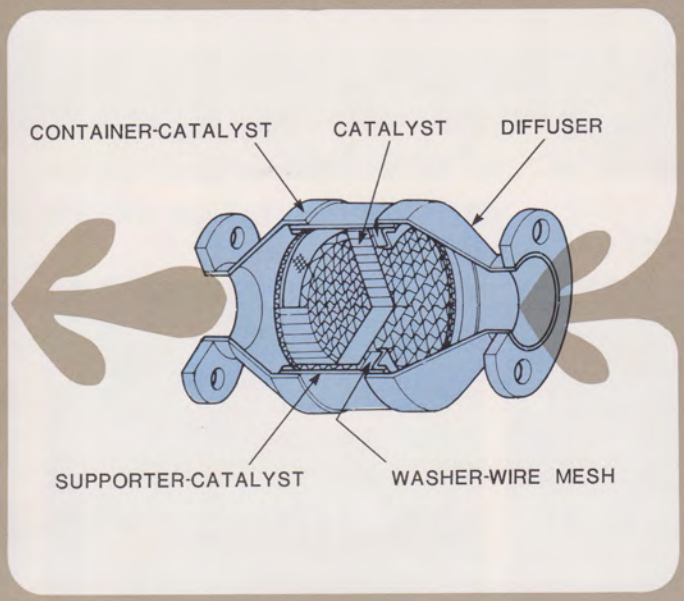
Datsun converters contain a honeycomb made of aluminum oxide, a porous substance that gases easily pass through. The honeycomb is coated with platinum and palladium, two precious metals. In fact, the platinum is the same metal used to make jewelry.

Platinum and palladium are what scientists call "catalysts". Catalysts are substances which can cause a chemical reaction without themselves reacting. For example, when oxides of nitrogen and hydrocarbons combine in the presence of sunlight to form photochemical smog, the sunlight acts as a catalyst.

In the presence of the catalyst in the converter, a carbon monoxide combines with oxygen to form carbon dioxide; hydrocarbons combine with oxygen to form both carbon dioxide and water. The oxygen for the burning is supplied by the air pump or air injection system.



Under normal use, the catalyst in the converter will deteriorate at a slow rate, and the converter should be good for tens of thousands of miles of driving. To ensure that the converter does perform satisfactorily for such an extended period of time, the converter housing is made of stainless steel.



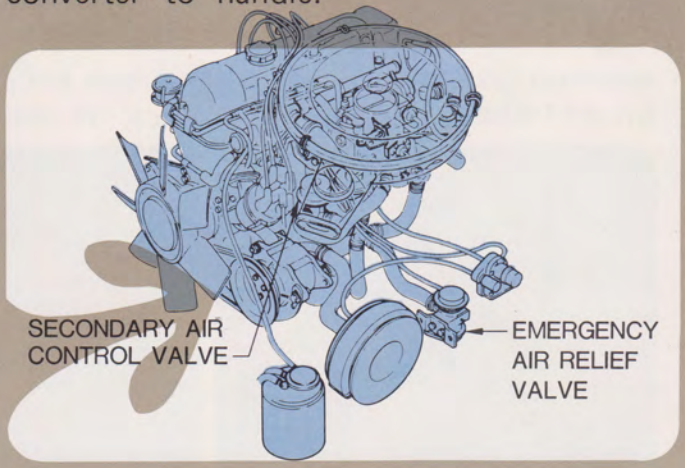
USE UNLEADED FUEL ONLY

One precaution the owner must take is to use unleaded fuel. Lead deposits in the converter cover the platinum and palladium, rendering the converter useless.

An operating converter produces heat, and too much gas and air in the converter may cause it to heat up dangerously. However, the following precautions have been taken to prevent the converter from overheating.

Two special relief valves have been installed on cars equipped with catalytic converters.

The secondary air control valve limits the amount of air injected during deceleration, when the manifold vacuum is high and large amounts of hydrocarbons are being emitted while the emergency relief valve eliminates air injection when the engine is laboring under a heavy load and manifold vacuum drops. During heavy load conditions, a full charge is delivered to the combustion chamber causing a large amount of exhaust gases for the converter to handle.



California models equipped with Electronic Fuel Injection use catalytic converters, but don't need an air injection system. This is because fuel injected models emit less hydrocarbons and carbon monoxide to begin with, and the converter alone is adequate to control these pollutants.

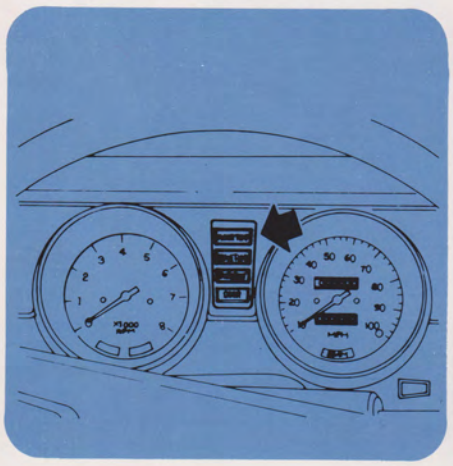
FLOOR TEMPERATURE WARNING SYSTEM

If the converter does overheat, the floor temperature warning system alerts the driver that the temperature of the vehicle floor pan, above the converter, is rising too high.

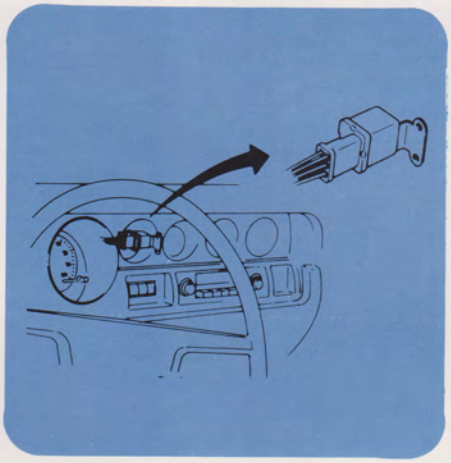
The warning system has only three parts; a warning light, a floor temperature sensor, and a relay.

You'll find information concerning the electrical system in the appendix section of the Engine Analysis Guide.

WARNING LIGHT
ON INSTRUMENT PANEL



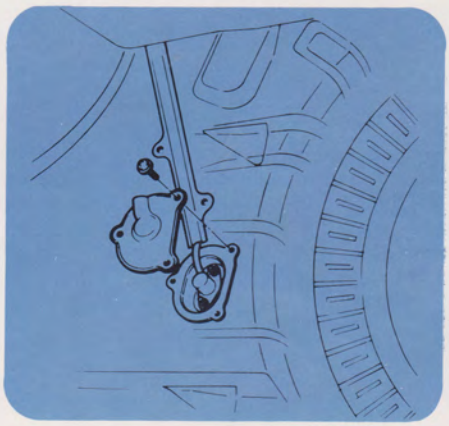
SENSOR RELAY IN
BACK OF INSTRUMENT PANEL



SENSOR ON STATION WAGON:
UNDER REAR SEAT



SENSOR ON SEDAN:
IN LUGGAGE COMPARTMENT

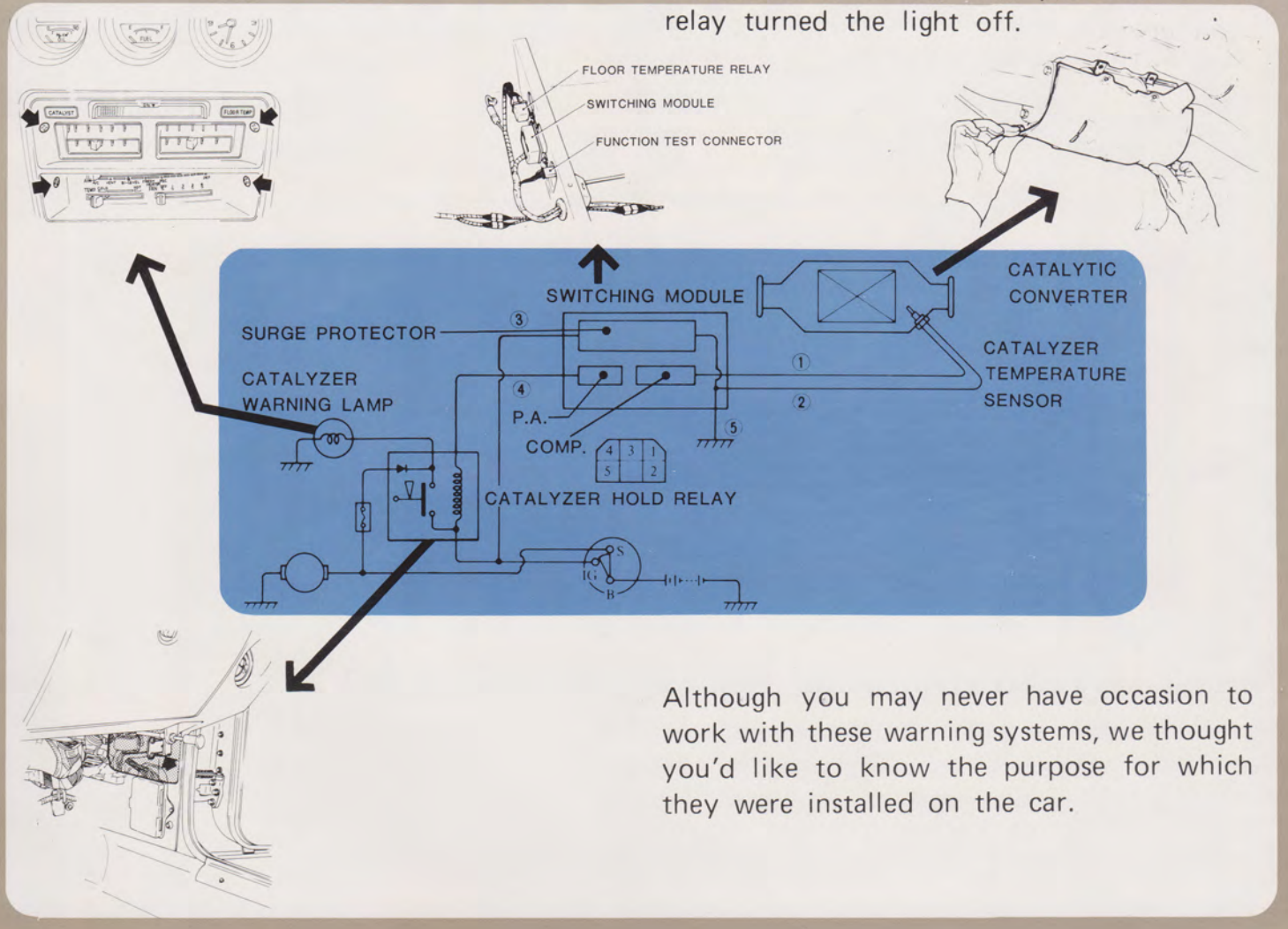


There was a second CATALYST WARNING LIGHT SYSTEM on early catalytic converter equipped Datsuns

On early catalytic converter-equipped models, a second converter warning system was also used. This system was much more complex than the floor temperature system. It consisted of a transistorized switching module, or control box, which sensed the actual temperature in the converter through a temperature sensor.

When the temperature in the converter rose to between 1500 and 1600 degrees, the control unit grounded a solenoid on the emergency air relief valve. The solenoid turned off the vacuum supply to the valve, opening the valve and venting air pump output to the atmosphere.

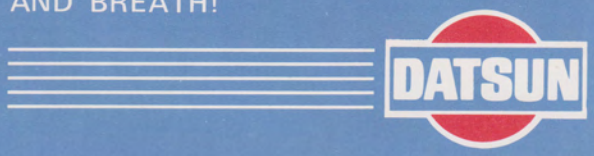
The module also controlled the ground circuit for a special warning light relay. At a little over 2,000 degrees, the relay would trip and the warning light go on. Once the light had been activated, it would come on whenever the ignition switch was turned on. Inserting a screwdriver in the hole provided in the relay turned the light off.



Although you may never have occasion to work with these warning systems, we thought you'd like to know the purpose for which they were installed on the car.

★ ★ ★ ★ ★ ★ ★ ★ ★

This manual which you have studied is the result of many hours of teamwork by a group of dedicated Datsun Training Instructors in conjunction with the Service Technical Training Department. We sincerely hope that the manual has been beneficial to you – not only in learning the technicalities of Datsun emission control systems, but also in understanding the need to control the pollution of our air – **IT'S A MATTER OF LIFE AND BREATH!**




The
END

DATSUN

Nissan Motor Corp. in U.S.A.

