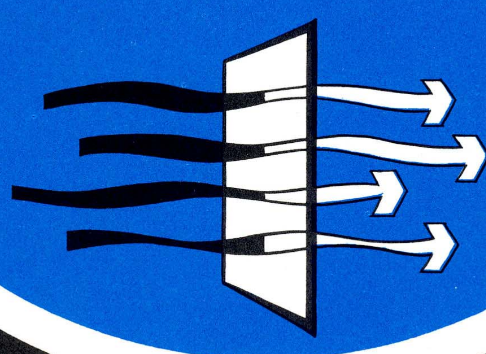
reference book 71/10

MASTER TECHNICIANS SERVICE CONFERENCE

EVOLUTION OF THE CLEANER AIR SYSTEM



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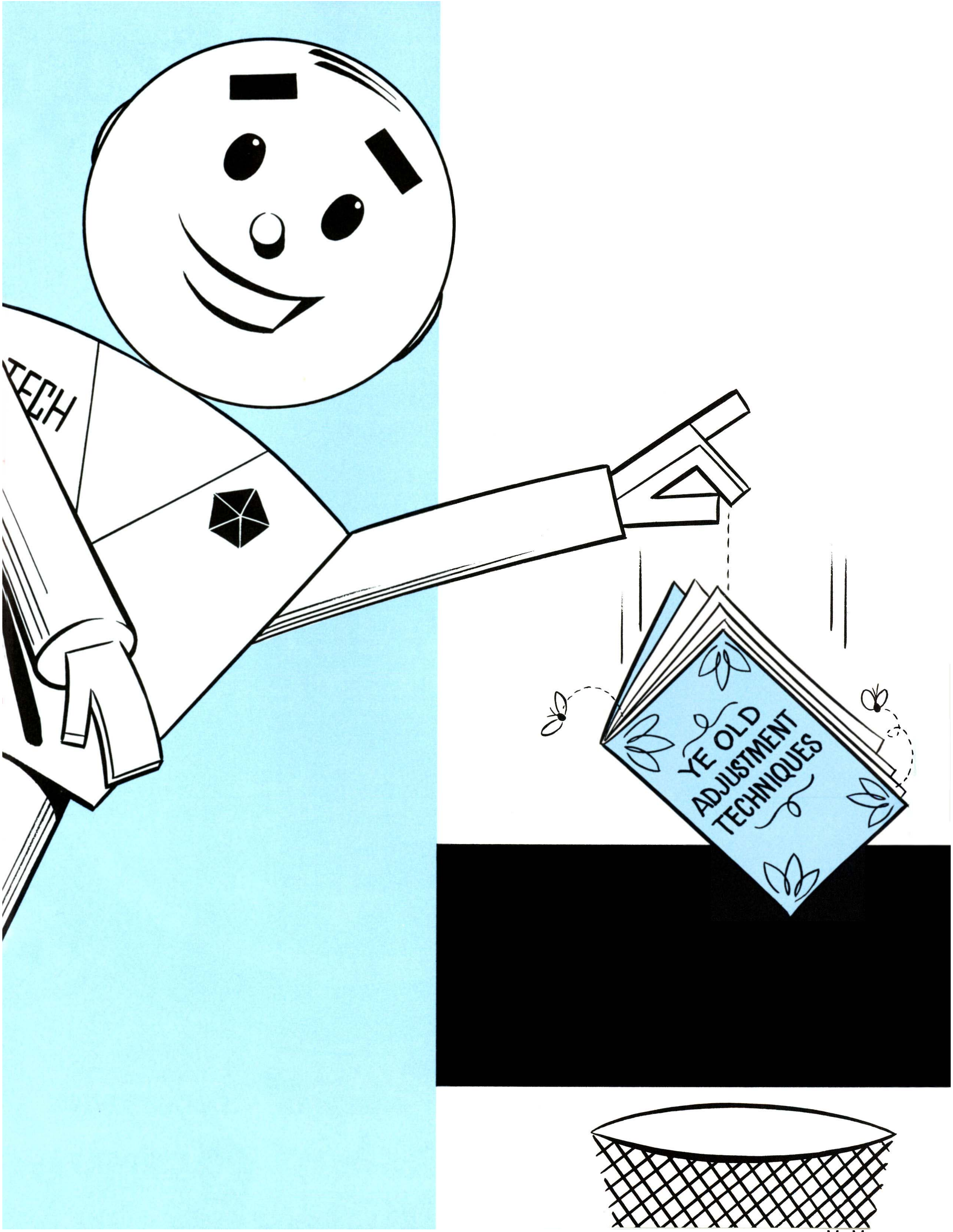
TECH
YE OLD
ADJUSTMENT
TECHNIQUES

OUT WITH THE OLD...

We've come a long way from the days when you could cover up some sub-standard engine conditions by turning up the idle speed, or when you could try to get better gas mileage by tinkering with the timing. That's all behind us now because emission control is here to stay with characteristics which require tighter than ever servicing tolerances.

At the present stage of development, exhaust emission from Chrysler Corporation cars is controlled through more complete burning of fuel inside the combustion chambers. To bring this about, there have been changes in the engine itself along with leaner mixtures and modified ignition timing which have narrowed tune-up tolerances literally to GO, NO-GO limits. As a result of all this, any adjustments we make must maintain the balance of performance, economy, and emission control that is built in or nothing will work properly.

To help you sort out the changes which have taken place in the process of developing the Cleaner Air System of today, and to prepare you for things to come, this session reviews Chrysler Corporation emission control from its beginning to the present.

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EMISSION CONTROL BASICS

From a simple crankcase ventilation system, emission control on Chrysler Corporation vehicles has progressed to an integrated control system which eliminates air pollution from crankcase vapors and fuel evaporation. Exhaust emissions are also greatly reduced by the system.

THREE KINDS OF POLLUTANTS

The specific pollutants controlled by the Chrysler Cleaner Air System are: Unburned hydrocarbon, carbon monoxide, and nitrogen oxides. The hydrocarbon is unburned gasoline vapor which comes from the crankcase, fuel system, and exhaust but the other emissions come only from the exhaust.

SYSTEM RETAINS VAPORS

Crankcase and fuel system emission control is relatively simple because the vapors are held in closed sub-systems and burned in the combustion chambers as part of the fuel mixture. However, the output of exhaust emissions varies with engine operating conditions, so emission control in this area is more complicated.

EXHAUST EMISSIONS VARY

Extensive research shows that hydrocarbon and carbon monoxide emission from the exhaust of unmodified engines is relatively low when the vehicle is accelerating or cruising, but is quite high when decelerating and running at low or idle speeds. This research also indicates that the exhaust emissions of these engines, in all operating modes, are greatly reduced by more complete combustion of the fuel.

COMBUSTION CUTS EMISSIONS

While other approaches to maximum fuel combustion can be used, Chrysler Corporation engineers adopted the concept of burning the fuel more completely *inside the engine itself* as the most practical method. As a result, the exhaust emission control function of the Cleaner Air System is based mainly on engine modifications, leaner mixtures, and ignition timing changes which all work together to do the job.

ELEMENTS ARE CLOSELY RELATED

Because the operation of all elements in the Cleaner Air System is closely integrated, procedures and specifications given in the Service Manuals must be followed closely to keep performance, fuel economy, and emission control in proper balance. The close working relationship of all the emission control elements is easier to understand if you think in terms of complete system operation rather than the separate functioning of the individual parts.

THERE'S ONLY ONE WAY

For the Master Technician, the whole situation boils down to this: There are no alternatives for specified procedures and specifications. You simply cannot get acceptable emission readings *and* good performance unless all the tune-up settings are within specification limits.

TUNE-UP IS A CONTROL FACTOR

Even on models which only have positive crankcase ventilation, exhaust emissions can be reduced quite a bit (hydrocarbon and carbon monoxide 50%, nitrogen oxides 30%) when you improve engine performance by doing a thorough tune-up. The engine, of course, must be in good mechanical condition or the tune-up will do little to improve performance or reduce emissions.

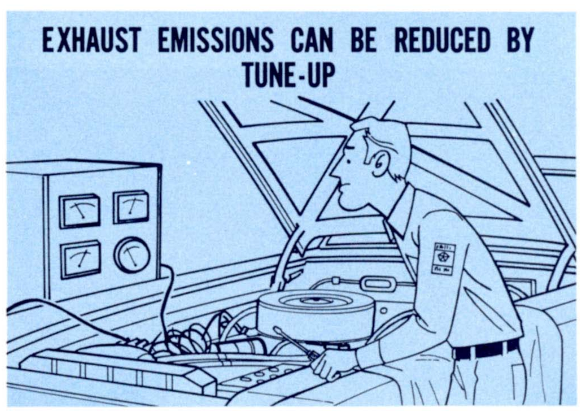


Fig. 1—Emission level can be cut in half

EMISSIONS AND EMISSION CONTROL

Before we talk about control systems or components, let's identify the sources of air pollution that come from the vehicle. Basically, we are concerned with: Crankcase Blowby Vapors, Fuel System Evaporation Losses, and Engine Exhaust.

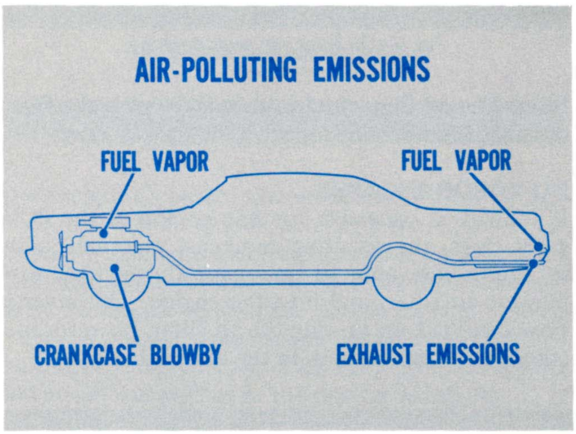


Fig. 2—Vehicle pollution sources

The air pollutants include unburned gasoline vapor, also called hydrocarbon, from the crankcase, the fuel system, and the exhaust. Added to this are carbon monoxide and nitrogen oxides, which come only from the exhaust.

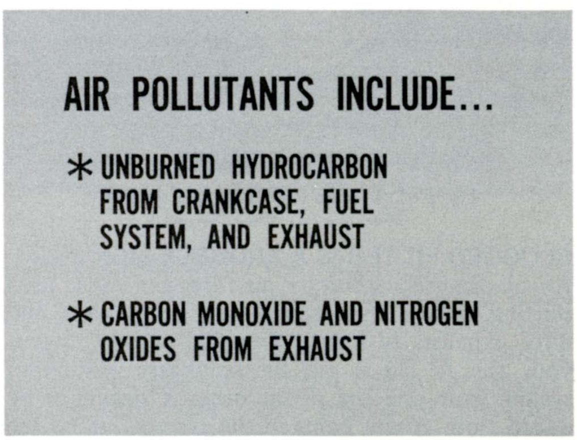


Fig. 3—Three kinds of air pollutants

CRANKCASE EMISSION

Crankcase blowby is essentially the high pressure gasses that are forced past the engine piston rings during the compression and power strokes. Crankcase vapors are mainly composed of unburned air/fuel mixture and exhaust gas.

ALL ENGINES HAVE SOME BLOWBY

Since the pistons must move up and down in the cylinder bores, a perfect sliding seal is not possible so there is some blowby even in new engines. Obviously, as mileage accumulates and parts wear, more blowby will get past the piston rings.

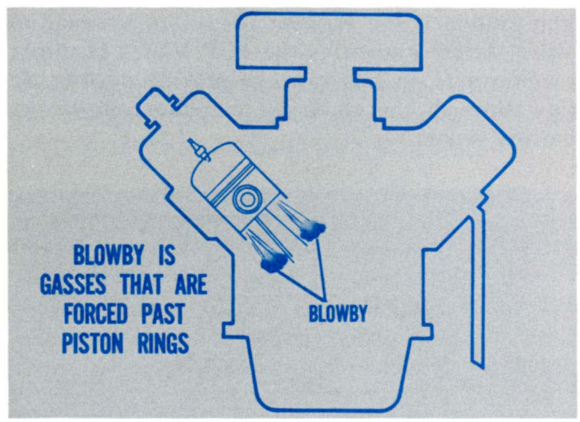


Fig. 4—Rings cannot seal perfectly

VAPORS ESCAPE THROUGH DRAFT TUBE

In engines without positive crankcase ventilation, air polluting blowby vapors pass directly to the atmosphere, mainly through a road draft tube on the engine which vents the crankcase. Air passing the open end of the draft tube produces a low pressure which causes air flow through the crankcase to remove the vapors.

POSITIVE FLOW ELIMINATES TUBE

To control crankcase air-polluting vapors, the first form of a positive crankcase ventilating system used on our vehicles eliminates the open draft

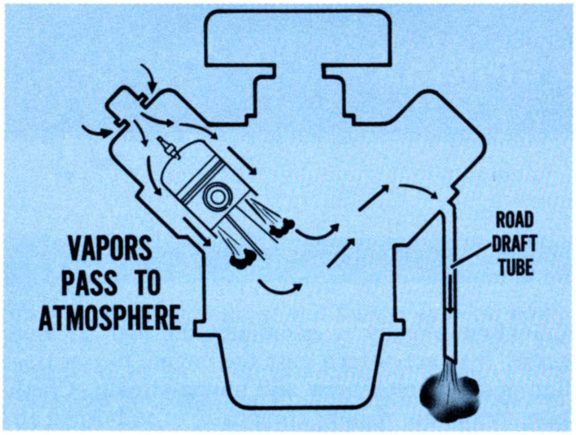


Fig. 5—Vehicle movement produces air flow

tube. Air enters at the oil filler cap and is drawn through the engine into the intake manifold. The vapors then pass into the combustion chambers and are burned as part of the air/fuel mixture.

PCV VALVE CONTROLS FLOW

The heart of the basic positive crankcase ventilation system is the Positive Crankcase Ventilation Valve, better known as the PCV Valve. Manifold vacuum acts on this valve to provide positive air flow through the crankcase to remove unwanted blowby vapors.

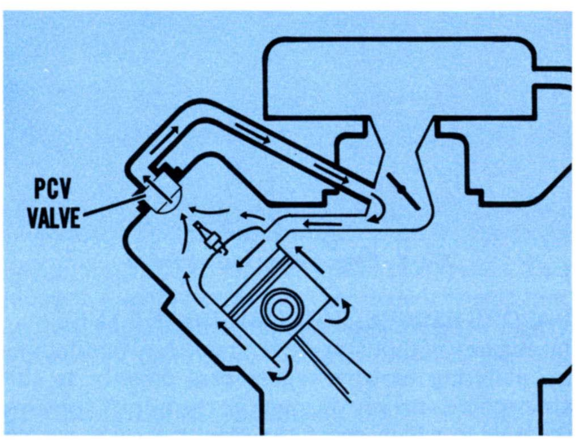


Fig. 6—Manifold vacuum acts on valve

CLOSED SYSTEM FILLER IS SEALED

Our present Fully Closed Crankcase Ventilation System works basically like the earlier positive system except that the incoming air first passes through the carburetor air cleaner housing and then enters the engine through the crankcase inlet filter. The oil filler cap in this system seals the filler opening when it is installed.

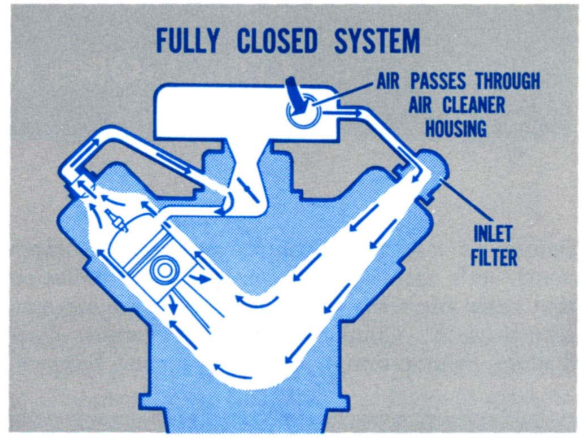


Fig. 7—Oil filler cap seals opening

NO VAPOR ESCAPES

If blowby is excessive for any reason or the PCV valve clogs, the resulting crankcase pressure build-up causes the vapor to flow back through the carburetor air filter, and into the engine. This reverse flow can load up or clog the air filter, however, no crankcase vapor escapes to the atmosphere.

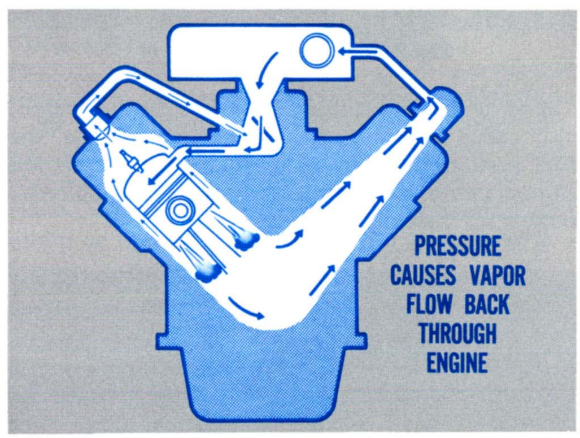


Fig. 8—Crankcase vapors cannot escape

CLOGGED FILTER IS A TROUBLE SIGN

An oil-clogged carburetor air filter can cause hard starting, power loss, stalling, low gas mileage, and dirty exhaust. Just remember that an oily filter is your cue to check out the crankcase ventilation system from one end to the other. Clogging or reduced flow at any point in the system can be the cause of trouble.

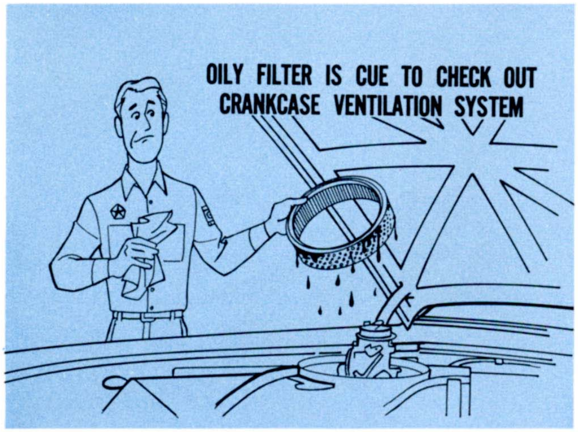


Fig. 9—Reverse flow clogs filter

EXHAUST EMISSIONS

The emission control system used on some of our 1967 and 1968 models is called the Cleaner Air Package. Tune-up specifications for vehicles with CAP are different from those without this equipment, so be sure to look for the identifying Vehicle Emission Label in the engine compartment before making any adjustments. CAP tune-up specs appear on the label as well as in the Service Manuals.

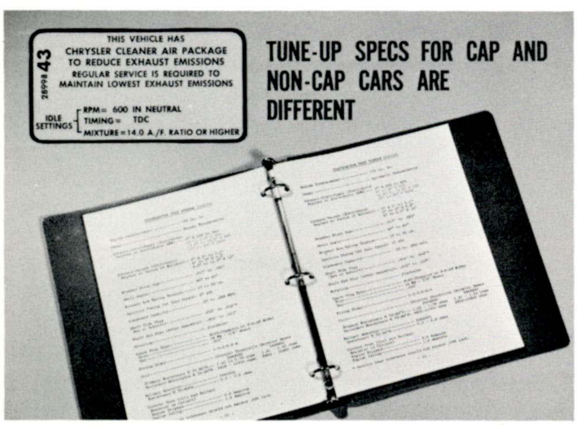


Fig. 10—Look for the label

LOWER EMISSION IS THE GOAL

Positive ventilation takes care of crankcase emission so the additional CAP System changes are concerned mainly with reducing emission of unburned hydrocarbon and carbon monoxide in the exhaust. This is done mainly with engine modifications, leaner mixtures, higher idle speeds, and ignition timing changes.

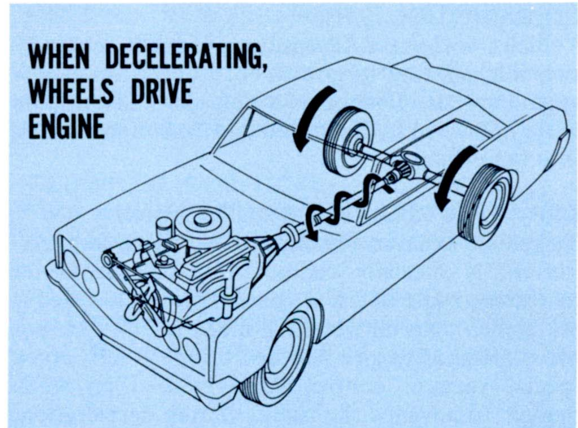


Fig. 11—Deceleration adds to air pollution

DECELERATION RAISES EMISSIONS

Even without CAP, our engines, when properly tuned, produce a relatively clean exhaust under most operating conditions. However, the emissions increase when the vehicle is decelerating.

MIXTURE DENSITY IS LOW

When decelerating, the throttle is at idle position but the rear wheels drive the engine faster than idle speed. The nearly closed throttle limits the amount and density of the mixture taken into the cylinders and this makes the mixture hard to ignite.

MIXTURE IS DILUTED

In addition to mixture ignition difficulties, leftover exhaust gas in the cylinders dilutes the incoming mixture and as a result it does not burn completely. Because of poor mixture ignition and incomplete combustion there is unburned and partly burned mixture in the exhaust on deceleration.

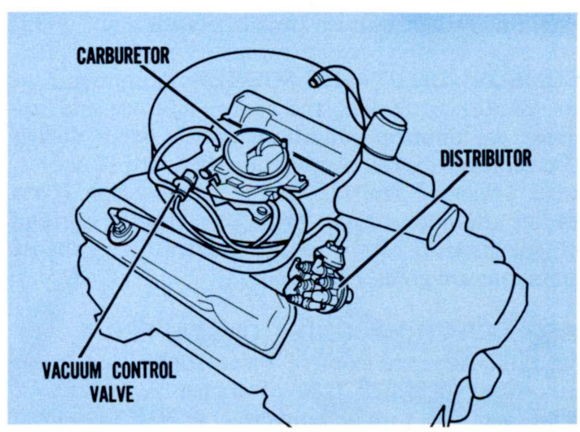


Fig. 12—CAP System components

IDLE MIXTURE IS RICH

Vehicles without CAP equipment use a relatively rich idle mixture to give smooth operation at low engine speeds. Obviously, a rich idle mixture puts more unburned hydrocarbon and carbon monoxide into the exhaust.

CAP AFFECTS MIXTURE AND TIMING

To reduce exhaust emissions, the CAP System carburetor is specially calibrated to provide leaner mixtures at idle and low speeds. Also, idle speed is set higher than on non-CAP models. The distributor is designed to give retarded timing at idle, and a special vacuum control valve is used on some models to advance the timing during deceleration.

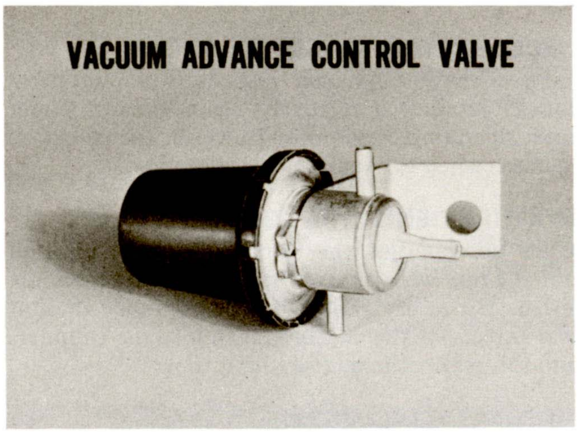


Fig. 13—Valve provides maximum advance

VALVE CONTROLS IGNITION TIMING

The Vacuum Advance Control Valve provides maximum vacuum advance during deceleration to improve mixture ignition. The valve works with the carburetor to control the vacuum applied to the vacuum advance unit on the distributor.

COMBUSTION STARTS SOONER

As mentioned earlier, the sparse mixture and exhaust gas dilution conditions which occur during deceleration makes combustion difficult. However, with advanced ignition timing, combustion starts earlier and allows time for more complete burning of the mixture. As a result, deceleration exhaust emissions are greatly reduced.

DECELERATION CONDITIONS DIFFER

Vacuum Advance Control Valve application varies according to which type of transmission is used. You see, the torque converter in a TorqueFlite transmission is designed to be more efficient when

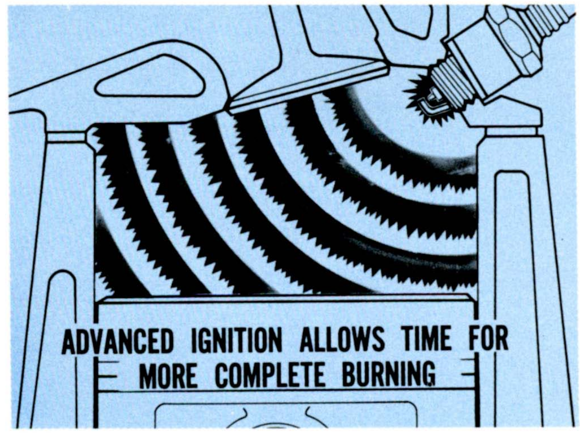


Fig. 14—Timing starts combustion earlier

the vehicle is driving than when it is decelerating. As a result of converter action, the engine speed is affected less in a TorqueFlite-equipped vehicle than in a manual transmission model.

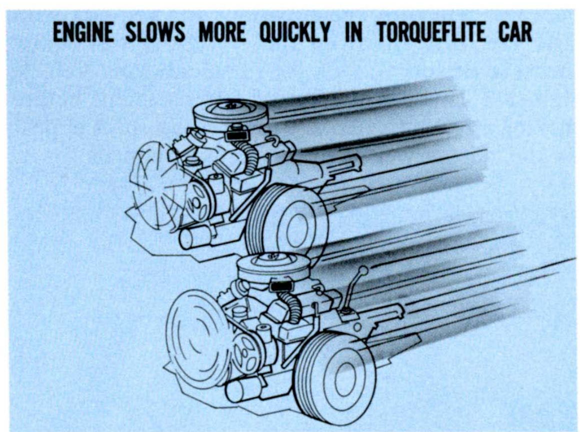


Fig. 15—TorqueFlite gives less engine braking

SOME MODELS HAVE NO VALVE

Because rapid engine slowdown is possible with TorqueFlite, exhaust emissions from these engines are relatively low during deceleration. In fact, there is little need for the advanced timing provided by the Vacuum Advance Control Valve, so you'll find some CAP models without a control valve.

CONDITIONS REQUIRE EXACT SETTINGS

Regardless of whether a CAP vehicle has a vacuum valve or not, you'll only invite trouble if you deviate from the specified tune-up settings for any reason. The specifications must be followed closely because there is more to CAP than modified carbu-

Fig. 16—CAP engine modifications

retor and distributor calibration, and possibly a vacuum control valve.

CAP INCLUDES OTHER FEATURES

With the CAP system, there are also refinements in the combustion chambers, manifold heat control, and fuel mixture distribution. Even the choke calibration is different.

CAP SYSTEM TUNE-UP TIPS

Following the recommended tune-up procedures is as important as using the correct specifications. Although it should be common practice in any tune-up, preventing any vacuum advance when you check or set the timing is specially important with CAP. At idle, the throttle plate of a CAP carburetor is positioned at the edge of the vacuum advance

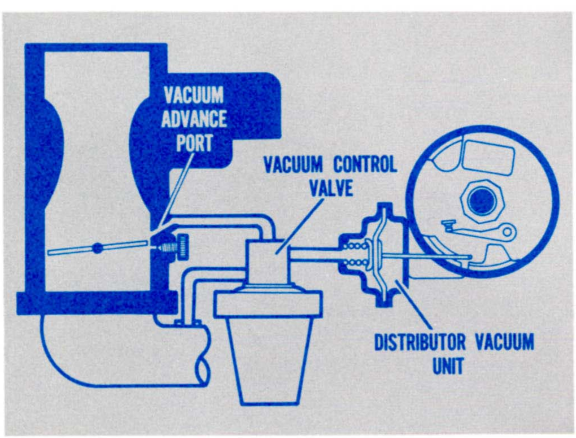


Fig. 17—Throttle plate is at edge of port

port where it could cause unwanted vacuum advance if the hose were connected. Also, a slight leak through the vacuum advance control valve could reach the distributor vacuum unit and cause unwanted timing advance.

IDLE SPEED IS CRITICAL

When setting CAP engine idle, make sure that the speed is not higher than specified. If the idle speed is set too high, you can get some centrifugal advance, and this will make the basic timing setting late when the engine slows down. In some cases, only 50 revs over the specified setting can pick up some centrifugal advance.

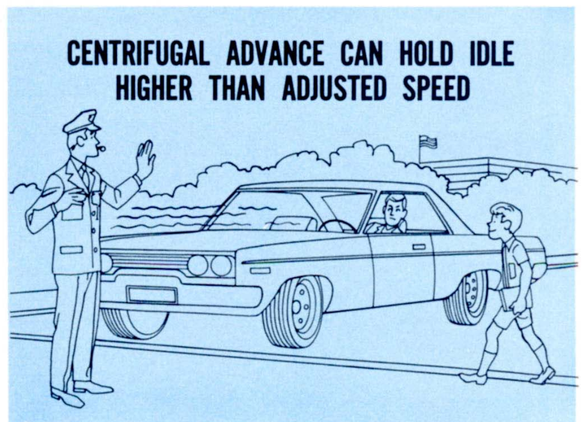
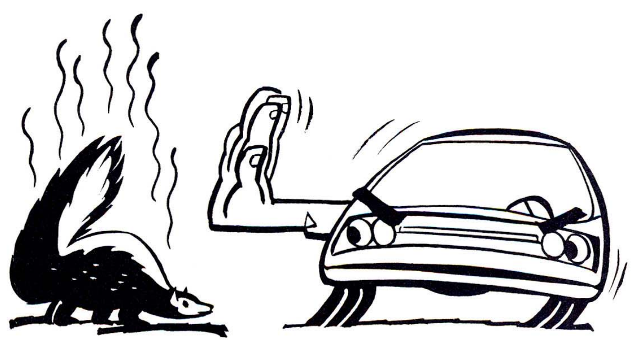


Fig. 18—Engine does not slow down normally

SPEED MAY EXCEED BASIC SETTING

Along with upsetting the basic timing, unwanted centrifugal advance can hold the idle higher than the adjusted speed when the throttle closes on deceleration. If this happens, the engine does not slow down to the adjusted idle speed but remains at a higher speed as when the fast-idle linkage hangs up or the vacuum advance control valve does not operate properly.



IMPROVEMENTS FOR GREATER EMISSION REDUCTION

From the basic CAP System, the next stage of development adds refinements which further reduce vehicle emissions. Carburetor and distributor calibrations are changed, and there are modifications in the combustion chambers, camshaft, manifold heat control, and fuel mixture distribution. Once again, choke calibration is changed.

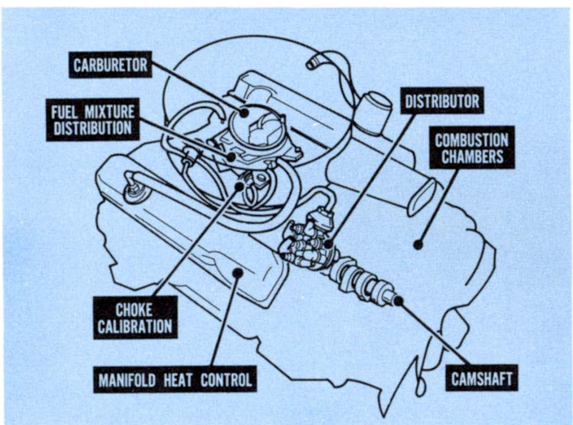


Fig. 19—Control System refinements

MIXTURE ADJUSTMENT IS LIMITED

The most obvious changes on these models are in the idle circuits of the carburetors. Some models limit the idle mixture screw adjustment with a sealed stop screw. Others, like the Holley single-barrel, use an internal idle mixture limiter orifice, plus an adjusting needle.

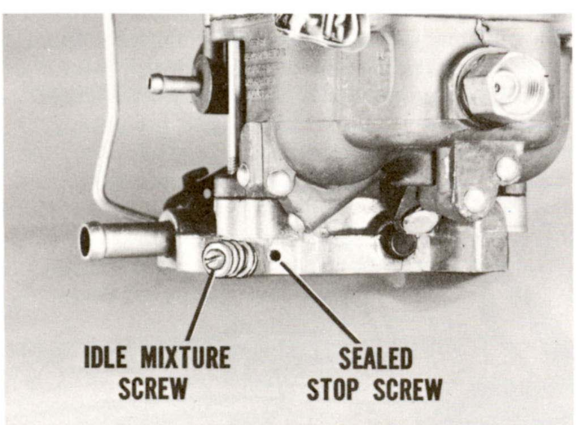


Fig. 20—Stop limits mixture adjustment

SCREW ADJUSTS AIR BLEED

Some carburetors in this group have a single air-bleed adjusting screw instead of the usual pair of mixture adjusting screws. In these carburetors the maximum-rich idle mixture is pre-set internally, leaving the air-bleed screw for final adjustment.

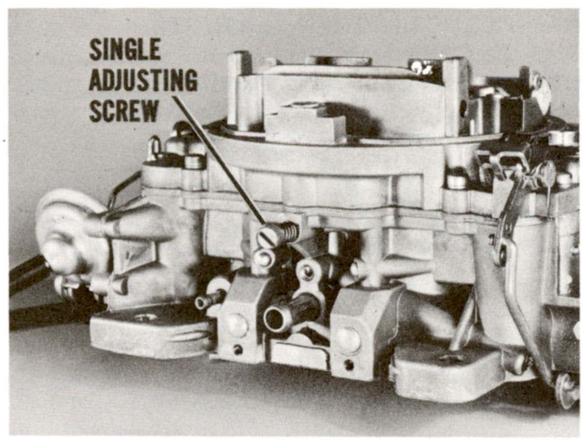


Fig. 21—Gives final touch-up adjustment

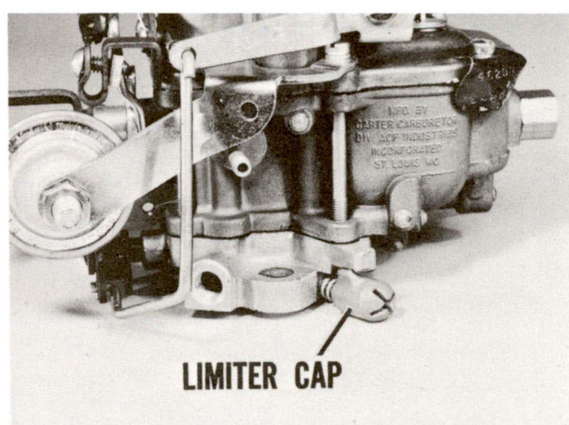


Fig. 22—Cap limits adjuster range

VALVE ADDS EXTRA AIR

In addition to the single-screw air-bleed adjustment, these carburetors also have a vacuum-operated check valve which adds extra air to the mixture when the throttle valve opens slightly. This action makes the off-idle mixture leaner to further reduce exhaust emissions.

LIMITER CAPS ON ADJUSTERS

On later models, the idle mixture adjusters have external limiter caps which prevent an over-rich setting. On the '69s, you'll find the Vacuum Advance Control Valve only on the 170 Manual Transmission Six and all 426 Hemi models.

CALIBRATION AND SPECIFICATIONS CHANGE

The 1969 models have improved choke modulation and again the distributor timing advance calibration is changed. You'll also find that the distributor specifications differ from previous models. In this case, the point gap figure remains the same as before, but the dwell angle is different.

TEMPERATURE CONTROL IS IMPORTANT

Along with other changes, the 1969 cooling system thermostat rating is raised ten degrees. The thermostat for six-cylinder engines is up to 200° and for V-8's, it's up to 190°. Since engine temperature affects exhaust emissions you can expect thermostat rating changes along with emission control system changes, so watch those specifications for model-to-model differences.

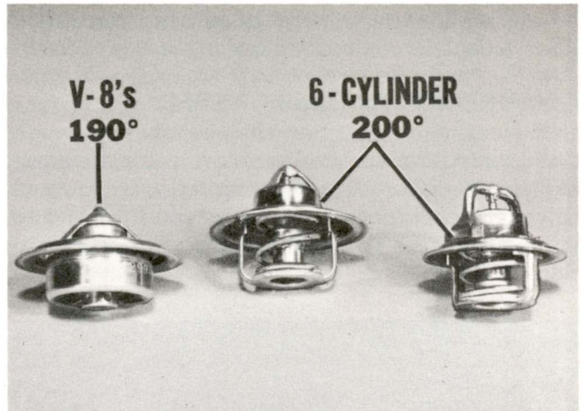
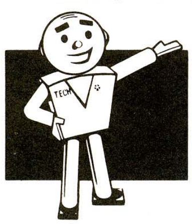


Fig. 23—Thermostat ratings also change

BE ALERT FOR CHANGES

While we're on the subject of specifications, one thing in this story on emission control development should be coming through loud and clear: Change Is the Name Of the Game. With continuing refinements planned for emission controls, the time is past when you can assume that last year's tune-up specifications and procedures apply to current models. Expect changes and you'll be right in step with the parade.



CURRENT MODEL SYSTEM FEATURES

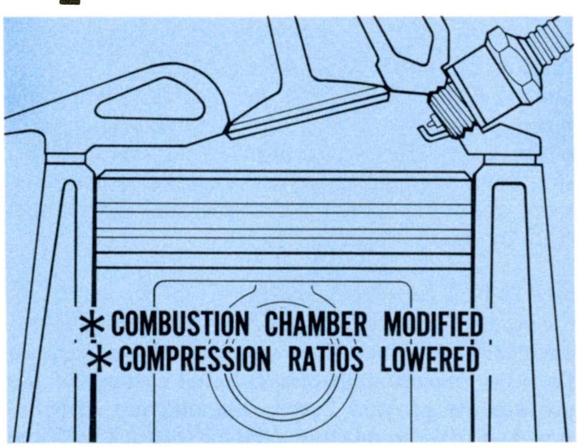


Fig. 24—Modified combustion characteristics

Additional controls are added on some 1970 models, and the emission control system, called the Cleaner Air System, is used on all Chrysler Corporation gasoline engine vehicles. This name appears on some earlier models, but not on trucks over 6,000 G.V.W. until 1970.

SYSTEM CONCEPT REMAINS SAME

The name is changed, but CAS is basically a continuation of the CAP system with refinements. If you think back over the development of emission control that we have covered up to this point, you will recall that there have been basic changes in the engines as well as in engine equipment. However, the important thing to understand is that the changes up to the present are basically a continuation of the Chrysler concept of emission control by more complete combustion *inside the engine itself.*

COMPRESSION RATIOS LOWERED

In the engine, combustion chamber shape is modified to expose more area for more complete burning of the mixture. Compression ratios are lowered to permit operation on lower octane fuels and to raise exhaust gas temperatures for additional emission reduction.

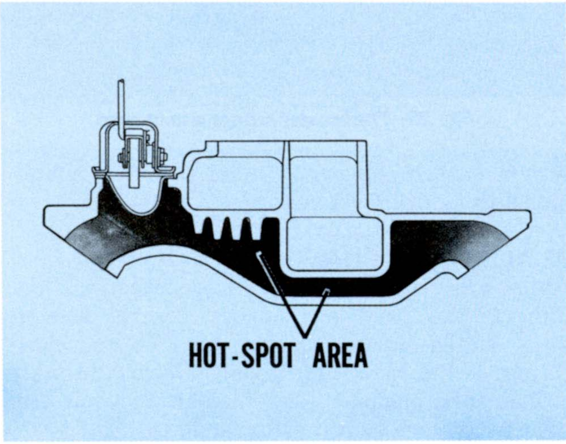


Fig. 25—Improves warm-up operation

WARM-UP IMPROVEMENTS

The intake manifold "hot-spot" area below the carburetor is modified to heat up more quickly so leaner warm-up mixtures can be used. The exhaust manifold heat control valve is also modified to work more effectively with the redesigned hot spot in the manifold.

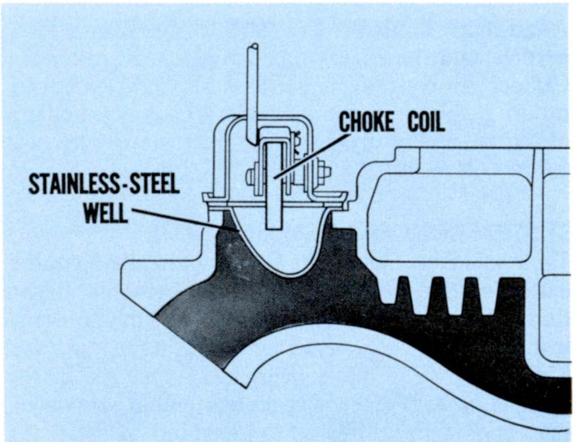


Fig. 26—Choke coil heats faster

CHOKE OPENS SOONER

The choke on these models opens sooner to make the warm-up mixture leaner. A thin-wall stainless-steel well in the manifold transfers exhaust cross-over heat to the choke coil more efficiently to heat the choke coil faster.

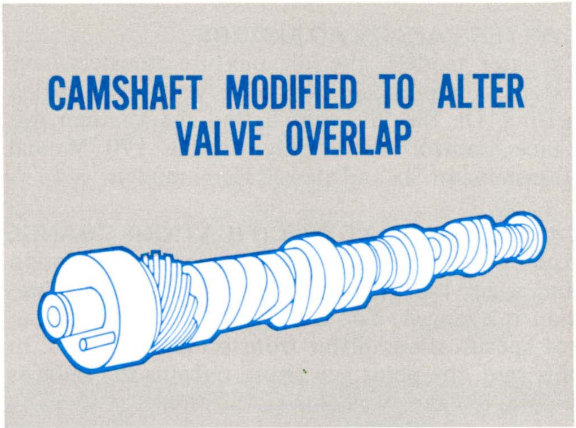


Fig. 27—Overlap affects exhaust emissions

CAMSHAFT IS MODIFIED

As in previous engines, camshaft design is modified to alter the intake and exhaust valve overlap. Since valve overlap affects mixture flow in and out of the combustion chambers, camshaft design changes right along with other emission control refinements in the engine.

THERMOSTAT RATING CHANGES

The cooling system thermostat rating for the 1970 models is 190° for all engines except the 318 and 383 two-barrel carburetor models and the 440 Standard V-8's. Thermostats rated at 195° are used in these three engines.

ANOTHER THERMOSTAT CHANGE

On the 1971 models, the thermostat temperature rating goes down to 185° for all engines as a result of further modifications in other parts of the emission control system. This backs up the earlier statement about watching the specifications for changes from model to model.

MIXTURES LEANER THAN BEFORE

Carburetor calibration is leaner than on previous engines, and all now have external limiter caps on the idle mixture adjusters. Internal carburetor improvements provide better idle mixture distribution and off-idle mixture control to work with the leaner mixtures.

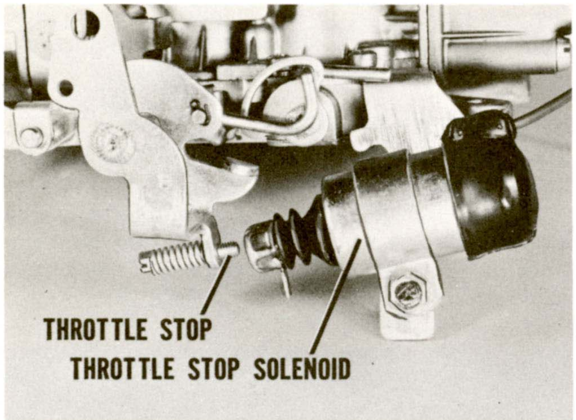


Fig. 28—Stop prevents "After-Run"

MORE SPEED GIVES LESS EMISSION

Higher idle speed is now used on our high-performance engines to reduce emission both on idle and deceleration. A throttle-stop solenoid allows the throttle to close below the idle setting when the engine is shut down. By allowing the throttle to close more completely, this arrangement prevents "After-Run" or dieseling which can result from the high idle speed setting.

TIMING RETARD ALSO REDUCES EMISSION

On our 383 and 440 V-8 engines, the distributor has a timing-retard solenoid connected to switch contacts on the carburetor throttle stop. When the throttle closes on idle or deceleration, the timing retards and works with the higher idle mixture flow to produce more complete combustion.

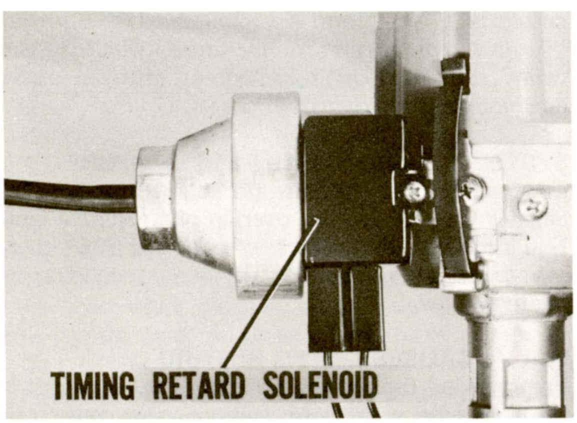


Fig. 29—Timing retard improves combustion

HANDLE WITH CARE

As when checking or setting the timing on earlier models with the Vacuum Advance Control Valve, there are a few precautions to observe when servicing the solenoid-type distributor. First, if you remove the vacuum advance unit hose for any reason, do it carefully so you won't upset the vacuum advance calibration. Just remember that electronic components inside the solenoid can be disturbed if you distort the assembly by pulling on the hose or by tapping the unit with a hammer when setting the timing.

DO IT RIGHT

Remember that the distributor solenoid must be connected and energized when checking or setting the basic timing so you'll have normal retard. However, when checking or setting point dwell, the solenoid is *disconnected at the carburetor* because no retard is wanted.

CAS SUB-SYSTEMS

Since the Cleaner Air System controls emissions which come from several sources on the vehicle, it is made up of sub-systems which work along with the basic engine modifications to produce overall emission control. One sub-system, already covered, is the Fully Closed Crankcase Ventilation System.

HEATED AIR INTAKE SYSTEM

With the Cleaner Air System on the 1970 models, we also get the Heated Air Intake System on all engines except some high-performance models. Of course, engines with the fresh-air intake scoop do not have the heated air intake.

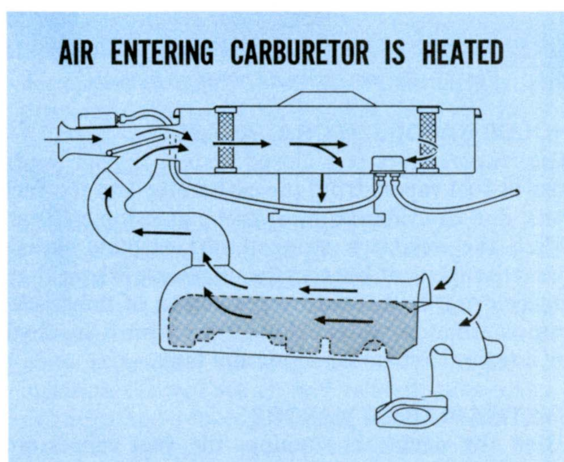


Fig. 30—Improves warm-up driveability

BETTER WARM-UP MIXTURE

With the Heated Air Intake System, air entering the carburetor in cold weather is heated to allow faster, more efficient engine warm-up. Pre-heating the intake air produces warm-weather driveability and reduces exhaust emission during warm-up.

DESIGNED FOR AVERAGE CONDITIONS

The Heated Air Intake System makes it possible to modify the engine design, operating temperatures, ignition timing, and carburetor calibration to more closely suit average operating conditions. As a result, less choking is needed so emissions are reduced during warm-up.

EVAPORATION CONTROL SYSTEM

Some 1970 and '71 models have the Vapor Saver or Evaporation Control System. Like the carburetor and distributor solenoids, the Vapor Saver is covered in detail in the Service Manuals and recent Master Tech Reference Books on the subject, so we'll only review the system's high spots.

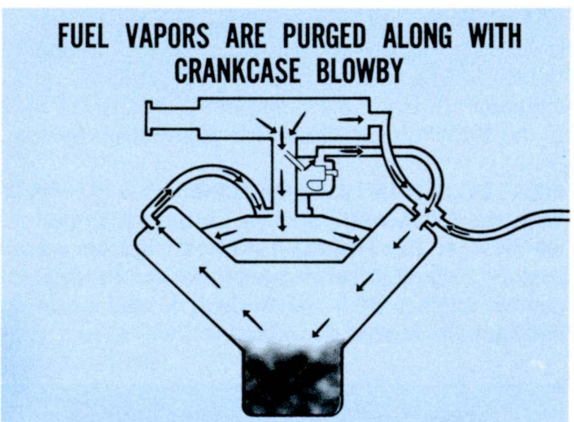


Fig. 31—System normally needs no servicing

HOLDS VAPORS IN CRANKCASE

The Vapor Saver is a closed system that prevents loss of fuel vapors from the carburetor and the fuel tank due to evaporation or fuel expansion spillage. When the engine is stopped, the gasoline vapors pass through vent lines to the crankcase where they are held until removed by the action of the crankcase ventilation system. Fuel expansion is handled by a separate chamber inside the tank.

SYSTEM PURGES VAPORS

When the engine is running, the fuel vapors are purged from the crankcase along with normal crankcase vapors. Positive ventilation flow draws the vapors into the intake manifold and combustion chambers. The Vapor Saver System normally requires no servicing.

NO_X CONTROL SYSTEM

The Cleaner Air System on some 1971 models also includes the NO_X System to control oxides of nitrogen in the exhaust. NO_X emission is controlled basically by lowering peak combustion temperatures. In other words, cooler burning produces less oxide emission.

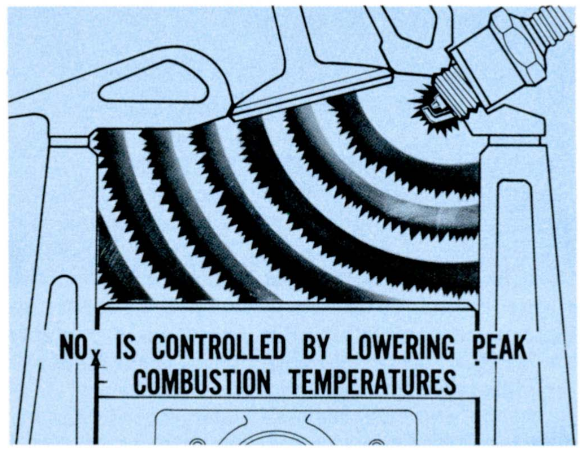


Fig. 32—Cooler combustion lowers emission

COMBUSTION TEMPERATURE IS CRITICAL

Here we run into a bit of a paradox because up to now the trend has been toward increasing combustion temperatures to get more complete burning of the mixture. While this principle still applies, you'll notice that NO_X control is concerned with lowering *peak combustion temperature,* which is the main critical factor in controlling nitrogen oxide emissions in the exhaust.

SYSTEM REDUCES PEAK TEMPERATURE

To control peak combustion temperatures, NO_X engines have more valve overlap plus retarded ignition timing at low vehicle speeds. The 185^{o} thermostat holds cooling system temperatures relatively low.

VALVE CAUSES TIMING RETARD

For retarded timing, the distributor vacuum unit is controlled by a solenoid vacuum valve connected between the distributor vacuum advance unit and the carburetor. The solenoid valve is operated by switches that sense outside air temperature and the speed of the vehicle.

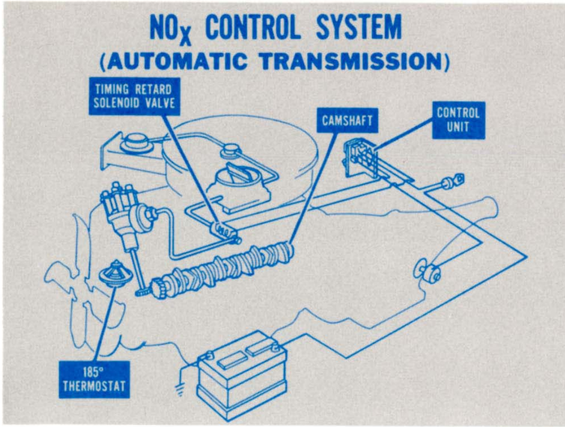


Fig. 33—System controls combustion temperatures

CONTROL NEEDED AT LOWER SPEEDS

The controls hold the distributor vacuum advance unit in retard position on acceleration up to 30 miles per hour. But if the outside air temperature goes above sixty degrees, the system automatically returns the distributor vacuum unit to normal timing advance operation.

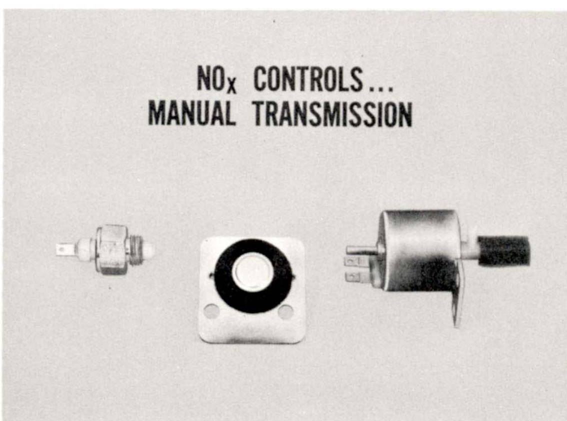


Fig. 34—Manual controls are simple

NO_X SYSTEM VARIATIONS

The NO_X controls for manual transmission vehicles are somewhat simpler, since only three components are used in these installations. There is a transmission on-off switch which allows normal ignition vacuum advance only in direct drive. A thermal switch senses outside air temperature to prevent NO_X System operation below 60 degrees, and a solenoid vacuum valve, identical to the one used on TorqueFlite vehicles, controls the ignition timing retard.

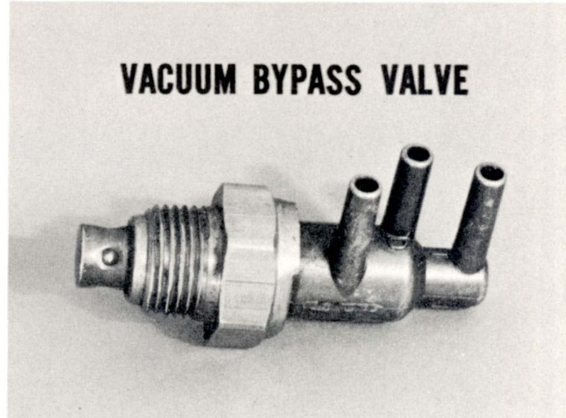


Fig. 35—Valve gives timing advance operation

OVERHEATING CAUSES BYPASS ACTION

In addition on some NO_X installations, you'll find a temperature-operated Vacuum Bypass Valve connected between the vacuum solenoid and the distributor vacuum advance unit. The Bypass Valve senses coolant temperature. If the engine overheats, the valve bypasses the NO_X system to provide vacuum timing advance operation until engine temperature returns to normal.

EMISSION CONTROL FOR USED CARS

To provide exhaust emission control for 1955 and later Chrysler vehicles which do not have emission controls, the UCCAP Kit is available. UCCAP stands for Used Car Cleaner Air Package and as the name suggests, it is essentially an add-on component. The kit includes a special vacuum control valve, a length of connecting hose, an identification decal, and complete installation instructions. To be properly effective, the engine must be in good mechanical condition and properly tuned when the kit is installed.

CHANGES WILL CONTINUE

With the description of the UCCAP Kit we have covered the evolution of the Cleaner Air System to the present. Be sure to remember that emission control in Chrysler Corporation vehicles is a complete integrated system; engine performance and emission control are closely related; tune-up specifications and procedures must be followed exactly; and that you can expect the Cleaner Air System components and specifications to continue changing in the future.

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