BY WAYNE THOMS

FIRST OF all, if you're looking for a simple solution to the smog riddle, stop right here. I'm an observer, not a scientist. If I had the answer, I'd be in Washington expounding for the benefit of mankind. Except for breathing the Los Angeles variety for more than 20 years (which should make me an authority by virtue of survival) I only know about smog what qualified scientists and officials tell me . . . and they don't all agree as to its causes, composition or cure.

Smog is a paradox. No one favors it, yet it has become a controversial item, sometimes political, with roots in the economic structure of America. People have blamed smog on everything from backyard incinerators (they were ruled out of Los Angeles County years ago), to heavy industry, to refineries, to automobiles.

Although Los Angeles gained notoriety with its smog, air monitoring by the U.S. Public Health Service indicates that L.A. is not the only smoggy city in the nation. For example, Washington, D.C., Birmingham, Ala., and Tucson and Phoenix, Ariz., sometimes have oxidant measurements high enough to cause eye irritation, while plant damage has been found in Maryland, New Jersey and St. Louis, not to mention California.

In the pocketbook, if not physiologically, it affects every American, if only by virtue of the smog devices that are being installed on automobiles at consumer expense. Since 1963 every new car has had an inexpensive crankcase device, and for 1966, new cars sold in California are being fitted with relatively expensive exhaust devices. It appears to be only a matter of time until every car in America has an exhaust device . . . whether we want it or not. Recently Congress passed a bill (SB 306) which requires exhaust devices on all new cars, starting in 1968.

I'd like to be able to state a valid case that would free the automobile from the bulk of the blame for smog. But I cannot. If some monstrous conspiracy is concealing the facts that would lay the blame elsewhere, it has been totally effective.

For the moment, at least, the internal combustion gasoline engine must take most of the responsibility for polluting our atmosphere. It does, of course, require the help of proper atmospheric conditions. Los Angeles has been cited as the classic example of what it takes to produce smog. Insulated by mountains, it commonly has a temperature inversion (about 270 days per year) and very mild breezes (average five mph during the summer) which keep pollutants near the ground. And when the sun hits the nitrogen oxides and unburned hydrocarbons that pour from exhaust pipes, the result is photochemical smog which is not dissipated because air circulation is insufficient. This is the smog that cuts visibility, burns the eyes, cracks rubber and damages vegetation among other unpleasant effects.

Unless you are a farmer or a gardener, chances are the idea of smog damage to plant life is a new concept. Such damage was first seen in the Los Angeles area in 1944, and can now be found in all the important regions of California, which we use as an example because it has been the state hardest hit. According to a 1964 report in the Archives of Environmental Health, ". . . about 14,000 square miles are now known to be affected by oxidant, ozone and ethylene, which are typically emitted from combustion processes and motor vehicles, and by fluoride and sulfur dioxide which are typically emitted from industrial sources."

What other damage to humans smog causes, no one knows exactly, but medical authorities suspect it has an influence in certain forms of cancer. Also, it often produces severe reactions in persons with respiratory ailments. Indeed, doctors commonly advise such patients to seek smog-free areas.

To understand smog, a short lesson in over-simplified chemistry is essential. All petroleum-based fuels are made up of hydrocarbons of which there are four classes and many types within each class. The type that offends us most are the olefins, although not all types of olefins are bad. Part of the smog problem, then, is when unburned olefinic hydrocarbons escape through automobile exhaust systems and they do escape as a routine matter of engine operation.

The other portion of the smog dilemma occurs when nitrogen oxides are formed. First comes nitric oxide which is created in the combustion chamber at burning. Once emitted out the exhaust it combines with more oxygen and forms nitrogen dioxide. It is the nitrogen dioxide which reacts with the olefinic hydrocarbons under sunlight to produce the irritating haze we call smog. Nitrogen dioxide is responsible for ozone formation, as well, and it is ozone that attacks rubber.

At various times theories have been advanced to cut smog by reducing the olefinic content of gasoline. It sounds quite logical, but scientists tell us there is no standard relationship between the gasoline that goes in the tank and exhaust the comes out the tailpipe. In fact, a series of tests carried out in 1957-58 by the Air Pollution Foundation and the American Petroleum Institute, in which different autos were operated with various fuels under varied driving conditions, showed that gasoline containing lots of olefins produced no more eye irritation or ozone than did gasoline containing no olefins at all.

A contradiction? Not really, because olefinic hydrocarbons are manufactured in the auto engine, which acts as a mobile "cracking plant," transforming non-olefinic gasoline into olefinic exhaust.

It was also found in the study that two new cars in good operating condition produced no smog whether the gasoline was non-olefinic or very high in olefin content, but when their engines were adjusted to simulate poor maintenance, smog symptoms were produced with all the fuels tested.

Two years later, the U.S. Bureau of Mines, reporting on extensive tests conducted at is Petroleum Research Center, added this gem: ". . . the majority of experimental data from this laboratory shows a slight trend toward decreased olefins in the exhaust with the higher olefinic content of the fuel."

Apparently ignoring this evidence, Los Angeles County limited the olefinic content of gasoline on July 1, 1960, banning the sale of any gasoline having a bromine number greater than 30 (approximately 13.5% olefins). This is of possible broad significance only because the Los Angeles County smog experience and subsequent regulations have been watched as a pilot model for broader legislation.

There remain those who dispute statements, that the automobile is the principal contributor to smog. Again we must turn to Los Angeles County, where official statistics measuring pollutants in the atmosphere are readily available. In January 1965, L.A. County had 3,450,000 gasoline-powered vehicles registered. In an engineering report of the county's Air Pollution Control District (Jan. '65), fuel consumption was measured at 7,400,000 gal. per day. The average emissions of air contaminants per day are staggering—and they place the blame for majority of smog squarely on the automobile. For example, hydrocarbons and other organic gases emitted totaled 2750 tons per day of which 1930 tons came from gasoline-engined vehicles. Of this amount, 1400 tons were from exhaust, the balance resulting from blow-by and evaporation.

There were several other offenders. Organic solvent uses (surface coating, dry cleaning, degreasing) accounted for 495 tons per day, while aircraft put out 30 tons. It should be of interest to those who accuse the refineries of being big smog sources that their total was 55 tons, while petroleum production accounted for 60 tons and marketing another 105 tons.

Of nitrogen oxides emitted, gasoline vehicles accounted for 490 tons per day of the 835-ton total, the petroleum industry only 45, and the combustion of fuels by industry either 180 or 270 tons, depending upon which of Los Angeles County's rules prohibiting fuel oil and requiring natural gas to be burned when it is available was in effect on a given day.

Admittedly statistics make for dull reading, but one can easily get all choked up over these.

An interesting aside concerns diesel exhausts. The visible black smoke, bad odor and heavy droplets they emit are far from pleasant, but they have absolutely nothing to do with photochemical smog, contrary to what most people think. For one thing, diesel exhaust contains virtually no hydrocarbons, and we know that hydrocarbons are a big share of what makes smog.

The fact is that smog is a terribly complex subject, and the experts are continually uncovering new data. The problem of learning how to measure components in exhaust gases has been a major project. We're dealing with microscopic measurements or parts-per-million chemistry. Finding one part per million is like locating a grain of table sugar in a half-cup of table salt and it requires techniques that did not even exist 10 years ago.

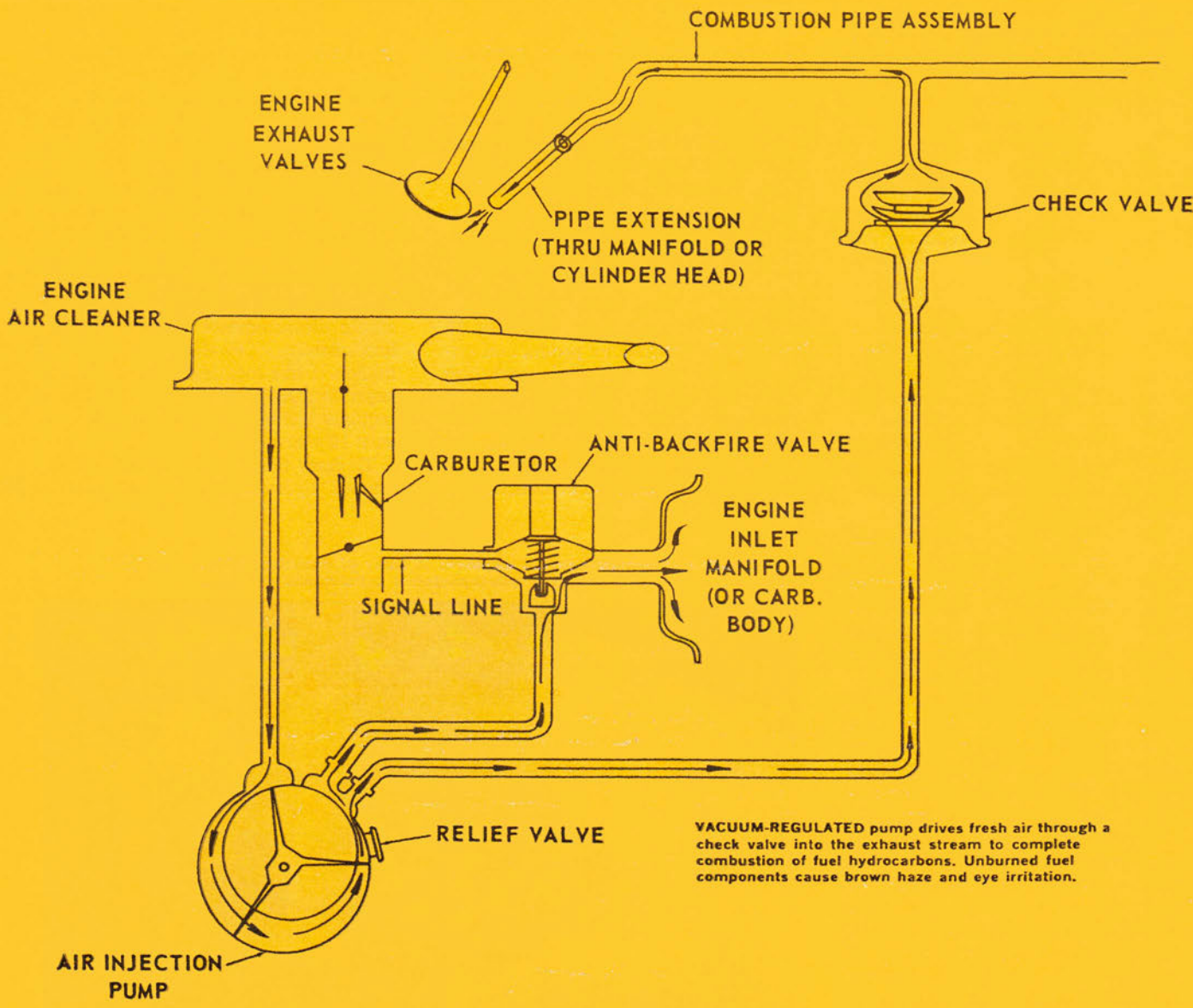
To carry the analogy farther, the unreacted hydrocarbons in the exhaust ▶

HIGH-SPEED photography aids GM engineers in study of conditions which promote luminous oxidation in a quartz-windowed experimental manifold.

SMOG

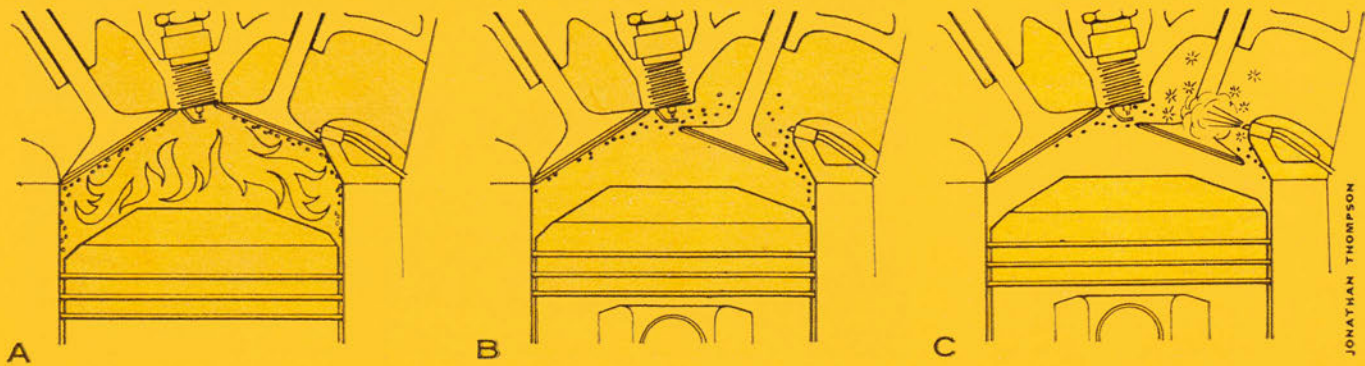
stream amount to 0.1% of the total. Not only has this concentration been accurately measured, but chemists and engineers have analyzed it to the point that more than 125 separate hydrocarbons have been identified in it.

Because they have a rather large stake in the problem, automobile companies have invested large sums in smog research. General Motors' program is enormous, as are the programs of the other builders. One of GM's important and intriguing accomplishments was development of a means to photograph, at high speed, the combustion process inside the engine. The photos revealed



VACUUM-REGULATED pump drives fresh air through a check valve into the exhaust stream to complete combustion of fuel hydrocarbons. Unburned fuel components cause brown haze and eye irritation.

AS COMBUSTION occurs (A), the flame front is quenched by cylinder walls, leaving a thin unburned layer. Particles from the quench layer (B) escape into the exhaust stream. Air injection (C) ignites the particles for relatively smog-free exhaust.



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the source of the unreacted hydrocarbons as a "thin skin" around the combustion chamber.

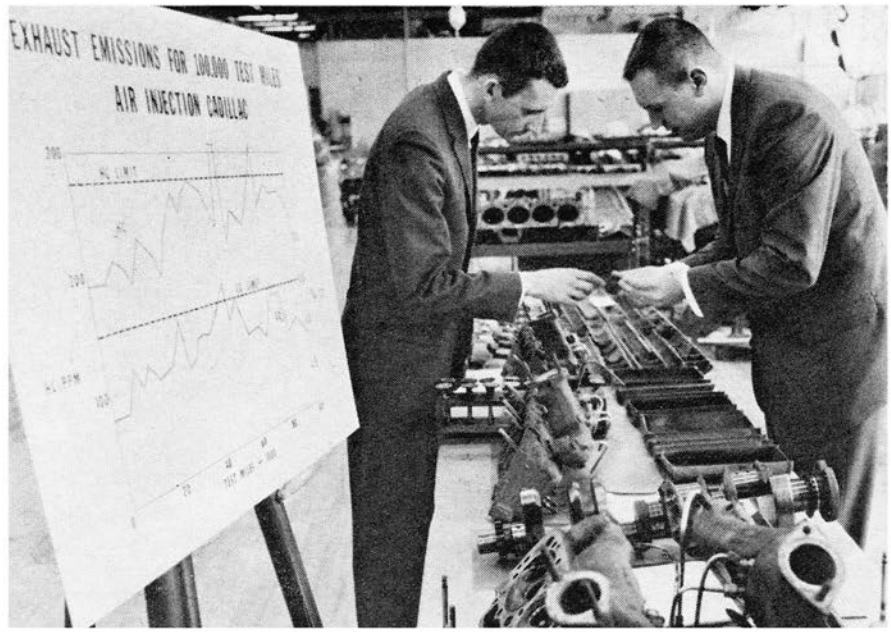
In practice this means that when the spark plug ignites the fuel/air mixture, a flame front sweeps through the combustion chamber. As this front approaches the relatively cool cylinder wall, a quenching action occurs. The flame front in effect is snuffed. This leaves a very thin margin of partially unburned air and fuel mixture around the wall, measuring from 0.002 to 0.01 in. thick. This skin is the origin of the partially reacted hydrocarbons that pass into the atmosphere through the tailpipe.

GM also has a 300-cu. ft. smog chamber, where 247 special fluorescent lamps irradiate exhaust gases, literally manufacturing smog. Logically enough, the technicians singled out Los Angeles noontime sun as the "ideal" atmospheric conditions to simulate.

To the layman it seems that the smog problem is bound up in a welter of discouraging scientific contradictions. As an example, compare these two facts from a GM report that documents research findings since 1955: (1) On Oct. 31, 1957, two research lab men reported that oxides of nitrogen in automotive exhaust could be reduced as much as 90%, but at a cost. They told the 22nd meeting of the Industrial Hygiene Foundation that an enriched air/fuel mixture through a maximum performance carburetor reduced oxides of nitrogen by 90%, but fuel economy slumped 26%. (Oxides of nitrogen, as we mentioned earlier, are blamed for smog's eye smarting qualities.) (2) On March 12, 1962, three GM researchers showed that significant reductions in exhaust hydrocarbons can be made by leaning air/fuel ratios and retarding spark timing, but maximum reductions result in poor vehicle operation. Lean ratio with retarded spark timing cut down hydrocarbon emissions as much as 25%, but fuel economy gains at lean ratio were offset by retarded spark timing. They also said that deposit accumulations in the combustion chamber significantly increase exhaust hydrocarbon emissions.

It doesn't sound promising, does it? There's a fundamental paradox in satisfying both conditions simultaneously—rich and lean mixture—to reduce both types of contaminants.

ANOTHER GM report issued in June 1965 to the Air Pollution Control Assn. pointed out some results from the smog chamber. In effect, it said that decreasing exhaust gas hydrocarbons reduced eye irritation and slowed the formation of two smog constituents, ozone and formaldehyde. However, decreasing nitrogen oxides had no effect on eye irritation and actually increased formation of ozone, a potent smog ingredient. The report also indicated that formaldehyde may be a major ingredient that causes eye irritation.



EFFECTS OF exhaust emission control devices on engine life are checked by GM engineers after 100,000-mile city driving tests in Los Angeles.

Might there not be an answer in some new fuel that could be burned in an internal combustion engine? The data here are incomplete, but a report issued by GM in 1964 had this to say about a blend of 25% ethyl alcohol and 75% gasoline: ". . . the exhaust did contain lower hydrocarbon concentrations than gasoline, but nitrogen oxide concentrations increased. Comparisons with gasoline indicated that addition of ethyl alcohol causes increase in surge, and in some cases, contributed to power loss."

By now we should be reasonably well convinced that the automobile is a prime smog manufacturer. Certainly industry is a serious offender, but factories are easier to control.

So, what can be done? The answers are not encouraging. If we can ignore statements such as those of a prominent Los Angeles City official who suggested (quite seriously) that we stop building freeways because each one that is built just throws up a whole new cloud of pollution from autos, perhaps we can pay heed to what some of the scientists have to say. In California, where automobile emission control projects are well advanced, the stated goal is a device on every car by 1970 . . . which would roll the smog level back to that of somewhere around 1940. Things weren't so bad then. Some days you could smell the orange blossoms. Unfortunately, a good many of the orange blossoms have been replaced with factories and tract houses, and the population (auto and human) is exploding as it is everywhere.

Privately, one official of the California Motor Vehicle Pollution Control Board expressed the belief that everything currently being done was a stopgap measure, that we would have no real relief until some new power source was worked out for the automobile. It could be a turbine, which has a very "clean" exhaust, an electric car, steam, maybe even large rubber bands. But he was convinced that the smog problems associated with the gasoline engine could never be solved, even though he considers it absolutely essential to stay on the track of better smog devices just to keep about even with the game.

One of the more pessimistic observations came recently from Prof. Morris Neiburger of the department of meteorology of the University of California at Los Angeles. He believes it is possible in the course of the next century, as population grows and power demands per capita increase all over the world that ". . . the amount of waste poured into the atmosphere by these activities will far exceed the atmosphere's capacity to diffuse and to remove the waste, and the atmosphere will grow progressively more polluted until, a century from now, the air is too toxic to permit human life. All of civilization will pass away, not from a sudden cataclysm, but from gradual suffocation by its own effluents."

He does not believe that workable controls for the auto engine to reduce its noxious emissions are possible, and suggests electric power, although he admits such a solution may be unrealistic and it might be too late before an aroused public demanded crash action.

We hope that between scientists, big government and the auto industry, someone can develop an answer to smog that will prove Prof. Neiburger wrong. As a matter of fact, I've been working on this giant electric fan, see, and I figure I could blow the stuff away from the cities, and . . . ■