

spreading metropolitan complexes. Nor will atomic power or natural gas—which contains very little sulfur—be of much help in the years just ahead.

There appear to be only two ways out. In the case of residual fuel oil, local authorities could require power companies to switch to No. 2 oil, which is low in sulfur but costs 80 percent more. Or petroleum companies could take part of the sulfur out of residual oil, raising its price 20 to 30 percent. As for coal, the only answer is to trap the sulfur dioxide after the fuel is burned, and to convert it to marketable acid or elemental sulfur. The Department of Health, Education, and Welfare is planning to spend \$7 million to build pilot models of some systems that show promise of being able to make such a conversion economically. Recently, officials of the Bureau of Mines estimated that any one of the three leading processes would impose an added cost, even when allowance was made for the sale of acid or sulfur, equivalent to an increase in fuel costs of 10 to 25 percent. The estimates, it should be noted, are based on the installation of these processes in a new, 800,000-kilowatt plant. The capital expense of fitting them into existing power stations, other studies show, would be much higher, perhaps doubling the augmented cost.

These figures are not quite so gloomy as they look. Fuel represents only about one-seventh of the total cost of generating and distributing electricity, or about 2.5 mills per kilowatt-hour. Even if the power companies were forced to burn low-sulfur fuel or were directed both to install sulfur dioxide recovery systems in new coal stations and to fit out similarly all the existing ones, the cost of the electricity generated by them—about 600 billion kilowatt-hours last year—would probably not rise by more than \$600 million a year.

Traffic in carbon monoxide

In terms of sheer tonnage, the automobile is the country's No. 1 air polluter. According to Public Health Service estimates, it accounts for over four-fifths of the 85 million tons of contaminants emitted by all forms of transportation, including trucks, buses, railroads, and airlines. The three dangerous and obnoxious ingredients issuing from the nation's 72 million automobile tail pipes are carbon monoxide, unburned hydrocarbons, and oxides of nitrogen. While it can kill a man by depriving his blood of its oxygen-carrying capabilities, carbon monoxide is generally not dangerous in open places. Nevertheless, it can reach dangerous concentrations in heavily traveled city intersections and expressways. Biochemist A. J. Haagen-Smit of California Institute of Technology says the level frequently gets to 30 p.p.m. on the Los Angeles freeways—enough to deprive the blood of 5 percent of its oxygen capacity if inhaled for eight hours—and sometimes reaches 120 p.p.m. in traffic jams. More trouble per ton is caused by the unburned hydrocarbons, some of them highly reactive, that spew out of cars. Their partners in crime are the oxides of nitrogen. All forms of combustion, particularly in motor vehicles and electric power stations, give off nitric oxide. Most of this is quickly converted into nitrogen dioxide, a whiskey-brown gas that is five times as toxic. When the sun shines on a mixture of hydrocarbons and nitrogen dioxide on a warm day, the result is photochemical smog.

The automobile industry has opposed controls on auto-

mobile exhaust emissions outside Los Angeles on the unpersuasive ground that other cities do not yet have an acute smog problem. But Washington, D.C., where the number of cars per square mile is three times as great as in the Los Angeles metropolitan area, has already had some eye-watering days. Denver figures that 40 percent of its pollution comes from the automobile, and in New York City the car contributes a third. "We didn't have that haze until they built the expressways," says a Chicago air-pollution man, "but we sure have it now."

Most of the radical proposals for dealing with smog, even if adopted, would barely enable cities to hold their own. Turbine-powered vehicles, now being tested by the auto manufacturers, are low in pollution ("It would make your eyes bug out, it's that low," enthuses a Chrysler man), but have not yet proved out. Diesel engines are noisier and costlier than the gasoline engine and, while they emit less carbon monoxide and hydrocarbons, they produce just as much oxides of nitrogen.

The only solution, for the foreseeable future, is to clean up the internal-combustion engine. Since 1963 the automobile companies have installed crankcase devices that vent back into the intake manifold the unburned gases that push past piston rings during combustion. But these "blow-by" devices, which actually were used on some makes years ago and then dropped, reduce only one of the car's three pollutants, hydrocarbons, and by only 30 percent. For this reason, California state authorities, who seek to roll back the pollution in Los Angeles to the 1940 level, have insisted on controlling exhaust emissions. Chrysler Corp. has a "cleaner air package," which meets California's standards, and adds \$13 to \$25 to the price of a new car. The device, which sends a leaner mixture to the engine and advances the spark during deceleration for more complete burning of fuel, can be maintained for only a dollar a year more than the cost of a recommended engine tune-up, Chrysler claims. The other three auto companies have announced systems that, like Chrysler's, alter fuel-air mixture and timing. But they have added a pump that injects air into the exhaust manifold to aid the burn-up of contaminants. This system would increase the price of a new car by as much as \$50. These devices are appearing for the first time on 1966-model cars sold in California.

Forcing Detroit to "find something"

The combination of crankcase "blow-by" device and exhaust controls, California authorities say, will reduce carbon monoxide emissions by 60 percent and hydrocarbons by about 70 percent. But, it will be ten years before 85 percent of the cars now on the road have them, and meanwhile the number of automobiles in the Los Angeles area may grow faster than smog is reduced. For this reason the state has ordered a further 15 percent cutback by 1970. At the moment, Detroit does not know how it will comply. "We have to find something, don't ask me what," says an official at General Motors' Warren, Michigan, research center. In addition, California may shortly set limits for emissions of oxides of nitrogen. The auto industry does not yet know how to control these, either, since they present totally different problems. But it seems safe to assume that Detroit will come up with something if it has to.

Now that Senator Muskie's bill has been passed, it is