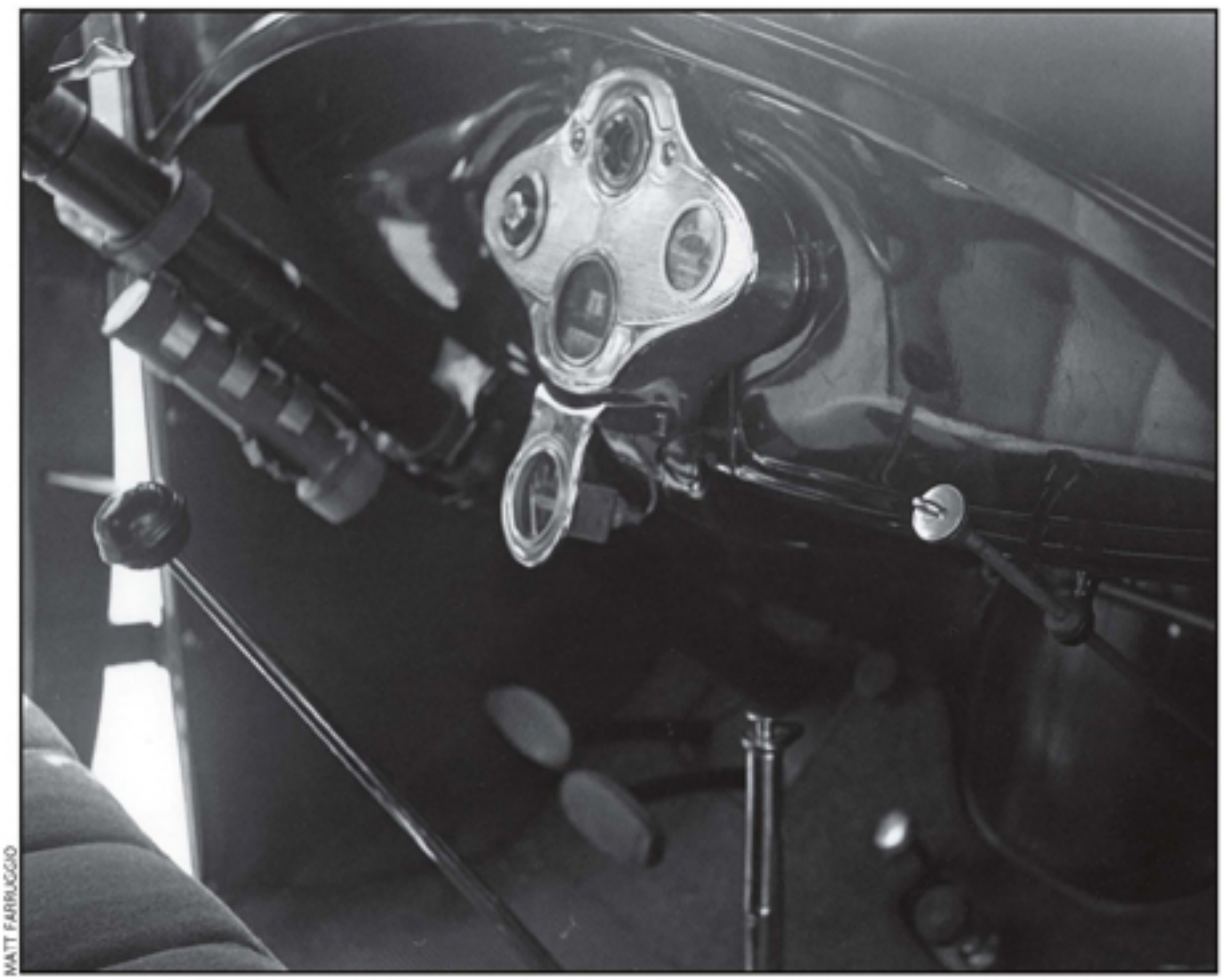
for all the cars it sells, or pay hefty fees for going over the average. So the rising popularity of SUVs that dragged down the CAFE of the American companies cost them plenty, since they couldn't meet their goals.

> *"Democracy is two wolves and a lamb voting on what to have for lunch. Liberty is a well-armed lamb contesting the vote."*
>
> —BENJAMIN FRANKLIN

Now enter the chicken or the egg problem of alcohol vehicles and alcohol pumps. In the 1980s, oil companies complained that they shouldn't be required to sell alcohol at the pump if there weren't cars to run on it. Car companies said they couldn't make cars run on alcohol if there was nowhere to buy it at the pump. To break this impasse, two pieces of legislation were passed in the early 1990s. The first required government fleets to buy vehicles that could run on renewable fuels; the second gave car companies CAFE credits if they made cars that could run on alcohol.

So auto companies got their credits, which allowed them to build more highly profitable SUVs, and the government got to buy cars that could be powered by renewable ethanol. But there was no requirement in either of these laws that mandated that these vehicles had to actually run on alcohol to earn their benefits. So FFVs were the perfect political solution. In other words, they fulfilled the letter of the law without upsetting any apple carts at the oil company boardrooms or in Detroit, while state and local governments received funding to buy flexible-fuel vehicles. Of course, nothing much changed at all. The bottleneck of lack of distribution did not change—even though there were now millions of FFVs on the road—because they could still run on gasoline.

Part of the devil's bargain in this deal came in the demand of the auto companies to make E-85 the legal definition of alcohol fuel. The car companies said they'd make the FFVs, but not if they had to pay for installing cold-start devices. That would cost them $50 per car. Now you might say, "What's $50 on a $30,000 SUV?" Well, on a million SUVs it's $50 million of Detroit's favorite dollars.



MATT FARRUGGIO

Fig. 22-2 Model A dual-fuel carburetor control. *The shiny knob on the right is for inserting or retracting the needle in a Model A carburetor's single jet. Depending on the setting, either gasoline or alcohol could be used.*

By permitting 15% gasoline to be added to alcohol and still call it alcohol fuel, vehicles can start in any weather without the inexpensive cold-start devices. So to allow the car companies to avoid this small expense, we are now saddled with E-85 and all the problems associated with trying to deal with toxic waste added to our otherwise clean alcohol fuel.

The other thing E-85 accomplished was the invisibility of FFVs. Most people who own them don't even know it. If they had to fill up their cold-start tank under the hood every six months, they would be quite aware that they owned an alcohol vehicle, something MegaOilron strenuously wanted to avoid.

In 2006, however, both Ford and GM changed their approach on FFVs, actively advertising their availability and even participating in a modest way in helping increase the number of alcohol pumps. We can all hope that this is the start of a duplication of Brazil, where in a few short years gasoline-only cars are becoming a thing of the past.

BASICS

An FFV engine can use any proportion of alcohol and gasoline in the same gas tank. In a way, it is what we always wanted in a car. The car runs on alcohol in town (95% of most people's driving), while retaining the ability to use gasoline for trips that might take you out of range of your alcohol source.

This is not the ideal way to run an engine on alcohol, since compromise is required on nearly every front, in order to accommodate burning the Oilygarchy's toxic waste. FFVs are a near-term bridge to a future where we end up having alcohol stations always within range. Our real visions will take the form of dedicated E-100 vehicles in the not-too-distant future.

The early line of flexible-fuel vehicles worked by having sophisticated software and a special fuel line sensor to tell the computer how much alcohol was in the mixture. Newer FFVs have done away with the fuel line sensor and just interpret data from the other standard oxygen sensors to provide the information needed by the ECU during and after each fill-up.

The computer, which has a fuel "map" for each increment of alcohol, relays how much alteration is needed for the particular mix of the day—to the car's fuel injection timing, ignition timing, and, in some cases, turbocharger. Using information from

REFORMING

Scientists at the U.S. National Research Energy Laboratory (NREL, formerly the Solar Energy Research Institute) have rediscovered a school of "vaporization" that was popular decades ago. This process is called "reforming." If you heat alcohol (or other fuels) in the absence of air to temperatures far above their boiling point, and duct them through certain catalytic metals, they will decompose into a variety of combustible gases. Different metals catalyze with different alcohols in different ways, and there are a variety of flammable gas byproducts, including hydrogen, carbon monoxide, methane, acetylene, and various aldehydes.

When this mixture is combusted, the thermal efficiency rivals that of hydrogen fuel cells, but without all the cost. Reforming can be done today using alcohol without a complete reworking of our fuel system's infrastructure; reformers could be manufactured to run home- or farm-scale cogenerators, getting a lot of people off the grid.

NREL's tests in the early 1980s on a methanol-fueled engine, which had a compression ratio of 14:1 and automatic spark advance, reached essentially double the mileage of alcohol's liquid mileage at 2000 rpm. This, of course, means that methanol was getting better mileage than gasoline. The difference with ethanol would be even greater. (More work has been done on methanol than ethanol due to research funding preferences.) The NREL engine fit underneath the hood of a Chevy Citation, and advancing technology has since meant smaller and more efficient engines.

Reforming is once again being worked on in a big way as part of the research for the front-end of fuel cell technology. Onboard reformers are considered the first step on the hydrogen fuel extravaganza. And, while most of the catalysts needed to reform gasoline to get hydrogen depend on pricey, monopoly-controlled platinum, several good catalysts for alcohol (nickel compounds, rhodium, and cerium) are cheap and widely available.

So, how does reforming take place? In a nutshell, alcohol is preheated to a boil by radiator water in a countercurrent heat exchanger. Then it's superheated by exhaust to very high temperatures and sent to a metal catalyst reactor. The issuing gases are cooled to a temperature (about 200°F) that doesn't tend to pre-ignite in the very high-compression engine that can be used. Radiator water is used as a coolant this time, rather than as a heating medium.

Depending on the catalyst, reactions occur at specific temperatures, and vapors inducted at different temperatures result in different byproduct breakdowns. Most of the catalytic metals require alcohol to be vaporized in the neighborhood of 600°C, but a few metals, such as nickel, yield excellent results—an incredibly clean combustion, high thermal efficiency, and very attractive mileage—at about half this temperature.