To Ron Goldfarb:
There is nothing better for a writer of books on off-beat subjects than an agent who *loves* to go fishing.
There are few technological adventure stories that are as rich, quirky, and peculiarly American as the early rise, the precipitous fall, and the modern resurgence of the electric car. If you are one of the millions of buyers who are now considering an electric vehicle, you should know that this car, like the lead character in a movie, has an intriguing backstory.

Peering out at you from the showroom window is a creature that is a product of enormous risks, long, frustrating struggles, dismal failure leading almost to its extinction, an unlikely resurrection, and finally a list of improbable victories. They include little wins that are happening daily as hundreds of thousands of car buyers begin to break buying habits that have dominated the economy for almost a century.

You have probably never been in love with your toaster or your refrigerator, but here is an electric appliance that might seduce you. Many Americans have fallen in love with their cars. Our country’s varicose network of highways was built for them. They have created millions of jobs, helped erect a robust manufacturing base, and generated a freedom of travel that is unparalleled in the world.

And they have also caused traffic congestion, pollution, noise, and a costly, sometimes dangerous reliance on imported oil. Then there are the carbon dioxide emissions that have convinced most scientists that our planet will become dangerously overheated unless we do something to minimize the emissions.

The electric vehicle that you’re looking at may be your way of trying to help solve some of these problems. It may just be a quest for a reliable, fuel-saving set of wheels. Or it may scratch that itch for performance that you’ve had for years. When you have to move, this car will give you a burst of silent power that you have probably never experienced.

The current electric vehicles are carefully designed not to shock you, but the sticker price on the rear window might. It may be higher than you have bargained for, but measured over the lifetime of these cars, the costs are likely to be cheaper than the other cars you have enjoyed or fantasized about owning. Cars, like a lot of the items you own, arrive with hidden costs.

The last razor or computer printer you bought came with a price tag that was deceptively cheap, but they subjected you to long investments in expensive blades and
printer ink. The last car you bought exposed you to volatile gasoline prices and, possibly, a long relationship with your auto dealer’s service department that you didn’t expect and didn’t budget for.

Well, think of the hybrid-electric or plug-in electric or fuel cell electric vehicle that may have aroused your curiosity as a kind of superhero, a track-tested revolutionary that has come to save you from some of the hidden costs. Because they have fewer moving parts, are more energy-efficient, and can run on cheaper, cleaner fuel, electric vehicles are creating a lengthening record of reliability and economic satisfaction that many drivers are now discovering.

Think of them as Indiana Jones on wheels. They are the product of thousands of adventurers, inventors, hot rodders, engineers, and risk takers who have relied mainly on America’s high technology to challenge the auto industry’s status quo. You need to do more than kick the tires to grasp the promise of these cars. but once you do, they will very likely give you a kick.

The roots of the first generation of electrics go directly back to one of the founders of the nation: Ben Franklin. His early experiments with electricity attracted a worldwide following that included a minor eighteenth-century Italian aristocrat, a reclusive dreamer named Alessandro Volta.

Volta, a public school administrator who fancied himself a physicist, was proud to describe himself as a “Franklinist.” He performed magic tricks using static electricity and wrote poems in Latin and lyrical papers on electricity’s mysterious properties and its possible future uses. When he described electricity as a miraculously invisible liquid, one of his mentors felt he had gone off the rails of science. He ordered Volta to “keep silent forever.”

Instead, Volta went back to his lab. In 1799 he built a stack of silver coins, interspersing them with poker chip–sized pieces of zinc and circular pieces of water-soaked cardboard. After he soaked his hands in water and then grasped both ends of this strange apparatus, he was rewarded with a substantial electric shock. He had invented the first storage battery.

The discovery brought him worldwide honors, including a medal from Napoleon, and immortality as a unit measuring the potential carrying capacity of a line connected to an electric current: the volt. Alas, Count Volta never fully understood the complex electro-chemical reaction that made his invention work. He has that in common with thousands of other pioneers who have spent their lives trying to fathom the continuing mysteries and quirks of batteries.

The pioneers’ work eventually led to the Electrobat, a black, 1,650-pound coffin-shaped vehicle carrying on its skinny wheels a battery derived from those that powered Philadelphia’s streetcars. It made its stunningly silent appearance on the
lakefront in Chicago on Thanksgiving Day 1895. Electrobat was one of the standouts of the nation’s first automobile race, even though it ran out of juice before the finish line and lost to a pack of noisy, fume-belching, gasoline-powered cars. The judges were so impressed they gave it an award for appearance.

Still, there were businessmen who saw electrics as the future. By 1900, the Electrobat morphed into the Mark XVII hansom cab. Although their batteries weighed nearly a ton, hundreds of these cabs zipped soundlessly along Manhattan streets at twenty miles per hour. They worked longer hours than horses could and did not poop on the streets. Plus, they provided an exotic thrill to passengers accustomed for generations to looking from the coach at the slowly churning backside of an animal.

“There is a sense of incompleteness about it,” marveled Cholly Knickerbocker, a columnist for the *New York Journal-American*. “You seem to be sitting on the end of a huge pushcart propelled by an invisible force and guided by a hidden hand.”

Most important, these cars made money. By the turn of the century more than twenty-seven manufacturers were making electrics. Among the leading customers creating the demand were society women, who disliked arriving at a reception in a cloud of dust in a vehicle propelled by explosions and steered either by a goggled chauffer or the man of the house.

The electrics offered a salonlike quiet and luxury refinements, including glassed-in enclosures, carved wood interiors, crystal flower vases, even patent leather fenders. Moreover, to go out for a spin, the woman did not have to negotiate with the chauffeur or her husband. She simply climbed in, pushed a button, and drove off.

Margaret Whitehead, the reigning society queen of Denver, drove her electric to opening nights, stepping out of her car perfectly composed to make her entrée. “One can wear the most perishable and delicately hued gown she possesses,” she explained, “and the daintiest of footwear without giving it a thought, for when she arrives at her destination, she is unsullied and her coiffure is as unruffled as it was when she left home.”

What appealed to women was that electric cars were simple and clean, with relatively few moving parts to break down. Advertising men took the story from there: “Takes no strength. The control is easy, simple,” said an ad for the Columbus Electric, once made in Columbus, Ohio. “A delicate woman can practically live in her car and never tire.”

Three gasoline-powered cars managed to cross the United States in 1903. Jouncing along nearly impassible and sometimes nonexistent roads, the cars had to be rebuilt en route by attendant mechanics who arranged for hundreds of replacement parts to be delivered by train.

By 1908, when O. P. Fritchle, the Denver chemist who designed and built Ms.
Whitehead’s car, made the first crossing for an electric vehicle, he needed only two new tires and a new lining for the brakes in his Victorian Phaeton, which stopped to charge up at dozens of electric utilities along the way. In some places he didn’t need utilities because he found a way to recharge his batteries by converting the energy captured by the car’s brakes into electricity. It worked, but the brakes wore out as he was coasting down the Alleghenies toward the East Coast.

In his reminiscences, Fritchle managed to wrap the struggle that tested the patience of first buyers of electrics on an almost daily basis in an aura of romance. He was a professional electrician who ran a garage that serviced electric cars in a fancy neighborhood. Well-heeled customers such as Ms. Whitehead paid him a monthly fee to keep their cars charged and to fuss with the pesky details.

The peskiness began with the fact that car batteries could weigh up to 1,200 pounds, often had to be removed for proper service, and formed a sludge at the bottom of their cells that caused short circuits if they weren’t regularly cleaned. Poorly charged batteries might strand their drivers anywhere and overcharged ones might explode. That event could start with a flash as brilliant as an arc light, and then the amateur driver would be treated to a fine spray of sulfuric acid.

For people who weren’t rich, the old electrics were a hard-to-acquire taste. The power lines needed to recharge them didn’t often run into poor neighborhoods. More prosperous people without electricity could still buy electrics by first acquiring five-hundred-watt power plants driven by a water-cooled gas engine. They were specially designed to recharge electrics. Sadly, they didn’t work very well. Charles Duryea, a gasoline-car enthusiast, was only half joking when he said: “A set of batteries was worse to take care of than a hospital full of sick dogs.”

The man who killed off the first generation of electric cars was Charles Franklin Kettering, a freelance inventor who later became the founder of research laboratories for General Motors. On February 17, 1911, he delivered his battery-powered invention, an automatic starter, to Cadillac Motor Company.

No longer did drivers of gasoline cars have to bend over the front bumper and turn the engine over with a hand crank, which started the engine but could result in broken arms and dislocated shoulders or other disasters. (Sometimes when the car was left in gear, it started and then simply ran over the driver.)

Because women didn’t like the hand crank, Kettering’s starter introduced them to gasoline-powered cars. At the time they cost only two-thirds of the price of the more elegant electrics. The electric starter also had the unintended side effect of freezing commercial battery technology in the United States for almost a century. The gasoline-powered cars required only a simple, sixty-five-pound storage battery and not the behemoths that powered electrics.
The man who eventually threw the market for gasoline cars into overdrive was a country boy from then-rural Dearborn, Michigan, who came to Detroit to learn about machinery. “Dynamic and attractive, [Henry] Ford exuded a self-confidence that made him a presence whenever he walked into a room,” was the way one biographer later described him.

Ford made himself an expert on repairing electric generators and rose to become the chief engineer for Detroit’s utility Detroit Edison. His ultimate boss, Thomas A. Edison, became enthusiastic about Ford’s hobby, which was tinkering with gasoline-powered engines. In the late 1890s, after seeing a sketch of Ford’s first car, the “quadricycle,” Edison told him: “You have it—the self-contained unit carrying its own fuel with it! Keep at it!”

Ford did. He worked with gasoline engines in his coal shed, his basement, and sometimes in his kitchen, where his adventurous wife, Clara, sometimes played the role of fuel pump. She poured drops of gasoline into a sputtering engine’s intake after Ford had bolted it to the kitchen sink.

A rare combination of a meticulous engineer and a charismatic marketing genius, Ford attracted backers and left the electricity business to form his first automobile company, which soon failed. There were hundreds of tinkerers like him trying to get into the car business and Ford quickly diagnosed his problem: to gain visibility in this nearly all-male market, he had to do something dramatic and different. So he built a racing car and made himself a legend.

Racing has usually been the key to the emergence of new automotive technologies. In 1901 Ford challenged Alexander Winton, a Cleveland bicycle manufacturer who had built what was reputedly the nation’s fastest car—the Winton Bullet. That set the stage for a ten-mile race before eight thousand onlookers in Grosse Pointe, Michigan.

Ford built a racer he called the Sweepstakes. When he couldn’t find anyone to drive it, Ford—who had never been on a racetrack before—climbed into the driver’s seat and pulled the throttle. When Winton’s car, which had almost twice the horsepower of Ford’s, began belching smoke, Ford passed the Bullet to become the only car to finish the race.

“Boy, I’ll never do that again,” exclaimed the dust-covered Ford amid the hoopla at the finish line. He almost didn’t get another chance because then his second car company, born out of the bankruptcy of the first one, failed.

But by this time Ford had achieved escape velocity. The headlines from his racing coup brought in more investors and drew reporters who, charmed by Ford’s down-home humor and his gift for understatement, wrote glowing accounts of his struggles. All this led to a new racing car, the 999, named after a legendary, record-setting New York Central express train. This car was mostly engine attached to a tiny driver’s
platform.

Ford cheered from the sidelines as his hired driver, a daredevil bicycle racer named Barney Oldfield, drove 999 across the finish line on October 25, 1902, to win the Manufacturers’ Challenge Cup and set an American speed record of nearly fifty miles per hour. That helped launch a third company, Ford Motor, which began by selling a few hundred cars a year.

After working through most of the letters of the alphabet, Ford and a committee of six men designed the Model T in 1908. It was lighter and simpler than its predecessors; sturdy enough to handle America’s rutted roads and built on a moving assembly line at a pace that allowed Ford to cut the car’s price from $780 to $360 by 1916. Mass production put it well within the range of the middle-class buyer. By 1918 half the cars in the United States were Model Ts. By 1927 Ford had sold fifteen million of them, creating a new national culture on wheels and leaving most of his competitors in the dust.

Ford had helped design one of the world’s largest and most competitive industries and pioneered an enduring marketing plan that used visions of racing, acceleration, and durability as the sizzle that has driven hundreds of millions into the showrooms to see the “steak.” “I never really thought much of racing,” Ford would explain, shrugging to his admiring coterie of reporters. “But as the others were doing it, I, too, had to do it.”

Makers of electrics didn’t give up without a fight. They knew their cars were more energy efficient and could generate more torque or quicker acceleration than Ford’s could. This inspired Baker Motor of Cleveland to launch the Road Torpedo, an electric car shaped like a rocket on wheels. It hit seventy miles per hour in a race on Staten Island in May 1902, but was then thrown off course by streetcar tracks and shot into a crowd of onlookers, killing two and injuring eight.

By 1916, the market economics and the looming war had driven nearly all electric car companies out of business. Woods Motor Vehicle of Chicago made a valiant last stand, rolling out the Woods Dual Power, an electric with unlimited range because it had both a battery-powered electric motor and a gasoline engine that recharged the batteries. This “hybrid,” selling for $2,650, quickly followed the rest of the electrics into oblivion. Its problem was that it was ninety years ahead of its time.

* * *

What we are watching now is the second act of this story; the start of a trillion-dollar, worldwide race to see who will dominate what could become one of the biggest commercial upheavals of the early twenty-first century: the resurgence of the electric car.
It may seem odd to describe this part of the story as a “race,” because it has been under way since the 1960s. But the pioneers in the race were only able to revive the corpse of an industry that had bloomed in the days of their grandfathers by staging a series of races that began to recapture public attention.

The first race was initiated by Wally Rippel, a bookish physics major at the California Institute of Technology, who challenged Massachusetts Institute of Technology students to race electric cars across the country. The first car to arrive on the rival campus won. It created so much interest that both cars were later flown to the Smithsonian Institution in Washington for an exhibit touting the “cars of the future.”

But the anticipated future didn’t really get moving until an Australian, Hans Tholstrup, who is known to millions of Australians as The Adventurer, staged another race. He was famous for his exploits, which included jumping a bus over a bunch of parked motorcycles. He was fired up by the feats of an American, Paul MacCready, who had designed a solar-powered aircraft that flew across the English Channel in 1981.

Tholstrup designed a light electric-powered car and drove it across Australia. Then he drew up the rules for a solar-powered electric car, set for December 1987, that lured in Japanese electronics and vehicle manufacturers. General Motors, which wanted an opportunity to show off solar power and battery technologies that it had developed during the Cold War, accepted the challenge and beat all contenders with an expensive, exotic car called Sunraycer. The resulting worldwide publicity coup hooked GM on electric cars.

The drivetrains of the electric cars people are buying today were born in that race. In the next two decades they were improved by American inventions, including the lithium-ion battery and fuel cells, which came out of the U.S. missile and space programs. These breakthroughs led to a number of others by pioneering inventors and businessmen, including Alan Cocconi, Elon Musk, and Geoffrey Ballard.

Former vice president Al Gore did not invent the Internet, but he did have a hand in the birth of the Supercar, a U.S. Department of Energy program that had an unintended but electrifying result in Japan. It provoked the launch of Toyota’s Prius, whose sales still dominate the growing electric car market today and whose success showed American carmakers that electric vehicles might be the car of the future after all.

Both polls and auto sales show Americans now realize there is much at stake in this race, but they know very little about the inventors, the hot-rodders, entrepreneurs, computer geeks, companies, regulators, and futurists who are part of this backstory because they paved the way for the reappearance of electric cars. The gamut of players in this drama is huge, running from the “father” of the Prius, an overstressed Japanese
engineer named Takeshi Uchiyamada, to President Barack Obama, whose campaigns projected visions of American-made electric cars, to Amory Lovins, a futurist visionary, and to torque-addicted American hot-rodders such as John “Plasma Boy” Wayland, “Electric Louie,” and “Big Daddy” Don Garlits.

One of the peculiarities of the race to perfect the electric car is that it quickly became global and is full of unexpected diversions. A recent phase of the story began in Vancouver, Canada, in the 1980s, when Geoffrey Ballard and a small team of researchers discovered that the design for fuel cells that electrified U.S. Gemini spacecraft in the 1960s was in the public domain.

They redesigned the fuel cells, made them more powerful and cheaper, and with financial, engineering, and political help from Daimler, the parent company of Mercedes-Benz, sold “stacks” of automotive fuel cells to automakers around the world. The resulting hydrogen-powered electric cars are just beginning to roll out of showrooms in the United States.

This sets up the present phase of the race, with hybrid-electrics, plug-in electric cars, and fuel cell cars all contending for a share of the trillion-dollar automobile market. Which technology will win? Which companies will dominate this market and which will be shoved to the wayside? Which countries will prosper as a result? And what could change the buying habits of millions of consumers and lure them into electric vehicles?

All of these questions are now hanging in the air, except for the last one. Automakers, parts suppliers, entrepreneurs, and advertisers see the future in the form of a new category of racing: Formula E. Its managers are staging electric car races in cities all around the world.

As electric vehicles begin to challenge speed records and race records long dominated by the internal combustion engine, the players in this race predict the electric car market will really take off in 2016, when the generic electric cars used in Formula E will be replaced by cars carrying automakers’ brands. This will turn one of the most popular, pulse-pounding sports in the world—auto racing—into a showcase for a powerful, clean, new product that could change lives and give some badly needed help to the environment. Watching them win will help people who may still scratch their heads over the mention of an electric car.
The Great Electric Car Race

What got Americans thinking again about electric cars started with the brownish blanket of smog that took shape over the varicose network of freeways growing out of Los Angeles in the 1950s. In the sixties the smog congealed into a semipermanent blanket of atmospheric filth that hung between the Pacific and the San Gabriel Mountains. Sunlight cooked its automobile exhaust and other ingredients into a more toxic stew as Los Angeles continued to sprawl.

Smog obscured the horizons. It sent a growing number of people to hospital emergency rooms. And it outraged students in the sophomore history class that Wally Rippel, a physics major, was taking at the California Institute of Technology in Pasadena in 1965.

The class discussion was about how the United States solves problems and it soon drifted into smog. Rippel, then a twenty-year-old day student, still remembers the rapid-fire questions: Why doesn’t the government pass regulations? Why should automakers continue to sell vehicles that fouled the air? Why would people blithely ignore such pollution when America had the tools and the money to clean the air? Hadn’t American scientists and engineers pivoted from the promise of the atomic age into the mind-numbing potential of the space age in a mere two decades? So why can’t they fix this?

But the really galvanizing moment for Rippel came when one of the class’s brighter and quieter members shouted three words: “We are they!” The room suddenly grew quiet.

Rippel lived in Hollywood. He was frequently prodded by his father to think of unconventional solutions and to believe that the American “can-do spirit” could solve almost anything. His father had not finished high school, yet he had become an NBC radio sound engineer and something of an electronics expert by reading a lot of books.

By 1965 most of the people who had worked on electric cars in the United States were dead, so the “we are they” moment in the Caltech classroom sent Wally to the
books. Books often romanticized the earlier phase of electric cars as their “golden age.” But romance meant little to Rippel, a physics major. He began with the basics: how much energy did it take to make a car go one mile? Soon he was scribbling multiple calculations: If every car in Los Angeles were electrically powered, electricity use would rise by 20 percent, but smog might drop by as much as 90 percent. That led to the next question: How would you go about making a modern electric car?

He initially thought of using fuel cells. They were much discussed in the sixties because they were being designed to power U.S. spacecraft. Rippel found them to be far too complicated and expensive. Batteries would be much cheaper and simpler, Rippel decided, so he read about those. They could power electric motors, giving them enormous spinning power or torque to propel cars. He discovered that transmissions were a problem in the earlier electric cars, making the cars jerky as drivers accelerated. But this was the space age and Rippel was sure that solid-state electronics could give these cars “glass-smooth acceleration.”

So he set about to design an electronic control system, following a manual he’d gotten from General Electric. He invested eighty dollars in what seemed to him to be an elegant solution, a solid-state device called a thyristor that controlled the electric flow by cutting it into segments, hence its nickname: the chopper. Rippel managed to fry his chopper by feeding it too much electrical current. After many mind-numbing hours of trial and error and more spectacular destructions, he gave up. It seemed too hard. “Looking back, I didn’t know what I didn’t know—the worst kind of ignorance,” he recalled.

But the other elements were there. Batteries had been used for over a century and chargers were readily available. Electric motors that were used in forklifts and other small industrial applications produced no emissions and were far more energy efficient. Stacked up against the gasoline engine, Rippel calculated, they had the ability to reduce emissions regardless of how the electricity they used was produced. After quizzesing a number of his Caltech professors, Wally Rippel decided that he was going to be “they.” So that summer he earned $1,000 working as a lab technician and invested $700 of it in a used 1959 Volkswagen Microbus that he set out to electrify.

One thing Rippel began to have doubts about during his junior year, when he began to assemble his electric VW, was equations that showed that it took almost a ton of lead-acid automobile storage batteries to get the car up to a mere thirty-five miles per hour. In theory batteries should be able to deliver fifty times more energy per pound than his did. Why didn’t they? Rippel upgraded to a set of golf cart batteries.

When he asked his professors about batteries, they were evasive. Rippel had stumbled into a data gap. “Batteries were something we didn’t talk about on campus. It
was still a topic like sex used to be during the Victorian age,” he recalled. After more research, Rippel concluded that his professors didn’t know exactly what went on in electric batteries. The electrochemical reactions in batteries tended, as he put it, “to be very messy. There’s a lot of stuff going on, so it’s hard to write an equation for things like that.” What was known about batteries came from trial and error, not from well-understood physical laws.

That brought Rippel back to brood on the “we are they” problem. After more frustrating experiments, in his senior year Rippel concluded that the grand solution to smog would require getting a lot of bright minds to focus on the problem at once. It would take a competition, one that was novel enough to capture public attention and outrageous enough to get young scientific minds focused on defeating the enemy—smog—by resolving the battery’s many issues.

While he was thinking of enemies, Rippel came up with the one that would definitely grab Caltech’s attention. That would be Massachusetts Institute of Technology, the Pasadena school’s longtime East Coast rival. Rippel’s school was the rising, younger West Coast upstart that had blossomed during the space age. When it came to innovative science, MIT graduates often seemed to feel they were the cerebral equivalent of the New York Yankees. They could be smug about their clout, which had been proven long before.

Other celebrated rivalries among the nation’s universities might be tested on the baseball diamonds or the basketball courts, but where could engineering geeks go to have it out? Rippel started thinking up the rules for a cross-country electric car race. It would be Rippel’s electric VW versus whatever MIT came up with. The idea was amusing enough to persuade the then-dean of Caltech to write his counterpart at MIT extending the challenge. The two schools had a long history of taking jabs at each other.

Partly because it was a Caltech idea, MIT’s dean immediately rejected the idea. Who needed that? But then a newspaper clipping of his curt rejection tickled the imaginations of one of the university’s unofficial fraternities, the Number Six Club. “Back in those days, we had a lot of time on our hands and we said well, why not?” explained Leon Loeb, a sophomore from Corpus Christi, Texas.

An engineering student with a dry wit and a flair for entrepreneurial ventures, Loeb became the leader and, as he put it, the “chief scrounger,” of the MIT effort. The MIT faculty became interested because one of its members had designed a state-of-the-art, electronically timed induction electric motor. Here was an almost poetic opportunity to show how easily MIT could still leave its cross-country rival in the dust.

MIT had excellent corporate connections and Loeb approached companies for donations to the MIT effort. He accumulated more than a half-million dollars’ worth of
equipment, including Detroit’s latest creation, a brand-new Chevrolet Corvair contributed by General Motors. It would be powered by nickel-cadmium batteries made by Gulton Industries, a New Jersey company. The batteries were big, normally used to kick over aircraft engines, and came with a special set of nylon tools that would hopefully prevent the MIT students from electrocuting themselves.

On paper, Loeb’s team had the race already won. MIT’s more powerful batteries cost $18,000 versus the $600 worth of car batteries powering Rippel’s VW. The Corvair was far more aerodynamic, even with 1,800 pounds of batteries stacked where the rear seat was and jammed into the front compartment of the rear-engine car.

But in the garage the calculations began to work out differently. Loeb’s team spent hours trying to coax meaningful life out of the futuristic induction motor that had been designed at MIT under a grant from the U.S. Department of Transportation. “The damn thing never did work,” explained Loeb. “Then it became ‘Oh, fuck it, we need something that will get us there.’”

MIT’s car wound up with the same electric motor that Caltech had, normally used to power industrial forklifts. The last-minute switch meant Loeb’s team had to spend all night before the race wrenching the final version of their Corvair together. They managed to mate the forklift motor with a four-speed transmission by leaving out the clutch, which would require drivers to do a lot of carefully synchronized shifting. “Boy, was it jerky,” recalls Loeb. “I still have on my desk some of the gears that had the teeth knocked out of them.”

On race day, August 26, 1968, Rippel’s moment had come. Over a cross-country hookup attached to a public address system, the two teams managed to greet each other with sarcasm. Rippel told the engineers from Cambridge that he was sure to meet them at the Massachusetts border. MIT’s riposte was that if Rippel’s team made it that far, they would be happy to provide free towing because Caltech would surely need it.

Then the heavily laden VW bus whooshed away from the Caltech campus in Pasadena at 9:00 A.M. Pacific daylight time followed by two chase cars and an assortment of vehicles carrying newspaper reporters and local television crews.

At the same time the Corvair left MIT headed west. Electric utilities—which have long nurtured a dream of selling gobs of power to electric car owners—had helped establish a chain of fifty-five charging stations extending across the United States that the teams could use. They consisted mainly of linemen waiting with connecting cables brought down from overhead power lines.

Under Rippel’s rules of the race, the first car to reach the other’s campus would win. Both teams calculated it would take them five days to navigate the designated 3,398-mile route across the country.
Despite their desperate all-nighter spent reengineering their car, Loeb’s MIT team appeared dressed in suits and ties for the prestart exchange of remarks in an attempt to establish a psychological advantage. They knew they still had a considerable edge when it came to the technology. Their car could go faster, recharge faster, and had a simpler, more aerodynamic design. But after that the posturing ended swiftly. There were cruel realities waiting for both teams out on the nation’s highways, most of them having to do with batteries.

As a backup, the MIT team brought along a Corvette capable of towing the Corvair in emergencies. Caltech’s car was followed by another towing a portable generator. The rules said that each side would be penalized by adding more time to their crossing if they used the tow truck or the generator. Each team was followed by judges and cars carrying reporters from _Machine Design_, a trade magazine that had volunteered to enforce the rules.

There were no cheerleaders waving pom-poms as the MIT team rolled out of the campus, but banners were flying and students were cheering as the electric Corvair disappeared in the distance. Getting out of sight was good because there were few witnesses to what happened twenty minutes later when MIT’s high-powered batteries pooped out. In a short shakedown test the weekend before the race, Loeb’s team noticed their batteries had a tendency to lose charge and overheat at the same time. Now they found the Corvair’s electric motor overheated, as well.

As part of their all-nighter before the race, the MIT team thought they had a fix for the simmering batteries with a jury-rigged cooling-and-ventilating system. It began with bags of ice dumped on the batteries and copper coils that carried the meltwater through the front seat and into a “bilge” in the Corvair’s trunk. Aside from the possibility of causing electrical problems, the melting bags of ice also leaked down the driver’s neck. They fogged the inside of the windshield so there were times when he couldn’t see.

But those were small issues compared with the batteries. Despite frequent attempts to charge them, their output remained so low that the Corvair had to be towed for two hundred miles to Buffalo, New York, racking up huge time penalties.

When they pulled into a service plaza near Buffalo the MIT team had been up for almost forty-eight hours. They had tried every trick they could think of to get the batteries to work better. None of them helped much. They called in a representative from Gulton Industries, who recommended overcharging the batteries, which seemed to Loeb and his team to be a dubious proposition. Overcharged batteries could blow up.

The psychological advantage, if MIT ever had one, seemed to have weakened. “By that time we had lost our idealism about what a battery really was,” Loeb recalled. “At
that time battery electro-chemistry was witchcraft and to a great extent it still is. I still don’t think that folks have got a very good handle on exactly what goes on in a battery.”

Shortly after dawn the sleepy, scruffy MIT crew watched as utility technicians gave their ailing battery what amounted to a supercharge. For almost six hours the Corvair’s batteries hissed, bubbled, and gurgled menacingly as the incoming juice from the power line split some of the batteries’ liquid electrolyte into oxygen and hydrogen, which the budding engineers also knew might blow up. “It was at this point when spirits were as low as the battery charge,” observed one accompanying judge from Machine Design. “It was a gamble and if it failed the MIT team would probably have called it quits. For them the race had become a go/no-go proposition.”

At about the same time, 3:00 P.M. California time, Wally Rippel’s VW was climbing mountains in eastern California. The uphill strain drained almost all of his battery charge, but the downhill replenished it because Rippel could coast and recharge them through one asset that most electric cars now have—regenerative braking. The system captured the energy from braking and turned it into electricity that fed back into the batteries.

On a downgrade just east of Seligman, Arizona, Rippel decided to drop the VW into second gear to make the batteries recharge even faster. There was a loud thud and the car rolled to a dead stop. One of the crew members got out and dashed around to the back, but Rippel knew that any frantic attempt to fix things now would be pointless. The extra RPMs from his downshift had blown the VW’s electric motor apart. It was the middle of the night and all was silent on the deserted highway. “So we sat there, thinking,” Rippel recalled.

Caltech’s adventure with the electrified Microbus had been, up to that point, mostly a one-man show directed by Rippel. In his mind he ran through all the new problems; a blown engine would not only have to be replaced, but specially machined before it could be made to fit the unique transmission he had rigged up for the VW. What it all added up to, for Rippel, was failure. He broke the silence. “I said to the team, ‘You know, I think this is over for us.’”

The first stirrings of a resurgence of the electric car now seemed stillborn. MIT was mystified and a little frightened by their batteries bubbling away in a gas station in Buffalo, New York, and Caltech was depressed and stranded along with pieces of their shattered engine on the road in the deserted mountains of Arizona.

The technology was too hard. There were too many voids in the knowledge that people had written in books. And the thousands of men and women who had done the trial and error that put an earlier generation of silent, clean electric vehicles on the road seventy years before this race were now silent themselves, or in no position to be of
any help.
When Dick Rubinstein, a Caltech junior who had been riding in a chase car, heard that Rippel was going to give up, he exploded.

This jarred Rippel out of his gloom. Rubinstein was the quietest, most self-contained member of the team. Rippel can still hear Rubinstein screaming at him: “Look, we’re going to Boston! The issue is how we’re going to get there.” Rubinstein seemed determined enough to push the car by hand, if that’s what it took. “Or,” he shouted at them, “we’re going to drive it under electric power…. So we’re going to get this done and whatever happens will happen!”

It was as though an electric charge had struck the car (that would happen later). The Caltech team came up with a plan. They would phone Electric Fuel Propulsion, a company in Michigan, and order a new motor to be delivered to Phoenix by air freight.

Robert Aronson, the owner of the company, modified an existing motor in a machine shop to fit Rippel’s car. The Caltech team picked it up at the airport, but had to use an Arizona machine shop to make some final adjustments. Then they sped the new engine back seventy miles to the stranded VW. Along the way they put together a plan for how the five of them could work in tandem, yanking out the shattered two-hundred-pound motor and installing the new one in fifteen minutes.

The whole transaction cost them twenty-three hours and thirty minutes, but Rippel’s VW was back on the highway, aiming for Cambridge. Rippel felt elated. “It was a lesson that I’ll never forget. When you work with a team it’s amazing what you can do if you really all agree on doing something.”

But Murphy’s law was running with them. Whatever could happen often did happen. A few hours later when they arrived in Amarillo, Texas, Murphy struck again. At charging areas there were three electric cables that had to be connected with large alligator clips to three points on the VW. There was a right way to connect them and a wrong way.

It was 4:30 in the morning. The Caltech team, again bleary-eyed from an all-night