A CENTURY
OF PROGRESS

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A CENTURY OF PROGRESS SERIES

THE NEW NECESSITY

The Culmination of a Century of Progress in Transportation

BY

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"*Carriages without horses shall go*"

MOTHER SHIPTON (16th Century)

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PREFACE

THE ensuing chapters are not intended to serve as a record of the past and current events connected with the automobile. It is obviously impossible to do justice to such a subject in the space allotted. So the reader will find that many things have been omitted—the ramifications of modern automobile production processes, the inside story of iron and steel, the fascinating story dealing with the advertising and sales aspects, and the biographies of those courageous and enterprising men who laid the foundations.

You ask then: "Since you have omitted so much, what is in these hundred-odd pages—what is the purpose behind it all?" That is not difficult to answer. Approximately forty years have passed since the Chicago World's Fair, at which was exhibited an automobile of European extraction. One might truthfully say that was really America's introduction to the automobile. Again in 1933, Chicago will celebrate with another Fair, the central theme of which is a Century of Progress. So the time appears appropriate to do a little stocktaking. Let us see what America has done about the automobile in those forty years and, what is equally as important, what the automobile has done to America.

It is generally realized that the price of progress is trouble. And the automobile has been no exception—some people still say it is a curse in disguise. It is not the purpose of this little volume to offer any refutation, nor is it an attempt to glorify the automobile, but rather is it an endeavor to give an insight into certain phases that perhaps may have hitherto escaped the eye of a busy people. It is hoped, though, that the volume perhaps will leave with the reader the impression that this new form of transportation is a worthy candidate for a position along side of food, clothing and shelter as—the new necessity.

THE AUTHORS.

Detroit, Michigan,
November 2, 1931.

CHAPTER I

RETROSPECT

The year is 1898. Suppose you walk to your front window and look out. Across the cobble-stone street in front of your neighbor's house, a horse hitched to a buggy is trying in vain to reach the lower branches of the nearest shade tree and at the same time to make the hovering flies keep their distance by rhythmically switching his tail. Then your line of vision is intercepted by a young man industriously pedalling a bicycle. Bill Snead is delivering a prescription for his father who owns the drug store down the street. It is a peaceful scene, undisturbed, except for the occasional rattle of a wagon or the clop-clop of a passing horse.

Suddenly, the peaceful atmosphere is shattered by a series of explosions. At each one the horse across the way flinches and begins to tremble. The noise becomes louder and louder. It is coming this way. Following the example of Mr. Holt next door, you rush out on the porch to get a better view. Down the block you see a crowd of children surrounding some sort of contraption in the middle of the street which is apparently the source of the disturbance. The explosions become louder and you ask neighbor Holt:

"What is that thing?"

"Don't know, unless it is one of those horseless carriages I read about the other day."

By that time the thing is abreast of the porch. With a prolonged wheeze it ceases its uncertain progress and silence reigns again. Curiosity gets the better of you, and you join the rapidly increasing crowd just in time to overhear a snatch of the conversation between the perspiring individual driving it and one of the crowd:

". . . Boston this morning, . . . have several automobiles there . . ."

While a man tries to calm the nerves of the nearby horse, the driver of the automobile crawls under the vehicle and begins to do things with a monkey wrench and a pair of pliers. After awhile, apparently satisfied with the results of his labor, he goes around to the side and, grabbing a handle, turns it rapidly. Then comes an explosion. Another. And then a steady stream of them. The driver then climbs into the quivering seat of the buggy, or thing that looks like a buggy, grabs a projecting metal bar with one hand, does this and that with the other, and something else with his feet. Then with a series of snorts, the pseudobuggy, quivering in every limb, crawls up the street and out of sight.

Perhaps, before you open the door of your house, you glance over at the horse again peacefully munching at the leaves and feel a mental reassurance. The horse seems so permanent, so established in the scheme of things. How his reliability stands out against a background of a man flat on his back under an imitation buggy! With a chuckle you say to yourself as you open the door: "All that fellow needs is a horse. He would then have a pretty good looking turnout."

The scene was typical of the period. The automobile caught most of the people unaware. But the keen observers could see that the world, in general, had been preparing for just such a thing for over a hundred years. Cranks, inventors, scientists—whatever you choose to call them—had for centuries been trying to find a mechanical substitute for the horse, and not without some degree of success. Large, ungainly steam coaches began to appear on the roads of Great Britain before the middle of the century. Regular service was established in 1831. But things were moving too fast. The inertia, always present in the human makeup, began to assert itself in a manner which was at once characteristic and effective. A toll of ten dollars was exacted for a steam carriage—exorbitant in comparison with the dollar toll exacted for a horse-drawn vehicle. Not satisfied with this, the conservatives further required that each self-propelled vehicle carry three drivers and be preceded by a man carrying a red flag. The horse came out of this early skirmish with flying colors.

But on the western side of the Atlantic, things began to happen that started to undermine the horse's firmly established position in the order of things. The connection at first sight appears vague. In 1859 a man by the name of Drake sank a steel pipe in Titusville, Pennsylvania and struck oil. One of the observers at the time wanted a small can of it, because he had an idea it would make "a mighty fine spread for buckwheat cakes." But actually the petroleum was used to produce kerosene to keep lamps burning. One thing, however, worried the refiners. They had a troublesome by-product—gasoline. They did not know what to do with it. Stoves were invented, street lamps erected, stationary gasoline engines built and naphtha launches designed. They all used gasoline, but in spite of this, a law was necessary to prevent the dumping of excess gasoline into rivers and harbors. If the refiners were lucky, they could sell it at less than a cent a gallon—but in the early nineties very few of them could sell it at all, and they dared not throw it overboard.

What then could they do with it? If some new invention would only appear upon the scene—something that would take this fuel off of their hands, their troubles would be over. The gasoline driven horseless carriage appeared as an answer to their prayers. Twenty million horses were up against a funny proposition this time—a white elephant.

The horse idea, however, appears to have been a fixation. When you wanted something that would move, something tractable and suited to the individual, you naturally thought of the horse. Even when the first bicycle was built, it was made to look like a horse—like the one in a merry-go-round—a wheel between the front legs and another between the rear. In the nineties, however, the bicycle had its place in the picture. It was cheaper than the horse and buggy, could be used for pleasure or as a means of light delivery and, most important of all, it made the people road-conscious.

The stage was all set for the automobile in America. A plentiful supply of cheap fuel was available. Roads other than mud had begun to stretch themselves between towns. The people were divorcing, in their minds, the wheel from the horse owing to the work of the bicycle. In 1876 rumors had already drifted in from Europe of an engine developed by a German named Otto—an internal combustion engine burning a hydro-carbon as a fuel. Benz, another German, seeing its application to a road vehicle, built a motor tricycle. A countryman of Benz, Daimler, quick to catch the trend of things, worked on the engine, reduced its weight and increased its power. So by 1885 Europe had begun to produce gasoline automobiles.

At the Chicago World's Fair in 1893, a Benz car was exhibited—the first automobile imported into the United States. Things were beginning to move rapidly. America was bitten by a new bug—the automobile. Americans were quick to recognize the possibilities of the automobile—it seemed to represent transportation in its most desirable form, possessing speed and exclusiveness. But the conservatives were there too—gazing humorously at the snorting buggy careening up Main Street, or smiling in a self-satisfied manner as they drove their smart turnouts past a horseless buggy stranded by the wayside.

Some of the self-propelled vehicles were noisy, but not all. The steamers and the electrics were not. They were very popular and, in the early shows, far outnumbered the gasoline variety.

Each type, however, had its drawback. The steamers required an expert engineer and were short-winded at high speed. The electrics were afflicted in a different way. Their appetites were too large for the amount of food they could carry along. In other words, they could not go far without having their batteries recharged. Weight was another great difficulty. Figures show this more clearly. Take for instance the ratio of the weight of the vehicle to its power for the three types: steam, 371 pounds; electric, 840 pounds; and gasoline, 185 pounds. The penalty of weight paid by carriages of the steam and electric type is clearly shown. But that was not the only factor. For every supply of fuel and water, for every battery charge, or tank of gasoline, depending on the type of vehicle, the steam car would develop nine horsepower hours, the electric fifteen horsepower hours and the gasoline car forty horsepower hours. This very clearly shows that the operating radius of the gasoline type was nearly three times as great as that of the electric, and over four times that of the steam car.

It was about this time that an inquisitive reporter buttonholed Mr. Edison and asked him what he thought of the situation. Mr. Edison, with his usual insight, replied:

"Talking of horseless carriages suggests to my mind that the horse is doomed; yet this animal shows a greater economy of force than man, for seventy per cent of the energy of the horse is available for work. But the horseless vehicle is the coming wonder."

"Do you think those vehicles will be run by electricity?" the reporter asked.

"I don't think so. As it looks at present, it would seem more likely that they would be run by a gasoline or naphtha motor of some kind. It is quite possible, however, that an electrical storage battery will be discovered that will prove more economical; but at present the gasoline or naphtha motor looks more promising."

It has been said that if you show a Yankee your idea of doing something, he can usually show you a better and a cheaper way of doing it. Europe showed America the automobile. Then Yankee ingenuity got to work and began to develop it, but to gain public approval was difficult.

One of the acid tests of the worth of an article is its salability. Alexander Winton sold the first American-made car in 1898. To sell a car, particularly an American-made car, in those days was quite a job because of a firmly entrenched idea. The average man, when introduced to the automobile for the first time, inevitably echoed the thoughts of the man who, after his first glimpse at an automobile, said: "All it needs is a horse. . . ." It was difficult to separate the horse from the buggy. Even after the two were separated, people were still apt to look for the horse when they saw the buggy—thinking he must be pushing instead of pulling or thinking that through some sleight-of-hand he had been reduced and hidden somewhere about the vehicle. The carriage and the horse were the Siamese twins of vehicular transportation—the early manufacturers simply could not separate the two and have each function individually.

Even the builders of automobiles themselves shared the blame for this condition. They stuck to the horse-and-buggy idea but left out the horse. When they designed a self-propelled vehicle, the buggy was selected as the model. So early automobiles had four buggy wheels, a buggy dash, and buggy springs. Some of them even had a whip socket. Then came trouble. The horse idea had its limits. There was an engine to be considered. You could not steer with reins. Steel-tired wheels were not at all satisfactory. But the engine was the greatest problem. It was a question of putting it behind, in front, or beneath. So in order to preserve the time-honored lines of the buggy, it was put beneath and to the rear. Inaccessible, of course. Steering was accomplished with a tiller bar—this being the first departure from the horse and buggy principle. Rubber tires solved the question of wheel cushioning. But nevertheless the 1898 automobile was nothing but a complete self-propelled buggy—just because people wanted buggies and because builders knew how to make them.

In addition to the sales resistance offered by the fixed idea of the horse and buggy, there existed a huge doubt as to the capability and reliability of the new vehicle. It often took the form of derision. Men crawling under cars, hammering at greasy parts, automobiles stranded or being towed—each picture told a story of unreliability that was hard to combat. Sometimes a peculiar twist was given, as we see in a news item issued by the War Department in 1899:

"Three automobiles have been purchased by the War Department for the use of officers. Each is equipped so that a mule may be hitched to it, should it refuse to run."

There was another thing that obstructed sales. Horseless carriages sold from one thousand dollars up. And you could buy more with the dollars of 1900 than you can with those of today. So the market was limited to the idle rich, the social climbers, or sportsmen. A few doctors bought them, but in general the professional classes and the men of moderate means—that is, the majority of the population—still used the horse and buggy. The automobile makers were quick to see the poor policy of catering to the small class at the top.

The majority had to be reached and persuaded. The man on the street had to be shown the benefits of the automobile rather than the disadvantages. The only way to do that was to make it possible for him to own one.

Winton, Haynes, and Duryea did not manufacture cars; they built then mostly by hand, with the aid of perhaps a lathe, a drill press, and men who were apt with their fingers—men who could plug holes in cast-iron cylinder blocks, construct spark plugs and make a conglomeration of ill-fitting parts run. No wonder automobiles cost over a thousand! But even at that price there were not enough cars to go around. However, in order to reach the average man, cars had to be made in a more economical manner and in greater volume. New methods had to be used. Car makers could no longer make parts. They had to buy them outside. The parts, therefore, had to be more or less standardized. The manufacturers became assemblers and in the ensuing years found out how to do assemblying very rapidly. Prices came down from an average of three thousand dollars in 1900 to about six hundred dollars in 1916. Why? Because parts were standardized and because production increased for the corresponding years from fewer than five thousand cars to over a million and a half. That is one lesson America taught the world—to make more for less instead of less for more. People buy the things that are nearest to their pocketbooks.

In the first years of the new century, a new personality appeared on the scene—Henry Ford. He had an idea—and it was a good one—that the slogan of the new industry should be "An automobile for everyone." In 1903 he set out to test his theory. In the ensuing five years, his sales increased from not quite two thousand to more than ten thousand cars. During this period, however, the rapidly growing automobile industry ran into a storm—one of those storms that harass established business at periodic intervals—a panic. And the infant, being new, did not know exactly what to do about it. In fact, economic planning was merely something one read about in text books. So fifty-two companies fell by the wayside.

But a panic cannot stop a people from wanting a thing, and people wanted automobiles. They wanted them more every day—advertising saw to that. The car makers had something to advertise too—cheaper cars, cars with dependable pneumatic tires with demountable rims, sliding transmissions, collapsible tops, side doors and electric lights. Self-starters added over a million more customers because women could not crank engines and men did not want to. The automobile had taken the American public by storm. Everybody wanted one, whether he could have it or not.

Life, however, was not all "beer and skittles" for the manufacturer. The automobile industry, like all new industries depending on a mechanical product, had its share of legal dissensions. In 1895 George Selden secured a patent on a gasoline engine as a means of driving an automobile. The Electric Vehicle Company, having a license agreement with Selden, decided to levy tribute on all cars coming within the scope of the patent. For thirteen years the manufacturers paid toll, and people were reluctant to buy cars that might include a patent suit. After much discussion, the matter reached, in 1911, the United States Circuit Court of Appeals. The weak link in the chain was found. Evidently it was Selden's intention to use an engine known as the Brayton type when he applied for a patent, since he did not have much use for the Otto type, which he characterized in an entry in his diary as, "another of those d—d Dutch engines." But nearly all of the manufacturers upon whom a tax had been levied used the Otto type. Consequently the American manufacturers were realeased from bondage. This, together with improved manufacturing methods, helped production figures to grow by leaps and bounds.

The car which men were manufacturing in 1916 was not the buggy of the nineties for the automobile had then become emancipated from the horse. Engineers in Europe said the proper place for the engine was in front of the car, where it could be more easily cooled and be more readily accessible. So the engine was taken from under the seat and brought to the front. The motor itself had changed from a one or two cylinder affair to one having four, six, or even eight cylinders. Cranking became a thing of the past—at the touch of a switch the engine started its even pulsations. Greater power was at the command of the driver. The car could now deliver twenty-six horsepower as compared to the four of 1900. But outwardly the car showed the greatest change —it was a far cry from the buggy. People were beginning to separate the two—to realize that here was something different, something new under the sun. Lower, better cushioned to road shock at high speed, more easily steered and more efficiently braked—the automobile had become a highly specialized sort of thing. It had entered a new and different phase.

Today transporation and the automobile are synonyms. Before 1900, any connection between the two was a matter of luck and of ability at roadside repairing. The automobile has evolved from luxury to a necessity—a necessity not to any specific class but to everybody. The automobile and the horse have exchanged places in so far as transportation is concerned, the former being constantly used in every day business and the latter used in recreation or farming.

There is a peculiar thing about the history of the automobile. People twenty years ago did not have the vaguest idea of the ultimate form of the vehicle. The same thing can be said of the people of today. It is a thing made to fit the changing demands of a changing people. We are still afflicted with many "horse-and-buggy" ideas. Such ideas and others comparable to them are still holding back the progress of the motor car as well as that of many other things. But in spite of this the automobile is promoting progress.

We hear our age described as an age of steel or of electricity, but the age of automobiles would fit just as well. Glance out of your office window at the scurrying cars, trucks and buses, all drawn by tiny threads of gasoline. No cobblestone streets there—just smooth boulevards flanked by thirty, forty, and fifty storied buildings. The manufacturing of the automobile, America's greatest industry, has erected many of those buildings, has caused many of those boulevards to be laid, and has taken its place as leader of our economic forces.

CHAPTER II

THE FOURTH NECESSITY

TRAVEL and the horse—travel limited to about thirty miles a day—were synonymous to our ancestors. One who took the trouble to look at a map of the country or of a state thirty years ago found there located, in various sizes of type, cities, towns and villages. If the map was of the right kind, it also showed double lines indicating railroads and solid lines indicating highways. The railroad trains came and carried people from little towns to big. But how about reaching the villages and farms? The railroads did not cover enough territory. The connecting links between those out-of-way places are shown on the map by dotted lines only—dirt roads. Those roads that appeared on the map of 1900 are relics of the Horse Age. The vehicles which traveled over them may have been travois, stage coaches, prairie schooners, buggies, or wagons, but they had the one universal power plant—the horse. The roads themselves mirrored this condition. They were made to answer the requirements of a vehicle which moved fewer than five miles in an hour. The same map showed large bare spaces where there were no railroads, no highways. Yet people were living there—the farmers, cut off from civilization by impossible miles. Those were the conditions at the beginning of the new century. On the map railroads meant cities. Highways meant towns. Mud roads stood for everything else.

Double lines began to make themselves manifest on maps after 1830, when railroad came into existence after George Stephenson's locomotive of 1825. Because this mode of transportation filled a crying need, ribbons of steel passed from city to city across states and continents. As a result the period between 1830 and 1900 witnessed the decline of the highways. Railroads usurped their position in the scheme of things. People forgot roads. They were interested only in rights-of-way and in getting near some railroad. Out in the country, however, things changed but little. The farmer and the villager were still isolated. They lived, so to speak, on islands off the steamship lanes. The farmer still plodded to town every week with his load of produce and on Sunday he hitched up Dobbin and drove to church as usual. The railroads did not enter his sphere to any great extent. However, in spite of his apparent indifference, he felt this limited horizon, this inability to communicate readily with his fellow-men.

In the city, however, things began to happen which promised changes in the structure of civilization. The year 1900 saw in the streets of the larger cities many self-propelled vehicles known as automobiles. It was in the city, indeed, that the automobile was born and received its vigorous start; it was several years before it had the courage to widen its horizon. The end of the pavement marked the end of its utility. The early vehicles were simply not constructed to cope with mud, ruts and rocks.

People, however, had decided they liked the automobile. It was just the thing they had always wanted. It possessed individuality and utility and so they bought automobiles by the thousands. Then the logical thing happened. It was expecting too much of these thousands of motorists to keep themselves confined to the narrow limits of the city's streets, especially since they reached these limits in one quarter of the time required by a horse-drawn turn-out. So they began to grumble, demanded automobile roads, and got them. The city began to spread its arm into the country; and one day one of these arms reached another arm extended by a neighboring city. The process went on until the map was criss-crossed with the black lines of paved highways.

The people of the city had become "road conscious." The people in the country heard of these things, and, strange to say, did not at first like the idea. The farmer did not exactly understand why the people from the city wanted to get out into the country. Accordingly, he grew suspicious and determined to stick to roads that were good enough for his father and grandfather. Things went along in this way until the farmer himself bought an automobile. Then for the first time he learned to appreciate the quality of the highway upon which he traveled. Roads began to come from the country into the town and the farmer and the city man began to pass each other going in opposite directions.

This ideal condition, however, was not reached overnight. The automobile could do its part provided it had a suitable highway, which was not always available. Most of the rural roads were dirt, or in wet weather, mud. That condition had to be altered and it was a long, slow process. In that improvement, the farmers cooperated and the State and National Governments did their parts, with the result that we now have nearly six times the rural mileage surfaced that we had thirty years ago. A net work of 3,000,000 miles of highways covers the United States—enough to girdle the globe 100 times. Ninety per cent of the population of our country is located in a zone ten miles wide flanking these roads. The automobile has taken America out of the mud and multiplied the possibilities of road transportation by ten.

Pick up a map of today and you will become aware of several things: first, how easy it is to obtain a map—any filling station will give you one gratis—and second the primary purpose of them. There are at least twenty-six million more maps in use today than in 1900. Every automobile owner has to have one because he is a potential tourist. People buy maps not to look for cities, oceans, or rivers, but for highways—the shortest highway from one place to another. That piece of paper is literally a network of black lines, red lines and dotted lines—national highways, state highways and country roads. Some of these stretch from coast to coast and from Maine to Florida. A glance at any one of them would show that its traffic is continuous in both directions—endless streams of vehicles, automobiles, buses, trucks, and vans, all moving with speed and precision.

If you look more closely, however, you will see that this rapidly moving stream of traffic is still running through a horse-and-buggy world. A man buys a car that will travel sixty miles an hour with ease, but if he makes a trip to a town sixty miles away, it takes him two hours to get there.

Why? Because he has to pass through a dozen small towns and through the busiest street in every town. In this case the road defeats its own purpose. If the country were really built for automobiles, it would be possible to travel along an express highway around the busy streets of all the towns at the possible speed of sixty miles an hour. The old point of view will eventually undergo change, in fact change has already begun. It has taken a long time to make the people realize that they even need roads. Without roads modern transportation would lack its keystone, and without transportation our present civilization would not be possible.

That is the most important thing—this change in the people as reflected in modern transportation. No man is tied down by a narrow horizon. Everywhere roads stretch—invitations to go and find out what is going on in the world outside. All you have to do is drive up to a filling station, buy two dollars worth of gasoline and you can go a hundred miles in any direction and return. That is the reason the world is smaller, it possesses an almost infinitely flexible vehicle on an almost infinite number of tracks. When these tracks or roads have covered every logical course and when an automobile can travel these roads with maximum speed and safety, then we can truthfully say that the automobile can do nothing further to liberalize the people of the world.

It is just this that has made the world smaller—another means of communication with its mutual exchange of ideas. The farmer is no longer anchored to his farm by a horse-and-buggy chain thirty miles long, and the city man's horizon does not end with the pavement. They have discovered each other and mutual distrust and suspicion have melted in the process. Automobiles travel faster than in the early days and every increase in speed diminishes the size of the world and makes it a more closely knit and stronger fabric. The man from Kansas now has a better understanding of the man from New York. He has an intelligent conception of racketeering, of traffic problems, and of all of those things that were formerly, to him, merely words. Similarly the New Yorker, picking up the morning paper and reading about a drought in Kansas or the need of farm relief, can sympathize and appreciate just how much such things mean to the farmer. He knows because he was out there last summer and saw those fields drying up under a blistering sun.

The automobile released the farmer and the villager from their bondage. More than any other device, it has helped break the monotony. Nothing has so much changed, perhaps, as the American village. In 1900 there were about 380 people to each mile of railroad that touched villages. Then a village was lucky if it could boast a mile of good highway. Today the 380 people have been increased to 450, and it is indeed a small village that does not have three miles of improved highway and, in addition, five miles of fairly serviceable road. The reason for this is apparent. The same village now has eighty automobiles—one to nearly every family in the community. And this is not a local condition. It is typical.

New worlds have also opened to the farmer. His travel radius has been increased from thirty to three hundred miles a day. He now travels over 5000 miles a year in his car. He can find a better market for his products or goods, can serve more people, and in turn reap benefits to himself. The city has moved more than two hundred miles closer. The farmer can take the family over on a week-end trip—see shows, buy clothes, and make himself up-to-date on current events. He and the city folk can understand each other better; they can have more things in common. In this changed world the children are not being overlooked. Every morning the bus comes by to take them to a central school and they have every advantage of the city children. In 1930 nearly a million and a half school children were daily transported by buses to schools. Thus better markets, recreation, and education, have been made available to the man who needed them the most—the farmer.

What part did the automobile play in the city man's life? He was not isolated. He had plentiful, convenient markets, recreation, and educational facilities. However, he lacked those things the farmer had in abundance—fresh air, sunshine, a garden, quiet, some place to be free from the noises and hurry of the city. He lacked the means of getting beyond the city streets, where all of those things could be had. The automobile filled his needs also, although they were just the reverse of the farmer's. The city had the country and the country had the city.

Cities have expanded; small communities have sprung up ten or fifteen miles from business centers with their own churches, movies, and markets, developing the neighborhood idea. Smith at the close of an harassing day at the office now gets into his car and in half an hour he is seated on his porch overlooking a green lawn on which the children play, or perhaps after supper he putters in the garden back of the house. He has traded places with farmer Jones. The automobile has supplied to each of them the thing most needed, namely, relief from a set of environments.

All of these changes also affect land values materially. Wherever a new road has been laid, the land values on either side have appreciated. Figuratively speaking, the land has been moved nearer to town. In many cases farms have become suburbs and land has doubled or tripled in value.

An investigation was made in one state recently, concerning the appreciation of land values due to better highways, which are of course incident to the automobile's widespread popularity. It was found that the average value of an acre of ground on the state highway was approximately $22.00 more than that of an acre located on a dirt road. A fact just as interesting, however, is that land on a dirt road decreases at the rate of $3.42 per acre for each increase of a mile from the nearest town. That gives us a clue as to why there are five times as many people living in the city now as there were in 1885, and only one and a half times as many living in the country as there were then. Today the urban population is seventy million and the rural, fifty-three million. Moreover, of all of these people, whether classed as city dwellers or rurals, seventy-five per cent live on surfaced roads.

Today, the automobile is the most popular form of transportation. It has taken its place beside the railroad, and as far as passenger transportation is concerned, has in many cases supplanted it. It may even come to a point where, if meeting a friend on the street, one might say: "Well, John is going to enter the university next week. He is going down on the 10:20. He is considerably excited about it, too—it is his first ride on a train." You wonder what sort of a boy John can be; nineteen years old, living in a town of nearly a hundred thousand people and having never ridden on a train! Then you remember that John has been brought up with a steering wheel in his hand, and has probably never had an occasion to use a train—his car has taken him wherever he wanted to go. John then is not such a queer specimen after all, but merely a product of the new order of things. He has a car; the roads are there; he can go wherever he wants and whenever he feels like it.

Such an incident would forcibly direct the attention to the change in the popular conception of transportation. The process started when people began to demand highways for their automobiles. It was a reversal of the movement that accompanied the introduction of the locomotive. The railroads, which had made obsolete the time-honored scheme of highway travel, were now in turn deprived of the patronage of a large number of their customers, particularly those who used the railroads for short trips. Not only did the old highways again enter into active service but new ones sprang up between towns and villages. Even the old country mud roads were resurfaced with gravel and given a coat of tar.

This change did not stop at individual transportation. When the people realized the possibilities of the new form of transportation, particularly its flexibility, buses were put into service. These were first used in the city, not to compete with organized city transportation facilities, but to supplement them. Since then, however, new types of buses have been developed which are used for interstate travel. There is at least one line which operates buses equipped with berths, for overnight trips. It is now possible, indeed, to travel the entire three thousand miles from New York to San Francisco by bus, a remarkable achievement for a vehicle whose former sphere of operation was virtually that of a city street car.

This idea of better highways is also the direct result of the relative progress of two forms of transportation—the steam locomotive and the automobile. The former has been developed to a remarkable degree. It is powerful and efficient. The rolling stock is many times that of thirty years ago. Thousands of miles of new track have been laid. But the very fact that the system requires these tracks imposes a penalty when one compares the flexibility of the gasoline-propelled vehicle. On the other hand, the car or truck of 1900 was certainly not a reliable beast of burden. Times, however, have changed and so has the gasoline-propelled vehicle—radically. That is not the only important thing, though. Roads and the new form of carrier have developed simultaneously, for roads have made possible the present widespread use of the automobile. The roads are a definite part of a new scheme of transportation economics, the foundation of which is the automobile.

Transportation covers two fields, passenger and freight service. The automobile is today the most popular vehicle for carrying passengers the world has ever known. The motor truck in its field becomes daily more efficient and adaptable. The freight train suffers from the inflexibility and must be assisted by the truck. Take for instance a load of furniture to be moved from New York to Chicago. Each piece must be crated and transported by truck to the New York freight terminal, where it is loaded into a freight car. Approximately three days later it arrives at the Chicago terminal where it is loaded on a truck and transported to its destination, there to be uncrated. The intercity moving-van performs the service in a different way. It drives up to the door of the New York residence, where the furniture is loaded without crating. Three days later, men will unload the furniture from the same van at the Chicago residence.

The train moves from terminal to terminal; the truck, from door to door, warehouse to warehouse, factory to dealer, or farmer to market.

In glancing through a magazine dealing with the economics of transportation, you will not go far before you come across the term "vehicle-hours." Now that term is the enemy of the horse, and the friend of the motor car or truck. The horse does not like to have his performance judged by the yardstick known as vehicle-hours, because that is one of his weak points. Here is one of the reasons. A horse drawing a wagon loaded with a ton of coal takes an hour to cover the four miles to a customer, making one vehicle-hour. A one-ton truck gets there in fifteen minutes making one-quarter of a vehicle-hour. That is one of the burdens the horse will always have to carry around with him, a surplus of vehicle-hours. And it is a sore affliction, because it wastes time and money. From the other point of view, it is just another of those instances where the motor-vehicle has economically justified its existence, by a time saving of two or three hundred per cent.

The automobile gets blamed for many things. For example it is said that it takes money from the banks, spoils the younger generation and decreases the funeral director's business. The argument is that people riding around out-of-doors are more healthy and do not die off at the usual rate. But it is only delaying the mortician's business. In other words, with the increase in the automobile business, the average increment or life cycle has been increased about five years, according to insurance authorities.

"All well and good" you say, "but how about accidents?" In the endeavor to solve that problem, automobile manufacturers spend a large part of their profits. One can see results in the car on the street. Four-wheel brakes, improved lights, and lower center of gravity, have increased the safety factor several hundred per cent. However, there will always exist one factor that the manufacturers cannot control. That is the peculiarly constructed piece of apparatus which sits immediately behind the steering wheel. He (or she) is responsible for more than ninety per cent of the accidents.

Recently on the way from Chicago two men were conversing in the smoking car. "You automobile people are ruining this country," said one. "People are spending money for motor cars and they ought to be spending it for something else. Don't you see that you are depleting the savings accounts of this country?"

Now by chance the other happened to have in his pocket a report of a Chicago bank showing the recent increase in the number of savings deposits. It proved clearly the fallacy of his friend's reasoning. For if you do withdraw money to buy an automobile, you only take it out of one person's account and put it in another's, unless you withdraw it to carry it permanently around in your pocket without spending it.

Economics may be a dull science, but it touches one of our most vulnerable spots, the bank account. Savings deposits vary directly with the economic disposition of salaries, and no one thing has affected so many salaries in the last twenty years as has the automobile. In 1900 the automobile industry did not influence salaries to any great extent for that infant industry employed fewer than three thousand people. But today the mechanic's wage is double that of the 1900 mechanic and one person out of every ten employed owes his livelihood either directly or indirectly to the automobile industry. That means four and a half million people, enough to populate Cleveland, St. Louis, Philadelphia, Boston, and Buffalo, or to equal the population of nine of our states. Such an industry cannot be ruining the country, or undermining savings accounts.

We have good times and bad times, prosperity and panics, and we have just passed through a depression—a time of unemployment, low commodity prices and low production. The very people who formerly said this automobile industry was ruining the country were praying for increased production of cars. They wanted something to start business upgrade—steel orders, wood orders, rubber, lacquer, copper orders, and all are vitally influenced by automobile sales. What they really wanted was to see all of those four and one half million employed at their old jobs and the re-establishment of a purchasing power of five and a half billion dollars yearly, with money enough to build and furnish annually half a million homes and to pay all expenses of their occupants.

The only conclusion that can be drawn is that we have been prone to look upon economics from the wrong standpoint. This changing point of view is illustrated by the recent situation in Scotland where the people are known the world over as being very thrifty. Quite naturally in that country large savings account are not surprising. However this Scotch thrift is today a bommerang injuring business. Millions of pounds sterling are lying idle when they could be doing useful service in the world of business.

The remedy does not depend upon the amount of money in the bank, or upon the amount of collateral paper, but upon the amount of useful material flowing through the channels of trade.

The greater the amount of such useful material present in trade, the greater will be the collateral in the banks. The automobile industry has affected economics in so far as it has taken base materials and transformed them into products which people regard as useful material as expressed by their wants.

The change of viewpoint is affecting the entire conception of progressive business. Whenever wants are synonymous with need, there is a static form of civilization that is unhealthy. When, however, new wants are created which are entirely different from needs, then there begins a mental reaction of far more importance than one that is purely economic. People begin to want things that they do not need; and as they begin to want these things they begin to become more alert mentally, more willing to work, more willing to do the unusual. Consequently it is possible to break the dangerous routine and step up our economic life to an entirely new plane.

CHAPTER III

A ROCK IN THE POOL

THE striking thing about the advent of the automobile was its suddenness. Practically unknown in 1895, ten years later it represented a hundred-million-dollar business. Industry was unprepared for such an uprising—the automobile started from "scratch." Picture to yourself the situation—the pioneers in possession of one or two hand-built models; orders for a hundred to five hundred cars for immediate delivery; the only manufacturing facilities consisting of a barn equipped with a lathe, a drill-press and a couple of machinists! Something had to be done about it. So the pioneers upset tradition and did things their own way—ordered parts, assembled them, and gave the public what it wanted. When the first mad rush had somewhat subsided and the manufacturer had time to draw his breath, he began to organize a factory. Organized industry kept a close watch on him to observe the results of the experiment.

The manufacturer looked at his product and then at his materials. The latter were inadequate, good enough for a buggy but not good enough to be made into parts moving at high speeds—not particularly shock-resistant. He had cast iron, malleable iron, and cold-rolled, medium, and high carbon steels. These were the essential materials of an automobile, but taking into consideration the existing lack of design knowledge and of heat treatment the result was not always a balanced car, particularly when weight was considered, weight being a contagious sort of thing, cumulative. A heavier, roomier body meant a heavier frame and a heavier frame necessitated larger springs and axles. Larger rubber tires must support these weights and a larger power plant was necessary to propel the vehicle. The manufacturer saw this and sought means of reducing the weight, and incidentally the cost, but without sacrifice of strength or durability. The aim was not achieved at once. The search has been going on for the last thirty years.

Today our cars are lighter, more sinewy. The product is more uniform. Breakage of such things as springs and axles—a common occurrence in the early days—is now comparatively rare. Two things helped to change the car—improved heat treatment and the introduction of alloy steels. The former enabled the manufacturer to develop the physical properties of steel to the greatest degree of which it is capable, probably doing more to lighten the car than any other one factor.

After 1907 alloy steel began to appear in the picture and almost immediately a more uniform and more workable material was placed in the manufacturers' hands. The car of today uses as many as eight to ten different alloy steels. Chrome vanadium is used in transmission gears and springs, chrome molybdenum or chrome nickel in propeller and rear axle shafts, and nickel steel in differential gears. Valve and clutch springs are made of manganese steel, ball bearings of chromium steel and body trim of stainless.

Today alloy steels go into the make-up of a great many mechanisms and structures. Buildings are faced with stainless steel. Alloy steel cables support the bridge over which fifty thousand cars pass each day. The knives we use at dinner are stainless steel and our safe deposit boxes at the bank are behind an alloy steel door.

The automobile industry demanded the best tool-steel available and from 1900 we can trace the improvement in quality and the rapid increase in the use of high-speed steels. The new industry depended on manufacturing speed for its very existence. That meant deeper cuts and higher cutting speeds. Out of this need have come such tool-steels as Stellite and more recently, tungsten carbide, the alloy which will cut glass. The effects of this have been far-reaching. As soon as an effective cutting tool was placed in the manufacturer's hand, he found he could use harder steels which he had formerly laid aside because he could not machine them. But the lathe manufacturer found his old lathes would not stand the accelerated pace and heavy cuts, so he made them sturdier, with massive tool blocks and a stronger feed. The machines then became electrified, equipped with anti-friction bearings, and using pneumatic chucking, because of the new demands made upon them.

The speed of production that the automobile manufacturers found necessary to an inexpensive product has been passed on to industry; and the high-speed cutting tools essential to automotive high production have found their way into nearly every manufacturing industry. Whether it is the radio in the corner or the clock on the mantel, high speed cutting tools have been used somewhere in its manufacture, enabling you to buy at a substantially lower price than if the article had been manufactured by the methods of 1900.

You cannot place a new industry in the midst of a group of established concerns without creating some kind of disturbance. But the new industry was an open-minded one. Some of the materials and methods mentioned were already known, but the manufacturers of bicycles, sewing machines, clocks, and firearms, had not utilized them to any great extent. It was the automobile industry that took them to its bosom, applied them to its products, and enlarged its factories to fill increased orders.

The early automobile was essentially a handmade mechanism. Personal craftsmanship entered into it to a great degree. When first built, it was made up of variety of parts drawn from a dozen different sources. Because of errors in specifications and because of further inaccuracies in fabrication the percentage of misfits was enormous; hence the extensive use of craftsmanship in order to obtain a working machine from a collection of dissimilar and inaccurate parts. Then the manufacturer or assembler decided to make his own parts and machine them. He was not handicapped by the thought of scrapping obsolete machinery—he had none to scrap. His one thought was to install machinery and processes that would enable him to produce parts accurately and in great volume.

These changes did not take place all at once. They cover a period of twenty or more years. Existing methods of building cars are so well known that it does not appear necessary to discuss at length the modern method of production; but it does appear fitting, at this point, to touch upon a few of the things that make possible a daily production of five thousand cars, radios, and other commodities and to present a few of the conceptions that have changed all former ideas as to how articles should be manufactured on a quantity as well as on a quality basis.

The average automobile was, to say the least, a heavy piece of machinery, weighing, on the average, from one and a half to two tons, with its major parts; in general, too heavy for a man to handle easily. The method of production used in the early days was a very simple one. A group of four or five men huddled around a frame, adding parts which they brought on trucks from other sections of the factory. Nothing could have been more wasteful of time and human energy. But far-seeing manufacturers, after analyzing the situation, installed conveyor systems and progressive assembly lines. The frame today is carried upon a moving conveyor or chain past groups of men, each of whom add a part or two. At the end of the line the body is added and the car driven off under its own power. No man has to lift heavy parts. He has only to guide them from the overhead conveyors, which bring them from other sections of the factory. This seems a simple solution for such a problem, but comparative figures show its effectiveness. In 1912 it took approximately fourteen hours for a group of men to assemble a car. Recent figures concerning one of our cars of largest production show a rate of five thousand cars a day.

This method of producing appealed to other manufacturers, who saw in it a solution of their own problems. Now, wherever a high production rate with a minimum of hand labor is required, you will find some form of assembly line or traveling conveyor. For instance in the canning business the series of operations is almost entirely automatic—a traveling conveyor carries the cans from one operator or machine to another. The system is infinitely flexible and lends itself to the rapid production of radios, vacuum cleaners, refrigerators, and other articles, as well as automobiles. It is true, however, that in the last-named business, it has reached its highest development and has the greatest number of ramifications. It is for this reason, probably, that this industry has become a mentor to the entire manufacturing world insofar as quantity production is concerned.

This, however, is only a part of the story. The automobile depends upon accuracy for its very existence. Pistons that travel in cylinders at a speed of forty feet per second must be accurate; and crankshafts that revolve at over three thousand revolutions per minute must be correctly aligned and balanced. The manual labor in the frabrication of a car has been reduced to a minimum, not only because of the time element but also because of the accuracy requirements. Hand fitting is a slow job and not at all compatible with an output of five thousand cars a day. So automatic machines had to be installed —machines that transform bar stock into a finished part that is slotted, threaded and chamfered all on one machine; centerless grinders equipped with a hopper into which are poured unfinished piston pins and from which emerge a product, finished to the ten thousandth of an inch.

The automobile has been a tonic to the builders of machinery. The impossible has been asked of them and they have supplied the world with machines which possess such uncanny speed and accuracy that articles alike in every detail can now be manufactured by the hundreds and thousands, and sold at a price that in another day and age would have seemed fabulous. It should not be concluded from the foregoing that the automobile has originated countless new manufacturing methods. Rather has it taken the tools and processes it has found and perfected them, expanded their use, and passed on to other industries ways and means of generally increasing production, improving products, and reducing manufacturing costs.

The automobile is interesting from the standpoint of materials alone. It has exerted a profound influence on established industries. It is essentially a vehicle made of iron, steel, wood, glass, leather, and rubber. But there are other materials to be considered. Motor vehicles in the United States consume nearly fifteen billion gallons of gasoline yearly or about eighty per cent of the total production.

As a consumer of raw materials the automobile has no equal in the history of the world. Before its advent iron and steel were used chiefly in building railroads, bridges, and steel structures. Today over one-half of the country's iron production goes into automobiles. As the largest customer of the iron industry, the automobile exerts a tremendous influence on the economics of the country.

When we mention materials that go into the make-up of a car, it would be inexcusable not to say a word about pyroxylin or lacquer finishes. There is a story which goes along with their development but that will be taken up in a later chapter. The first cars finished in production with the new material appeared in 1923. The others quickly took the hint. Pyroxylin, however, was not confined to the automobile industry—it spread like wildfire. The new finish with its durability, soft lustre, and ease of application, found its way into hundreds of plants and appeared on as many products. Today we cannot escape it. We look at furniture. It is lacquered. We buy a radio and find that the attractive finish is pyroxylin. Even some of the refrigerators in our kitchens are finished with a white lacquer. The automobile has helped bring beauty and color into the home. It has placed in the hands of the manufacturer a means for making his product more attractive to the buyer from the standpoints both of appearance and of economy.

In 1900 the rubber industry was in its infancy. Today we consume approximately four hundred thousands tons of rubber a year valued at more than a hundred million dollars. The interesting fact in connection with this is that the automobile industry consumes eighty-four per cent of that total. Here again the automobile has paved the way to progress and placed a new and vigorous enterprise in the ranks of organized industry.

So it goes throughout nearly all of the industrial world. Plate glass was formerly used only in show-cases and shop windows, but now, since the increased vogue of the closed car, nearly three-quarters of all the plate glass manufactured goes into car windows. The automobile today is the greatest consumer of nickel, lead, and of all forms of steel—strips, sheets, and bars. It takes yearly fifty-seven per cent of the total production of upholstery leather, or approximately two square miles, to cover the seats of our cars.

Think of the results to the industrial world of putting upon the market a product that doubles the malleable iron consumption, triples the plate glass production and quadruples the use of rubber! No other one artifact in history has affected so many people and so many industries, has provided so great an outlet for old products, and has utilized so many new machines and processes.

The automobile industry has not simply confined itself to the rôle of consumer of raw materials. It has created new professions and enteprises which depend directly upon it for their existence. Professional chauffeurs number half a million. Over a million and a half men are employed as truck drivers. The car, once it is sold, is not forgotten. The twenty-six million automobiles on the road are not neglected. An army of nearly half a million mechanics service them and there are over fifty thousand dealers who own and operate service garages. The manufacture and sale of accessories is a business that has been growing with the industry. There are plants scattered all over the United States that do nothing but manufacture mirrors, trunks, and radiator ornaments. Other companies manufacture replacement parts, batteries, horns, spark plugs, and instruments.

One cannot travel without receiving a deep impression of the economic changes wrought by the new mode of transportation. Filling stations are seldom out of sight—$650,000,000 is invested in these alone. Refreshment stands line the roads, tourist camps with their signs "Tourists—Board and Lodging" are seen many times in passing through even the smallest towns. There has been a reversion—the old nomadic strain has reasserted itself and once more the open road beckons. People have been quick to recognize this and realize that the tourist represents a source of profit—he is willing to pay for comfort and convenience when traveling. Here are some of the typical new enterprises that have followed the automobile's introduction.

In looking back over the past thirty years, we cannot but recognize the power of the new factor. In 1900 a new product was dropped into the midst of organized industry—a veritable rock in a pool; a product which created its own demand; a thing everyone wanted to possess. Like the rock in the water its influence spread in ever-widening circles, touching the iron trade, changing the rubber manufacturing business; and converting a by-product of the petroleum industry into its major item.

Not satisfied with demanding huge quantities of already-known materials and products, the new industry began to bring new ones into existence and then upset all the traditions of manufacturing by installing novel and little-used processes and methods. Many mistakes were made, but out of it all has grown our largest industry. This alone has been sufficient to convince other industries that the processes and methods used are basically sound and represent a step forward. Many of them have taken pages from the experience of the new industry and successfully applied the knowledge to their own products.

The ripple of 1900 has grown into the wave of today. The automobile industry is constantly exerting an ever-widening influence. Today, with its highly organized research facilities, it is in a better position than ever to forge ahead, discovering new materials and new processes, and exerting a beneficial influence on the whole of the organized industrial world.

CHAPTER IV

THIS BUSINESS OF INVENTING

MAN is naturally inventive or civilization would not have advanced as far as it has. When Benz placed Otto's engine in a three-wheeled vehicle and the result was called an automobile, an entirely new field was opened to inventive genius. The new vehicle was composed of many thousands of parts and it was quite evident that there existed considerable room for improvement. Over forty years have passed and although our present car bears little resemblance to those of the pioneers, it is not yet perfect. The problems also have changed considerably—they are no longer of an elementary nature. They depend more than ever upon organized methods of attack for their solution and less upon the brains and facilities of the lone inventor. The automobile industry of today has two sources from which to obtain new ideas—the inventing public and its own engineering staffs or research laboratories.

"I have an idea." How many hundreds of manufacturers run across this phrase in their morning mail! If we take the mail of one large business organization as a fair example, it would seem that over half the inventors introduce themselves in this fashion and unwittingly, perhaps, they are giving the manufacturers an insight into what to expect. Automobile manufacturers, in common with many others, welcome good ideas. But even a good idea is just the beginning of the battle, as we shall soon see. What every car producer really wants is facts in a new, concrete, successfully working form.

When an inventor presents an idea, the manufacturer knows, unless it is already on the market, that it is in all probability as far from being a commercially practicable device as New York is from Los Angeles. The obstacles separating the two are just as great; the Plain of Cut and Try, the Patent River and the Mountains of Test must all be crossed before the device reaches the sunny State of Royalties. There is another thing that should not be overlooked: the average man when he begins to put an idea into material form is usually handicapped with inadequate facilities, small capital, and insufficient scientific background—he is trying to bridge the distance in a covered wagon.

Not so many years ago we heard that old man Smith had built an engine that would run without fuel. Every town had one such person—a man who seemed to spend nearly all of his time and money fitting something together in the basement or the attic. He never seemed to get anywhere, except to the bank for a loan. There was a reason for that, a reason that applied to nearly all cases—he lacked adequate preparation. He was not prepared for all of the problems that arose, scientific, legal, and financial.

Today the picture has changed somewhat. The world is a little more business-like, or hard-boiled, whichever you choose to call it. The manufacturer, as we have seen, is placing his ideas on a paying basis by establishing a research laboratory. His engineers may estimate but they do it scientifically, with a great deal of experience available. They work together and pool thoughts. Science is a tool instead of a handicap; machinery is available for any type of test and finances are not burdensome. Research has charted the Plain, bridged the River, tunneled the Mountain. The private inventor, to succeed, must compete with the carefully organized effort of trained specialists.

Let us take a look at this individual. In the first place, what kind of person is he? He is not always the sort you would expect, not the rather eccentric type previously mentioned. He is quite likely to be a successful business man—a lawyer or a doctor who has an automobile which does not please him in all details. Perhaps it skids on an icy street, or perhaps the headlights do not follow the road as he would like, or perhaps he hates to lower the window to signal the direction in which he is going to turn. So he thinks about it. Then one day he notices men sanding an icy street and he sees a remedy for slippery pavements; he realizes that if the front wheels turn, the lights can be made to turn also; or he suddenly considers that it would be possible to use a mechanical arm operated from within the car to do his signalling, with no need to lower the window. His next step is to sit down and write a letter concerning the idea which he thinks will help the manufacturer improve his product and in addition decrease the accident risk.

What is wrong with all this?

The inventor says he has never seen anything like it and he knows it will work. Right then is the time to stop, investigate, and apply the grain of salt. Let us take first his statement that he "has never seen anything like it." Maybe he has not, but if he had taken the trouble to look through a patent index he would have found that a hundred or more patents on sanding devices, movable headlights, or directional signals have already been granted. The inventor does not always do this but nearly always a patent search would save much of his time and thought and, in most cases, his money. Strange as it may seem, there is often a peculiar quirk of the mind of the individual which makes him concentrate, ostrich-fashion, on his device and willingly blind himself to what is taking place around him. Such people too frequently prefer to spend their own time and money first and meet disappointment later.

Since we are on the subject of patents, let us discuss another angle of this business of inventing. Unless the person submitting an idea does so merely as a helpful suggestion, he naturally expects a reward. So one of the first questions he must answer is "What have you to sell?" He may have an idea, but is it original and patentable? That is the first thing every manufacturer asks and even if there is evidence of that, he still does not know whether or not he can use it to advantage in his business. You ask, "Why can't he use it?" Principally because there is such a wide gap between "maybe it will work" and "it works."

The inventor says his device works. That word "works" covers considerable ground. To the individual it means that if we do *this*, *that* will happen and the device is a success. To the engineer it means that if we do *this* a million times, *that* will happen a million times, in rain or shine, hot or cold, through mud or sand, over hills, or on the race track at seventy-five miles an hour. The automobile of today is not a makeshift device. People refuse to tinker and repair as they did in the early years. They cannot be bothered. In fact it bothers some people to stop long enough to have their gasoline tanks filled. The engineer knows that.

Let us suppose it does work. Here is a device that does thus and so, just as the inventor intended and to the satisfaction of the manufacturer. The latter produces over a thousand cars a day. So incidentally he must make a thousand or more such devices a day. He looks at the article, takes it apart and mentally adds up the forging or stamping dies it will require, the machining operations necessary, and the finish it will take. That is the production point of view.

Suppose the device has undergone the threefold scrutiny—legal, production, and engineering—has it fulfilled all the requirements? No. The executive must look over the reports and determine its acceptability. That is where economics enters the picture. Here is one way of looking at it: let us take all of the inventions that have come to our attention. How many of them simplify the car, make one blade grow where two grew before? You can eliminate at least seventy-five per cent of them right away. That is one of the acid tests of acceptability. Every fixture added to the car is a new problem. Hand in hand with this question of simplicity enters the question of economics. Does the invention perform the same function more cheaply than the part it is intended to replace?

Let us assume the device answers successfully all these requirements, does the executive then have an agreement drawn up with the inventor? Not always. Because, since his company has a research laboratory, it might be that the laboratory is developing or has developed the same thing, so the company would be paying for it twice. It is that sort of thing with which the individual contends, a series of obstacles, any one of which can upset the apple cart. When the inventor recognizes these difficulties and gives them their proper weight, then we shall have fewer and better inventions.

Of course, there are a few people who will always invent—inspired souls who must get it out of their systems. From these we get the so-called perpetual motion machines, fuelless engines, and other devices designed to cheat physical laws. It is not only perpetual motion machines; it may be a combination automobile, truck, tractor, airplane, and seaplane, all in one, or a car in which an explosive takes the place of the usual brakes. All differ except in that one basic respect—a disregard for the fundamental principles of science, for laws any school boy could point out in a second's time. That is invention in its worst form. Fortunately, since scientific knowledge has become more widespread, there are fewer of these every year. When they have altogether ceased we can say, with more than a grain of truth, that the world is becoming wiser.

People may wonder, and quite rightly, if every invention submitted to a company is given the same careful scrutiny, has to run the gauntlet of the engineer, legal representative, production expert, and executive. It must, but not exactly in the manner described. Can you imagine passing around by letter or personal contact half a thousand inventions a month and getting a written opinion on each one? Most companies solve this problem by collecting the inventions and bringing them before a board or committee every week or so. That committee is composed of the engineering, legal, production, and executive elements.

In this way the inventor is best served. No one man can tell him the company is not interested—every man on the committee has a voice in the decision. The inventor himself gets quicker action. He does not have to wait weeks while his brain-child pursues a devious and unchartered route through the channels of investigation. It is just one of those things the manufacturer does today to separate the wheat from the chaff quickly and efficiently, and the inventor and the company both benefit by it.

More than likely, however, the visitor or the writer cannot be classified as a professional inventor, as we have mentioned before. He is just as likely to be a business man who takes it upon himself to improve the automobile. That brings us to another point. Why doesn't a man stick to his own field of activity? The taxicab driver works on a machine for milking cows and the farmer spends the winter months designing a new traffic signal. Then they wonder why their inventions do not fill the manufacturer's needs.

If you were to pick a man to design an engine, a pair of headlights or a set of brakes for a car, which would you select, a lawyer or a doctor? Neither—and why? Because of the obvious unsuitability of either for the job. But does your neighbor who has that movable headlight idea think about it that way? He does not. He will not hesitate to say that he can show technically trained and experienced research engineers a thing or two. Usually this is a sad experience for him, for he will probably be shown similar things that have been studied and discarded years before, for one reason or another. This man, if he is wise, will have learned his lesson well. In the future he will confine his activities to being a lawyer, doctor, or a member of the profession for which he has been trained. This does not mean that every invention submitted in this manner is worthless. Valuable ideas do originate from such sources, but they are so rare as to be almost negligible when compared to the disappointments.

In going over a few statistics recently it was found that fewer than 1/50 of 1 per cent of a group of 35,000 inventions submitted contained merit in the eyes of the manufacturer. Think of it—less than 1 out of 5,000! Such is not only a matter of disappointment and punctured ambitions; it is an unjustifiable economic waste of money and labor, especially the latter. It is the inventor that is most concerned—it is his labor that is going to waste and his money that is being spent.

The manufacturers want new devices as sources of profit. Radios, automobiles, talking machines, and talking movies are all dependent on new ideas to keep them alive and to satisfy the ever-increasing demands of a public whose wants are apparently limitless. What would these companies do if they depended entirely on outside ideas for progress? What would the public get in return? One idea out of approximately every five thousand submitted! Progress would be slow, products less desirable and profits small. The whole thing ultimately returns to the buying public—it would be receiving less for its money. That is an unhealthy condition.

For this reason research laboratories have been established—to assure a systematic change-making. Business men have come to appreciate the commercial value of hiring professional fault-finders, whose stock in trade is intelligent imagination, clear thinking, careful observation and definite recording of facts. These qualities, coupled with a fair share of business acumen and ordinary horse-sense, make such men invaluable. They are very seldom called inventors but in a way they must be. If the public or the engineers are dissatisfied with things, these are the men who must find or invent something to better conditions.

Regardless, though, of the size of a company's laboratories or of its staff of research engineers, it cannot hope to orginate all of the improvements of its products. Some must come from without. That leads us to the story of one inventor who once paid us a visit, who had a slightly warped idea of this situation. He had a gasoline turbine which he claimed, as many others have, was vibrationless, compact, simple—in short, the answer to the engineer's prayer. Somewhat sceptical, we asked him what he had done about the fundamental trouble with such turbines, the blades' becoming overheated. He looked at us in scorn; "That is a detail—what are your research laboratories for? I can't think of all of the good things!"

The engineer and the inventor may each supply a part of a new development, but usually it is one that gives promise of success—not one that has been tested unsuccessfully the world over. They are both striving for the same goal—in this case, the perfection of the automobile. Here is something, though, the inventor should remember—he is handicapped. He does not always have the facilities of the engineer—his machine shop, his testing laboratories, and the advice and cooperation of a group of highly trained scientists, production engineers, and business men. He is, nine times out of ten, playing a lone hand, which after all is a handicap. To overcome this—and it is a tremendous thing, as we have seen—he must make sure he has left no stone unturned, no test untried and nothing to change.

If the people who have ideas would remember these things and evaluate them properly, many fruitless trips would never be made, many dollars would not go into models which duplicate old principles, and much time would not be taken from more constructive things. After all it is this last thing that is most important. We all have our jobs and if we "stick to our last" in all probability we shall be farther ahead than if we try to climb the fence to get into the next field, which may not be as green as it appears from a distance.

CHAPTER V

FAULT FINDERS

THE automobile was not invented. It came about like the solving of a picture puzzle—a piece here, a piece there. Otto's engine was joined to the buggy, and the fuel tank was filled with gasoline. The puzzle was solved when Dunlop's tires were fitted to the wheels. So no one man invented the automobile. It was the fitting together of hundreds of inventions and discoveries occurring in the centuries since the principle of the wheel was first discovered.

Since the coming of the automobile the entire mechanism has undergone a transformation. The development appears in almost definite cycles. For instance the period prior to 1910, a purely arbitrary data since there exists no abrupt transition, might be called the Inventing Period—a period of developments sponsored by individuals. The first automobiles constituted a virgin field for inventive genius—there were so many things that were obviously susceptible to improvement. The inventing public did not hesitate long in taking advantage of the situation. Tops, windshields, demountable rims, lighting systems, and self-starters, were fruit of the period. The tools of invention were necessity and observation. A clever mechanic could very easily see things that were obviously wrong and improvements were not long in coming forth. But it did not take long to make all of the obvious improvements and when that had been done, the edge of the inventor's tools had been dulled so that they could make but little impression on the new and harder problems. The situation called for another method of attack and for different tools.

There was only one logical solution to the problem-organized systematic research. The realization of this marked the beginning of the modern phase, the Period of Research. The automobile had become more intricate, more complex. No single man could be relied upon for the systematic improvement demanded by the public. The situation did not call for a monologuist but for a troupe—an organized group of scientists working with chemistry, mathematics and physics, as its tools. It is only necessary to compare the car of today with that of twenty years ago to see the effects of organized research methods—high speed, multi-cylinder engines, anti-knock fuels, and lacquer finishes, are all results of group effort. But before these developments are discussed in more detail, let us go a little into the whys and wherefores of research as the automotive industry knows it.

We hear the word "research" on every hand today. Why is it? What is the magic attached to the word? It is just another way of saying "progress"—the two are, in a way, synonyms. Let us go into the fundamentals a little. If any one went back and picked up the products of twenty years ago and tried to sell them today, he would fail. That is because of change. Since that time approximately fifty million new people have come into the world and they all have new ideas and new things. Entirely apart from the scientific relationship of research, if there is one function more important than another, it is this—to make people recognize that they are living in a state of change. The world hates change, yet it is the only thing that has ever brought progress. The problem of instilling into industry the importance of systematic change-making, which will keep step with every day progress of the scientific world, is one of the greatest contributions research can make.

Human standards are constantly changing. Values do not exist in materials; they exist in the minds of the people. As an illustration, let us take one of the cars of latest model and seal it in glass—the premise being that the automobile will change in no way, shape, or form, no matter how long it is allowed to be there. The price of the car, $2000, is written on the case. A year later, accompanied by a salesman, we go back and the salesman appraises the car at $1800. Two years later it is appraised at $1600—$400 less than its original value. The car has not changed but its value in the public's eye has. Better cars than the one in the case can be had for $2000. In fact, the public realizes the new car is worth $400 more than the one in the case. That is the premium attributable to research.

One of the fundamental purposes of research is to foster a healthy dissatisfaction. Recently a certain man who was curious as to just what people wanted to buy approached a friend of his, a banker, with this proposition:

"I am a salesman, a universal salesman. I can give you immediate delivery, at the lowest market price, on anything you want, from golf clubs to a yacht. What do you want to buy?"

The banker thought awhile, looked out of the window, shifted some papers on his desk and finally admitted, "I can't seem to think of anything just now."

That told the man all he wanted to know. He realized that today the wants of the people are few—they seems to have everything; radios, automobiles, and airplanes. Things in general seem to be standardized as well as stabilized. People have a tendency to become easily satisfied but it is easily seen that such a condition, if universally accepted, can lead to but one thing—stagnation. That means that approximately 40 per cent of the people would be unemployed because 60 per cent can produced what 100 per cent consumes. There is only one way out and that is through the development of new products and systematic improvement of the old to create new demands. More definitely, research is capable of doing one or more of a number of things. It can reduce the cost of production or operating costs. It may also increase the product's utility or sales appeal and in the long run produce new business. To the research worker himself, research is always valuable because no matter what technical information is obtained, there is, in nearly all cases, something fundamental and useful in it.

It is perfectly safe to say that any research organization can be taken into an industry and, given five years, can develop enough new material to pay for its operation, regardless of the industry to which it is assigned. The fundamental basis of all research in engineering is how to keep in pace with the times on a common-sense economic basis, to find out what to do when the company cannot do what it is doing now. The research department should be called "The Department of the Economic-Change Men." There is a department for buying raw materials, a factory for fabricating them, a financial department, a sales department. The research department is analogous; it should be the department for procuring new ideas and organizing them so that they can pass as a material into the factory for the support and continuous development of the industry.

This "Economic-Change Department" is a mixture made up of three ingredients: problems, men, and apparatus. Every industry in the world has some problems and it is in the economic solution of these problems that engineering and research enter the picture. A certain company hears that another concern has installed a research department and is getting wonderful results. So the board of directors says it is the thing to do and takes steps to hire men and build a laboratory. That is putting the cart before the horse. The first thing is the problem—what is wrong with the product? No one needs a laboratory to go out where a problem is, find out what it is, and get acquainted with it. After the problem is known to be present it can be solved. Perhaps a pair of tin snips and a soldering iron are all that are needed to do the work. The problem comes first; not the laboratory.

Assuming that we have such a problem, we must analyze it and locate the limiting factors or the unknown elements. That can be done on a piece of paper or a blackboard. Suppose it is a truck that is giving trouble. By the simple process of elimination we narrow it down to the engine. Now it becomes a question of whether the part does not function correctly or whether it does not fit the operator. By "not fitting the operator" is meant that it is too technical or too unsuitable physiologically. When such things have been determined, it becomes a simple matter to allocate the problem to some definite line of research. It may be a metallurgical problem or one of design. Very seldom will it be tremendously complicated or baffling. When the acquaintance of the problem has been made and it has been assigned to some particular department of research is the logical time to organize a research laboratory.

Every once in a while someone says: "Well, now that is a very difficult problem—a *very* difficult problem." A careful analysis will show that nine times out of ten a difficult problem is one we do not know how to solve. So we are blaming the problem instead of our ignorance, just as the doctors do with incurable diseases. Such diseases are the ones the doctors do not know how to cure and they blame them rather than themselves. A difficult problem is the one a person does not know how to unravel and a very, very difficult problem is one he never heard of before.

That brings up the subject of research personnel. One usually thinks of laboratories as being run by experts, but actually experts usually prove to be more destructive than constructive—they usually know all the ways a thing cannot be done. Although some of our best engineers were graduated from the School of Hard Knocks, such men are the exception rather than the rule. Of the two men striving to reach a certain goal the man with the engineering degree has the better chance—the road has been cleared of many obstacles that often prove impassable to the untrained man.

It is born in every man to carry around with him a zoo filled with pet prejudices, but the smaller the zoo the more valuable the man. The prime requisites of a good research worker are a certain amount of intelligent ignorance and open-mindedness. Impatience has ruined more research projects than any other single thing—the more complex the problem, the more time and patience is necessary. The research man must place himself in the car buyer's position, and ask himself: "Do I want this thing on my car?" That is to say, he must be a psychologist because even in pure research 60 per cent of the problem is psychological and only 40 per cent is material. It is also very difficult for a man to do things against his experience. Regardless of what is or is not known, the most difficult and dangerous thing to deal with in all such problems is past experience, because it says "You ought to do so and so." It restricts thinking.

When steels were in the process of development, the most common figure for tensile strength was about 80,000 pounds per square inch. One day a man submitted a sample of steel to our laboratories that would withstand 350,000 pounds per square inch. It was given to one of the men to drill. Nothing was heard of it for a week, so we looked up the man and asked him what he had done about it. He said, "I couldn't drill it—it's too hard." And he showed us. He used an ordinary drill on the piece and it curled right up. One of the engineers asked him if he had tried a diamond point. "Why no," he replied, "I haven't." So he tried it and cut through with ease. The metal was not too hard it was the drill that was too soft. When a man cannot solve a problem, he is a soft drill. Every laboratory has some such men in its personnel—men who place the blame on the product rather than admit their own incompetency.

A research problem is not solved with apparatus; it is solved in a man's head. No one ever solved anything in a research laboratory. The laboratory is the means by which it is possible to do the solving, after the man has the idea clarified in his mind. In other words, the apparatus is used to get an idea from the outside into the man's head, so the amount of equipment used is simply an indication of the density of the material through which the idea must penetrate.

One of the best examples of research is that performed in a western university under difficult conditions by Dr. Rosenau, who developed the principle of focal infection. Now Dr. Rosenau wanted to do that research work in the university in which he was located, but the dean was not favorably disposed. That is one of the handicaps frequently encountered—few research problems, at the time they are proposed, look sensible. In this case the experimenter wanted to do the job but he lacked two things, space to experiment and a microscope. But the janitor had a space for buckets under a stairway. This enterprising young fellow, became friendly with him and persuaded him to keep his buckets elsewhere. Then he found a collection of discarded apparatus and picked out enough parts to assemble a microscope. He solved this problem and today it is one of the most notable accomplishments of that particular university.

Unfortunately research, as sometimes employed, is not always profitable. It may be because of the overstressing or underestimating of one of the three controlling factors. The department may be equipped with elaborate apparatus and inadequate personnel or vice versa, but the most common error is to establish a research department before the problems to be solved are determined. It then becomes the tendency to place a nice brass rail around the department and list it on the account books of the concern as an advertising luxury. Misdirected research is as bad as no research at all. Some people seem to think of research as a panacea for all the ills of modern industry. They seem to think that all a concern has to do is to set up a laboratory, hire engineers, and its future prosperity is assured. But nothing could be more ridiculous. The problems come first and the department should be fitted to that particular business, to better its products and to help outline its future policies, that the company may grow from year to year.

The researches that have resulted in putting a motor car into nearly every American family have not all been confined to the fields of science and engineering. Research, whether it is strictly scientific or practical—and it is scarcely ever one without the other—consists simply of one thing, getting the facts. In order to make automobiles cheaper and cheaper as well as better and better, it has been necessary to get the facts on materials, on engineering, on purchasing, on manufacturing, on sales, on service, on advertising, and on many other things.

It has all been very much worth while. Let us consider the cost-of-living dollar as compared to the automotive dollar. Today the cost-of-living dollar is worth $0.68 as compared to the dollar of 1914, while the automobile purchasing dollar, on the same basis, is worth $1.28. So as the result of much persistent experimentation and consequent development within the automobile industry, today a dollar will go nearly twice as far in the automobile salesroom as it will, on the average, in other places where goods are sold. If the cost of cars had been allowed to follow the cost-of-living curves since 1914, the people who bought automobiles last year would have had to pay approximately three billion more for them than they did.

When the results of research are put in terms of dollars and cents, it is easy to appreciate the value of making changes. The changes to be made, however, are not always as obvious as some of the results would seem to indicate. The difficulty is that we lack the imagination. We read the Arabian Nights and think that it is a collection of stories in a book. It is not. It is a set of principles. Aladdin's Lamp is a story of course, but there is a psychological principle back of it which is this: that when one continues to wish for a thing, he eventually gets it. If we are satisfied with what we have, we stay where we are. So we need a mental Aladdin's Lamp to make us wish for the thing we need. If it is economically sound, we shall get it.

CHAPTER VI

ETHYL AND OTHER THINGS

IF A person had suddenly left civilization fifteen years ago and reappeared today he would undoubtedly open his eyes with amazement at the changes. New skyscrapers, new styles, radios, and thousands of automobiles rapidly threading their way around one another in a stream of traffic that is apparently endless. And probably one of the first things this man would do would be to buy a new car and eventually drive into some filling station to refuel.

"What will it be, sir?" the attendant asks. And our friend observes that he has more than one choice of gasoline, each at a different price. He is at a loss as to what to say because the last time he bought gas, fifteen years ago, all he had to say was, "Fill her up!" So he asks the attendant what he would recommend.

Well, your car has a pretty high compression ratio and to get the best out of the engine I would suggest ethyl." So the new owner drives away somewhat puzzled about the whole thing. Just what is ethyl and what has compression ratio to do with it?

Let us go back over those fifteen years and see what has happened and why. About 1915 engines were becoming larger and larger because of the demand for increased power. The engines were large, but the piston speeds were relatively low; in fact, 1000 feet per minute was a good average. But it stands to reason that you cannot go on increasing engine displacement indefinitely—the passengers must have some place to sit. Engineers foresaw the demand for higher-powered, faster cars—the whole tempo of life was being accelerated. And they knew there were two things that could be done to get this power: increase the engine size or perform some sleight-of-hand and make engines of the same size more powerful. If the first alternative was discounted because of its already obvious disadvantages, the only thing to do would be to concentrate on the latter.

There was one thing they knew they could do to get more power out of an engine of given size—raise the compression ratio. A gasoline engine is as effective as the amount of compression which can be given to the air-gasoline mixture in the cylinder, or as effective as the compression ratio, as engineers call it. But a remedy so obvious must have had some drawback and it did—knock. That was the nightmare of all automotive engineers. It was perfectly audible to the most unskilled driver, yet it was intangible. You could not remove it from an engine with an S-wrench and a pair of pliers. It called for a more subtle means of attack. So the engineers began to look around for things to enable them to get under the skin of knock.

So they observed the flame during ordinary combustion and then during knocking combustion. There was a difference—the former was bluish, the latter, yellowish or orange. So they looked around for something to darken the gasoline, thinking that the tendency of darker colors to absorb more of the radiant heat from the cylinder walls might change the color of the flame, or in other words, prevent the engine from knocking. Following this line of attack, one day they tried iodine, adding a little of it to the ordinary gasoline with which the engine knocked. The knock ceased. And although iodine was out of the question for commercial use because of its cost, a knock-suppressor had been found—a vulnerable spot in the armor existed and undoubtedly there were others. The assumption was correct. But it was also realized after locating other knock-suppressors that it was a property of the elements themselves rather than of the color of their compounds that determined their effectiveness.

But the ideal anti-knock agent had not been found so they looked around for additional clues. One of these led them to Langmuir's Periodic Table of Elements, a hypothetical grouping of all the elements according to their atomic weights. There a singular fact was brought out—all of the anti-knock agents found so far were very close together on the Table. So they turned their attention to the neighbors that had not been tried.

Two of them were selenium and tellurium. Selenium oxychloride, the compound first tried, has a peculiar property all its own. It always brings to mind the fable of the universal solvent. As the tale is told, on one cold wintry day a motorist had a flat tire in front of the laboratory of two men who claimed to have discovered a universal solvent. He asked if he could telephone for a new tire and also if he might come inside while waiting for repairs. He stepped inside and the conversation turned to the occupation of the two fellows. They admitted that they were chemists and that they had discovered a universal solvent, a thing that would dissolve anything placed in it. "Well, I don't know much about such things," commented the motorist, "and this question may seem to be a foolish one, but what are you going to keep it in?" The compound of selenium that was tried had about the same characteristics—it eliminated the knock but it also took away the spark plugs.

Tellurium, the other, also had a distinctive property which is characteristic of the organic compounds of selenium. In this case, it was the odor. It had about the most disagreeable odor that ever affected the human nose—that of garlic intensified a thousand times. It was so bad, that among chemists it was called "tellurium poisoning." It permeated the clothes of those working with it. T. A. Boyd, who was one of those afflicted in this way, recalls that "In those days every one in the laboratory carried an atmosphere with him, and his coming was announced before he fully arrived. . . . Some of the boys would walk a mile rather than subject themselves to the ordeal of riding on a street car. . . . One fellow tells of a little scheme that he worked in order to enjoy a picture show one evening. When he entered the theatre, he looked around till he spied a rather seedy-looking fellow of foreign extraction and sat down near him, hoping that suspicion might fall on that innocent and unsuspecting individual."

Of course many of the clues to discover the best anti-knock agent led to blind alleys, but out of them all came the possibility of putting metals in oil solutions—a thing never done before. So the search went on until the number of different chemical compounds, many of which had never been prepared before, that were tried reached a staggering total. In the meantime, an ideal anti-knock had gradually begun to take shape in the minds of the chemists, but it had difficulty in materializing. Finally Thomas Midgley, Jr., by a process of elimination, concluded that an obscure compound of lead fitted the idea of an ideal anti-knock like a glove. By a process of persistent experimentation the compound, lead tetraethyl, was isolated.

It took the knock out and the American Chemical Society awarded Midgley the Nicholas Medal. But tetraethyl lead was too expensive, even though composed of the cheapest of elements—metallic lead, carbon and hydrogen. With the aid of other chemists, the gap between possibility and practicability was bridged and now it costs only a few cents to make knock-proof a gallon of the ordinary gasoline used in the average car.

The car manufacturers have not hesitated to take adventage of the possibilities offered by this new fuel. They have raised the compression ratios of their engines until now the average ratio is a little over 5 to 1 as compared to the $3\frac{1}{2}$ to 1 ratio usually encountered fifteen years ago. Piston speeds have jumped from 1,000 feet per minute to over 3,000. The ultimate result is that from an engine of 250 cu. in. displacement, we now obtain over 80 horsepower instead of the 30 horsepower of 1915. Of course this cannot be attributed solely to the change in fuels. Engine designers have accomplished unheard of things during this period. They have done the seemingly miraculous with combustion chambers, valves, and the design of the rapidly reciprocating and rotating engine parts.

But what does this all mean to the exile from civilization who has just returned? It means that the new car he has bought is designed to deliver its maximum efficiency when ethyl gas is used. The designer has, in many cases, purposely added half a compression ratio to take full advantage of this standard anti-knock gasoline. The results is a car that will travel seventy miles an hour with ease, take the steep hills in "high", and split seconds when the amber light turns to green—all because certain scientists knew what they were looking for and, by systematic research, found it.

CHAPTER VII

THE CORROSION MYSTERY

Early in the twenties a rather wealthy old lady who lived in a town near New York bought a sedan of a certain make to facilitate her shopping. Her nephew, a high school student, finally persuaded her to buy him a sport roadster of the same make. The old lady was driven downtown every day by her chauffeur, made the rounds of the stores, and then returned home. The young chap, however, had different ideas about how a car should be driven. Every afternoon, after school, he would burn up the road outside of town or, during vacation, take long cross-country tours and in general put the roadster through its paces.

A year passed and the aunt's car was taken to the service station to have the engine rebuilt. Her nephew's car was running like a watch in spite of the fact he had driven it twice as far at three times the speed—it was just broken in nicely. So the old lady wrote the factory to find out why the car driven in harum-scarum fashion by her nephew should outwear the sedan carefully groomed by her meticulous chauffeur.

Again, in the foothills of western Pennsylvania two other cars were writing rather peculiar history. Mr. A lived on top of one of the hills and was accustomed every morning to coasting down to work to the factory at the head of the valley. His friend, Mr. B, whom he had persuaded to buy a similar car, lived at the other end of the valley. So he drove up the valley road every morning to the same factory. They had bought their cars at practically the same time and had about the same mileage when Mr. A wrote to the factory to find out just why he had to spend nearly a hundred dollars to have his engine overhauled and Mr. B's car apparently would not have to be overhauled for years to come.

And down in Birmingham a man was having a terrible time. It happened on St. Patrick's Day. He was out in the country, miles from civilization, and his engine "gave up the ghost". A garage man was called, found the timing chain in the engine had stretched, and installed a new one. The car started on its way, apparently as good as new. And it acted that way for a year, until the fatal St. Patrick's Day again rolled around and about a week later another timing chain was installed. So he told several of his friends about it and they said, "Oh! Don't worry, we have had the same trouble. It is well known that March is a bad month for timing chains!" But our friend was not satisfied so he wrote to the factory to inquire as to just what St. Patrick's Day and timing chains in automobile engines had in common.

Back in the service departments of the factories they analyzed freakish letters of this sort that came pouring in, and decided that the timing chain was the culprit. So they called in the chain manufacturers and together they experimented on new materials, changed heat-treatments, tested and installed new designs. At length the trouble ceased as abruptly as it had begun and an atmosphere of relief was in evidence in the service departments. A year rolled by and in the early part of the following spring, about St. Patrick's Day, in various parts of the country, engines stalled, cylinders missed, and timing chains stretched and parted company with the gears. And the seeming remedy of the year before, when tried, was found to have no effect. Evidently the timing chain problem was not one for amateurs. It called for the new scientific school of detection. So research engineers and chemists were ordered to those sections of the country where they were the most trouble, to search for clues.

One thing was obvious: the destructive element, whatever it might be, always chose the same location in which to wreak its havoc—the inside of the engine, or any place in contact with the engine oil. And then the theories began to arrive from the field—the worn parts were poorly heat-treated, the cast-iron was impure, the oil was of improper grade, or there was electrical leakage. Some even said that, to get rid of the trouble, all steel parts should be of the same chemical analysis and heat-treatment.

And so it went on until two chemists concentrated on certain badly-worn parts—the body rather than the scene of the crime, so to speak. Some parts were badly pitted and they scraped off a bit of that metal about the size of a pin head where the little pits were in evidence. With extreme care they analyzed that small bit of metal and found abundant traces of iron sulphur compounds—far more than the usual amount found in steel or iron. They tested out the lubricating oil to see if that was the source of the sulphur but found that was not the answer. There seemed to be only one possible solution then—it must be the fuel.

So they re-staged the whole event. When the car is cranking over and over again and the cylinder walls are cold, water condenses in the engine and trickles down the walls of the cylinder into the crankcase. The water, of course, comes from the burning of the fuel and the air in the engine—about a gallon of water for every gallon of fuel. But where does the sulphur come from? The fuel mixes with air and is burned in the cylinder. At the same time any sulphur that happens to be in the fuel must burn also. That was the clue that solved the mystery. Research chemists proved that the sulphur which burned, forming oxides of sulphur, was dissolving in the water condensed in the engine and forming sulphurous or sulphuric acid. This acid was corroding the metal parts, wasting away the chains, and eating the piston pins and camshafts.

Now this formation of an acid in the crankcase is a peculiar sort of thing. In the first place, the harder a car is driven the less tendency there is for the acid to form, owing to the accompanying heat, which drives off the water vapor. That is the reason why the nephew who drove the sport roadster did not have the same trouble as his aunt whose car was rarely driven hard. Again, the man who coasted down hill every morning accumulated, in the process, excessive water vapor which in time took its toll. It was also found out why St. Patrick's day ushered in a bad period in the life of cars. Cold weather and low temperatures were ideal for the formation of vapor and there was no relief for the parts exposed to this corrosive during the entire winter. In concentrated form the acid slowly etched nearly all of the moving parts of the engine. So in early spring the weakened parts broke, the timing chain stretched, slipped off, and stalled the engine. Quite logically, things about reached the climax on St. Patrick's Day.

So conditions reached the point where it could be said "Here is the trouble, here is the cause—but what is the cure?" Water could not be eliminated, because it is a by-product of combustion. To eliminate sulphur entirely from the fuel would be unnecessarily costly. What then was the solution? Again research was called upon when other methods failed. The research men knew from everyday experience that when clothes are wet, the wind will dry them, that when a room is full of smoke, an open window will make a draught and clear it. So, said they, why not remove this corrosive vapor from the crankcase by putting in windows and sending a draught through? The plan worked and although we hear of isolated cases of corrosion here and there it is essentially a thing of the past. Corrosion has been controlled. There are and will undoubtedly be more new mysteries; otherwise there would be no progress. But we know that in the future we are prepared for every new problem. Physics or chemistry has a new remedy and a new method of attack.

CHAPTER VIII

GUNCOTTON, MICROBES AND AUTOMOBILES

"SAVE the surface and you save all," runs the slogan of a well-known paint-manufacturer's association. And since 1900 that is just what automobile builders have been trying to do—save the surface.

Things went along very well until people decided that a million and a half automobiles a year were not enough to supply their needs, and asked for more. It was about that time that one of us happened to take a little tour through the plant of one of the large companies. To the right were automobiles, to the left were more. They stretched ahead as far as one could see and one was afraid to look back. Somebody asked the production manager how many cars surrounded us. "Oh, about fifteen thousand being painted," he said, "and about half of those will be scratched and will have to go through again." Mentally calculating the company's daily production, it was suddenly realized it took over seventeen days to paint a car—more than $20,000,000.00 in automobiles sitting in warehouses waiting for the paint to dry! Here seemed to be a change to give the people what they wanted—more automobiles, if only those cars could be turned loose.

So in the autumn of 1921 a "Paint and Enamel Committee" was appointed to look into the whys and wherefores of finishing cars. But before we start that committee to functioning, let us look a little into this business of painting cars. Black enamel, such as is commonly used on automobile fenders, had been developed to a fairly satisfactory finish. Parts, such as fenders, or in some cases, complete bodies, could be finished in one or two hours. But there were two drawbacks: it could be had only in black, and it required the use of temperatures of 400° Fahrenheit or over for drying. The regular varnish finish, which the automobile industry had inherited from the horse-and-buggy days, permitted the use of normal temperatures and any desired colors; but it was very slow. In the case of higher grade cars it often required a month to finish one.

And that was the situation when the "Paint and Enamel Committee" met. Here was the problem put before them: The industry absolutely had to have a finish that would decrease the time of finishing from days to hours; it must not require temperatures beyond those wood could stand; it must be as inexpensive as the varnishing process; yet it must be applicable in all colors and last the lifetime of the automobile. In other words, it must have all of the advantages of enamel and varnish without any of the disadvantages.

When the committee and the paint men all over the country heard of these requirements, they said, "No. Any finish takes time to apply, since it dries by absorbing oxygen from the air, and the coats must be applied thin enough to absorb oxygen—you can't change nature" But some toy factories were found which used a sprayed finish of cellulose nitrate. When the toy men were asked why such a finish could not be used on automobiles, they laughed and said, "You don't know this stuff; it would dry before it hit the metal." But only seeing is believing, so "this stuff" was tried. The toy men were right—it hit the sides of the automobile and bounced off like hail stones in a July storm bouncing off a tin roof. But the problem now was not so difficult. As they say in the army after they put a shell either side of the target, it was "bracketed"—varnish is too slow; existing lacquers, too fast.

Let us go back and list some of the ancestors, as they might be called, of the lacquer that finally resulted from this search. Below are the four things which appear to be the responsible agents.

1. The recognition of the need for a new finish.
2. The development of a low-viscosity cellulose nitrate.
3. The development of the butyl-alcohol industry.
4. The development of a system of finishing automobiles which takes advantage of desirable properties of the material and avoids, as much as possible, any of its fundamental disadvantages.

The first of these has been discussed, so let us start with the second ancestor. Let us roll time back 100 years. The year 1833 saw Braconnot in a small laboratory in France dissolving potato starch with concentrated nitric acid and pouring out a little of the resulting thick acid liquid on a piece of paper to let it dry. A little later he looked at it and found that the liquid had hardened and the paper was protected by a very brilliant varnish-like coating—"superior to that furnished by the best gums". After pondering awhile he wrote down in his notebook a name for it—"xyloidine". Five years later, Pelouze, a fellow-countryman of Braconnot, repeated the experiment, using cotton instead of potato starch but he called the resulting nitrocellulose "pyroxylin".

Another five years and the scene shifts to Germany. Christian Frederick Schönbein mixed sulfuric acid with the nitric acid and treated cotton with the mixture. The result was a substance which exploded violently and because of this property was called guncotton. On July 28, 1846, in Bale, Schönbein fired the first cannon loaded with guncotton. But in the ensuing years guncotton was not used very widely—its behavior was too erratic. However, at the battle of Santiago when the smoke from the black powder caused the gunners to lose sight of the enemy, all of those concerned decided something had to be done about it. So those who fashioned the weapons of war again turned their attention to guncotton. Out of it all came cellulose nitrate for smokeless powder and a revived interest in another member of the same family, namely, cellulose nitrate lacquers.

But the kind of cellulose nitrate that was in general use gave such thick solutions with such a small percentage of film-forming material that another type seemed desirable. This new variety, called "low-viscosity cellulose nitrate," was developed as a result and today forms the basis of automobile finishing lacquers.

Butyl alcohol is another of the constituents of automobile lacquer; but we will not go as far back into its ancestry. About 1910 efforts were being made to make synthetic rubber. It appeared that two materials, butadiene and isoprene might be of use in this work. About that time a peculiar micro-organism was discovered. This organism had a remarkable appetite for field corn such as we feed to hogs; but instead of converting it to bacon it made of it butyl alcohol, acetone and ethyl alcohol, in the ratios of 6:3:1. It was found that butyl alcohol was a good raw material from which to make butadiene and isoprene and so the micro-organism was studied and trained to make butyl alcohol and acetone.

The British War Department had standardized a war method of making its smokeless powder and in that official method, large amounts of acetone were used. Pig iron formerly was made using charcoal, and one of the by-products in the manufacture of charcoal was acetone. But the pig-iron industry had been gradually swinging over to coke instead of charcoal, and when the World War made its great demands for smokeless powder, the British found that there was not sufficient charcoal being made to make enough acetone for the required amount of smokeless powder. A few of these micro-organisms which made butyl alcohol and acetone from corn were still in captivity, however, and they were put to work making acetone. The butyl alcohol, which was made in twice the amount, was an undesirable by-product, but the micro-organisms refused to make acetone without at the same time making twice as much butyl alcohol.

At first this butyl alcohol was thrown away. As the war progressed, America became involved, and about that time the 18th Amendment was adopted. Some of the distilleries which had been making whisky were temporarily closed. But since acetone in still greater quantities was required, they began making it together with butyl alcohol, by means of the fermentation process. They believed that the butyl alcohol should have some use but no one wanted it. So at one plant it was stored in a large swimming pool while they tried to find a use for it. Now amyl alcohol was a raw material for making amyl acetate or "banana oil" which was at that time a very important ingredient of certain lacquers. It was simply a lacquer solvent made from amyl alcohol. At that time its source was Russia; it was a by-product of vodka. But the war and prohibition in Russia shut off the supply. It was found, however, that the butyl alcohol in the swimming pool was a good substitute. And so the cycle was completed.

Today practically every car has a lacquer finish —a finish that can be applied in less than eight hours; one that is more durable, more easily applied, and more attractive than either varnish or black enamel. However, the use of this material has not been confined to the automobile. It has invaded the home and with it has come color—furniture, radios and refrigerators are now lacquer-finished.

But this development has a greater meaning for the people of the world. It is a reassurance that nature is still on the job and always will be, operating through human agencies to meet the ever-increasing and broadening needs of people, providing a new substance to replace a disappearing one. There is no waste in nature. What we regard as waste is merely a dormant substance awaiting the hand of research to start it serving some practical and valuable career.

CHAPTER IX

STANDARDIZATION

STANDARDIZATION is not a new thing. It is as old as the Medes and Persians. From the dawn of history we have had standards of trade—money, weights, and measures. But since we are concerned with only one phase of the subject—its relation to the automobile industry and to the car-buying public—let us go back approximately thirty years to the days when Duryea, Haynes, Ford, Olds, and Winton, were beginning to make and sell automobiles.

It was a peculiar situation; the demand exceeded the supply. The pioneers were not manufacturers, they were assemblers. The carriage-makers supplied many of the parts to the fledgling business, which was destined to grow into the nation's greatest industry and to sound the death knell of the horse-and-buggy era. Spark plugs were homemade, schoolboys spent their vacation hours punching holes in washers and stringing them on tubes for radiators. The form the steering apparatus took depended entirely on the builder's whim.

It is not hard to imagine what happened when such things were put into the hands of the public.

Take for instance a very common occurrence. The failure of a spark plug in a one or two cylinder engine in those days meant being stranded or towed home. But even after the owner had the car safely housed upon his own premises, was he any better off? He would write to the factory for half a dozen new plugs and after a week or so maybe they would arrive. Our friend, in anticipation of a good day's motoring, would pay a visit to the garage and attempt to install the new plug, only to find the hole shrunken or else that the new plug was too large. So he would write to the factory and a smaller plug would be sent. Again to the garage and "Eureka! It fits." But no, just a minute; it seems to be binding. Then he realizes that the threads are not similar. Another letter produces the reply, "We are very sorry to have inconvenienced you, but since your car was delivered we have changed the threads of our spark plugs. . . ." All of this goes to show what a hold the automobile had on the people even at that early date; people eagerly embraced the opportunity to acquire future trouble. High maintenance and repair charges made the initial cost of the automobile seem comparatively negligible. The fundamental requirements of the early car-owner were a vast amount of patience and perseverance, together with a very loose purse string.

The manufacturers also had their difficulties. They had to rely nearly entirely upon the makers of parts to deliver such things as castings, gears, nuts, bolts, and springs, and they had to go to the carriage-makers for bodies. The parts-makers did not keep an abundant stock, but rather attempted to fill individual orders as they came in. Replacements were, therefore, a matter of luck. There was very little a car-assember could do, if he did not like the treatment he received at the hands of his supplier of parts. If he changed to another source, he was very lucky if he did not have to redesign his entire car, because the parts manufactured by different companies possessed an individuality that did not lend itself to interchangeability with similar parts produced by other companies.

According to J. K. Barnes, at least 800 different kinds of lock washers were made to fit 3 or 4 bolts of different size—200 different washers for bolts of a single diameter. Automobile makers were using 1600 sizes of steel tubing, 80 sizes were used by one company alone. When alloy steels came into vogue, there were as many kinds of such steels as there were steel-and-car companies—about 230. Each steel salesman had his "special brand, mysterious ingredients, secret processes, and high prices."

The economics of the situation caused some of the leaders of the industry to rebel, and they got together to discuss matters. Thus the endless chain of standardization of automobile parts was started under the direction of the Association of Licensed Automobile Manufacturers. In 1910 the work was taken over by the Society of Automobile Engineers now known as the S.A.E. or Society of Automotive Engineers. The 800 sizes of lock washers have become 16 and the 1600 varieties of steel tubing are now 17, in 13 thicknesses. These men, however, point with pride to what they consider the Standards Committee's most important accomplishment—the shrinkage in the number of alloy steels from 230 to approximately 50, all of which are carried in stock by the steel companies and can be ordered by number. In the searching effort to simplify, no part of the automobile has been overlooked—more than 200 parts and materials have been standardized.

Other things took place in this process besides standardization. One of the members of the early engineering committee was Hiram P. Maxim. At one of the meetings, the subject of exhaust mufflers was under discussion. A member casually remarked that some similar arrangement of baffles ought to be as effective in silencing the report of a gun as it was in silencing the exhaust of a gasoline engine. One of the men present was gifted with keen ears and a mechanical turn of mind. At their next meeting Mr. Maxim demonstrated the now famous Maxim Silencer.

Let us revert to the things called standards. How do people go about standardizing parts and materials? As far as the automobile is concerned, there are certain things that must be made the way they are. It would not be possible, for instance, to make our vehicles very much wider because our roadways would not accommodate them. Similarly, vehicles cannot be made much lower because even the best boulevards are, at times, rough, and "rutty" with snow and ice. These things may be termed "standards of necessity."

Most of our standards are based on experience. There is a certain fundamental relation between research and standards. The former is generally an effort to escape from, or to improve upon, existing standards. But matters which are the subject of research today, probably will be, in many instances, standards of the future—that is, after they have been proved and modified in service. If we had the facilities and patience, we could probably trace every specification back to fundamental experiments conducted by someone, at some time. But the intervening time-interval between experiment and specification often covers a lifetime.

Lacquers and chrome-plating were not generally adopted by the industry until the third decade of the present century, even though cellulose nitrates were known in 1845 and chrome plating was being worked with by Bunsen in 1854.

Standards in use today are formulated with a view to economy and manufacturing expediency and in turn are furnishing the car buyer with a less expensive product for which repair parts can be obtained with the minimum of expense and inconvenience. It would be entirely possible to to make an operatable automobile with a different thread for every bolt and screw—in fact, the first cars approached that sort of variety. Cylinders and pistons would function even if they were not all the same size. There are a vast number of possibilities with respect to the sizes of spark plugs, ball bearings, and tires. After a minor part, such as a lamp socket or a fan pulley has been designed and proved in service, there may appear no good reason for changing it when a new model is produced. The continued use of a standard not only saves time and expense in designing but also justifies the installation of special equipment which, in turn, results in low manufacturing costs.

Today when a draftsman redesigns some part of a car, he does not draw upon his imagination for the dimensions. He does not say, "Well, let's see, that bolt ought to be about $\frac{5}{16}$ of an inch with 22 threads to the inch." Instead he refers to the handbook of standards and finds that the proper number of threads for a diameter of $\frac{5}{16}$ is 24. So he specifies that figure, knowing that the bolts can be obtained promptly from any one of a hundred or more different sources of supply and that they will all be interchangeable.

That word "interchangeable" is the sum and substance of all standardization. It is the key to mass production. Fabrication has become a matter of timed operations rather than of individual ingenuity in getting mismatched pieces together. There are specified tolerances that are rigidly adhered to. Pieces are no longer antagonistic. They are interchangeable—they fit. And the owner nowadays, when a plug fails him, goes to an accessory shop or maybe to a corner filling station, and asks for a spark plug. In about the time it takes to replenish the water in the radiator, it has been installed and he is on his way again. The owner and the manufacturer both profit by this new form of simplicity. It has been estimated that the annual saving to the automobile industry alone amounts to three-quarters of a billion dollars. Surely it is very much worth while.

We have gone a little into the benefits of the system. So let us look at the other side of the picture. It is important to note that most of the standards apply to relatively minor details—nuts, bolts, and fittings. Any attempt to standardize the major factors of design would stifle progress. People have their own ideas as to what their automobiles should do and how they should look—we cannot standardize such things. If a customer wants economical transportation, it must be supplied. If he prefers artistic elegance, that too must be forthcoming. Most present day cars are a compromise between the two.

Some years ago just what standardization of design would lead to was forcibly brought to our attention. A car dealer in Kentucky had a very "live prospect" in the person of a society woman of his city. It was about the time of the Louisville races. He offered her the loan of a car, which we shall call the Regent, to try it out by driving to the races. She accepted the offer, and the dealer, when she drove the car away said, "Don't take my word for its being a good car; ask any Regent owner you see at the races." She came back two days later and drove into the garage.

"Don't you want to keep the car?" asked the dealer.

"No, I don't," she said, emphatically, "I don't want a car I can't pick out on the street. I asked four people at the races how they liked their Regents, and three of the cars were Comets."

Economics tells us there are two things that form the basis of all industry—supply and demand Prosperity depends upon the proper and critical adjustment between the two. In the early days the demand exceeded the supply. Today standardization makes mass production possible and permits manufacture of stock, thus smoothing out temporary differences between supply and demand. But as just pointed out, the adjustment is very critical. As soon as anything becomes standardized the tendency is for it to be produced in larger quantities by labor-saving machinery. If the demand changes ever so slightly the result is overproduction.

Lack of coordination within industries and between industries is one major cause of business fluctuations. The national standardization movement is making a definite forward step toward the correction of this situation. To be sound, standardization must be carried out in such a way as not to restrict the development of materials or devices that may be desirable but different from materials or devices known or in common use. The new development of today may be the standard of tomorrow. Continued prosperity therefore depends upon the constant development of new things. Standardization must always go forward without building fences to prevent development or to block future progress.

Today there is a tendency to drift too far in the other direction—some of our engineers have a standardization complex. People are obsessed with the fallacy that if we standardize everything the millennium is upon us. It becomes the habit of everyone to want to make everything like everything else, and sell these things at a profit. There should be moderation in all things. A man by the name of David Parry once wrote a book called *The Scarlet Empire* in which "inspectors forced each person to laugh every twenty minutes for the good of his health." "That is absurd," you say. Of course it is, but is it any more ridiculous than trying to force the same ideas upon everyone? And that is the deepest pitfall in the path of standardization. Standardize materials, but never submit to the standardization of ideas.

CHAPTER X

SUPPLYING THE WORLD'S NEEDS

SINCE the days of the clipper ships, a hundred years ago, Americans have roamed the Seven Seas trading and bargaining with American goods. The past hundred years have seen many changes. Fast freighters have taken the place of clipper ships. America has forged to the front in world trade. Its products are known to the ends of the earth. And the automobile has changed in position from an imported article in 1900, to one of the first three of our exports in 1930.

The development started when the American manufacturers turned the tables on European producers and proceeded to sell them automobiles cheaper than they could deliver them to us. Although it has gone on this way for the last twenty-five years the surface has hardly been scratched. It has been said that taking into consideration population, wealth, and existing roads, Europe today is the world's greatest automotive vacuum. It has 300 million inhabitants and but 4 million cars, while the United States with less than half the population has over 6 times as many automobiles.

A number of things have contributed to bring about this situation. The Great War of course was a major factor causing motorization to be retarded while political, economic and industrial readjustments occupied the limelight. But, as is so often the case, the chief factor was a state of mind. The average European still looks upon the automobile as a luxury while approximately 75 per cent of the American people regard it as a business necessity.

So American producers have set out to change that attitude of mind, although they had to go to Europe to do it. Two of the world's largest automobile builders have begun to make cars on European soil. History is going to repeat itself because these two companies with their experience in finance, sales, and production will certainly create more than a ripple in the pool of European industrialism. In addition to any impression that might be made upon the European methods of mass production and marketing, a greater result is to be hoped for—a change in a state of mind, a change in the conception of the automobile as a destroyer of wealth to that of a producer.

America's new product has travelled farther than Europe. Like the clipper ships, it has sailed the Seven Seas—it is known in the jungles of Papua and at the rim of the Artic, from the Cape of Good Hope to Siberia.

All sorts of difficulties, however, have beset this movement. Even to get into a country after crossing thousands of miles of ocean, the automobile must climb a tariff wall, which may add anywhere from 30 to 40 per cent to the price of the car. However the larger producers found that by establishing foreign assembly plants and by importing only the parts, they could reduce the tariff considerably and in addition serve two other purposes—become an addition to local industry and also make cheap and dependable transportation available not only for the immediate vicinity but for the thousands of square miles of surrounding territory.

This comparatively recent phase has seen, so to speak, the industry following the product—an assembly plant here, another there, until such plants reached a total of 150, scattered over the map at nearly all of the vital trade points. These plants have blended into the local scheme of things. They employ local labor and use local material wherever possible. The life of the native has been greatly changed. In many cases it has become more purposeful—he has become a part of a great modern industrial enterprise. He often learns a new trade and his standards of living have been lifted to a new plane. Consequently he is more contented as the result of being better fed, better clad, and of being the proud possessor of more worldly goods, which, in some cases now even include an automobile. But this new enterprise also has problems. Since of necessity a large proportion of the assembly-plant personnel is of the native variety, there are certain conditions that must be overcome. For instance, at least 90 per cent of the workers do not know a nut from a bolt, so they have to be given a mechanical education of sorts. That is only one of the difficulties. There is the problem of languages. In one plant in Bombay, orders are now posted in four languages: English, Gujarati, Marathi and Urdu. These just about cover the plant's personnel which is 91 per cent Indian.

This native touch, though, is not always a handicap. The Javanese workman can hold his work with his toes as well as with his hands. That ability has been ingrained in him through generations. He uses modern tools just as skillfully as he does his native tools and incidentally he improves upon the mass-production system. The little Japanese, striping wheels in a corner of the plant, at one time may have delicately depicted Fujiyama on a silk screen, but that only improves his deftness with a striping gun.

When the car is completed, inspected, and passed on to the sales-agency, the next problem is to sell it. Did you ever try to sell a black kitten to a dark-skinned citizen of Alabama? If so, you have a faint conception of what some of these overseas salesmen are confronted with. Take as an example just one thing—the color of the car. You cannot sell a green automobile in India—green is bad luck. In Japan, if your car is maroon, you have to keep it hidden in a garage because only the Imperial Household may use maroon. And in China, if your car happens to be of a yellow tinge, it means but one thing—you are in mourning!

Then there are other things that stand between the salesman and the would-be buyer. Consider taxes. A car selling for about $700.00 in Detroit and taxed approximately $13.00 here, would be taxed $96.00 in Berlin and $106.00 in London. The motorist who pays 15 to 20 cents a gallon for gasoline in Detroit would pay 30 cents in England, 40 cents in France and Germany 44 cents in Australia, and in some places in South America it would cost over 50 cents. To make it more difficult, our overseas salesmen must cover 300 different counties, speak 14 languages and trade with 35 different kinds of money.

But in spite of all of these obstacles our automotive exports have grown to exceed half a billion dollars. This simply goes to prove that the advantages of foreign automobile trade overweigh the disadvantages—in spite of obstacles in the form of tariffs, taxes, local customs and superstitions, language difficulties, and mechanical ignorance.

This new process of international trade performs functions other than solving the local employment problem. It is a first-class consumer of local products and incidentally a promoter of economic welfare abroad. Many countries make excellent automobile parts and the foreign assembly plants are giving the other fellow a hand by purchasing French tires, Belgian glass, German horns, Australian batteries, and English cloth. When the cycle has been completed everyone is benefited—the butcher, the baker, and the candlestick maker.

It has been said that you cannot do anything in the world without affecting someone else. When we build an automobile in Detroit, it is hard to conceive that it is going to vitally influence the routine of existence of, say, a native of Java. But that is the case because Java is one of the sources of supply for rubber and the automobile used more than four-fifths of the rubber produced today. And so it goes. We get cotton from India and

Egypt, silk from Japan and France, cork from Spain, graphite from Ceylon, tungsten from China, wool from Australia, wood from Canada and Norway. The automobile, without doubt, is the world's most cosmopolitan product. This is only part of the story. Steamships and railways must transport these materials and oil must be taken from the earth, transported, refined, and sold to furnish fuel for the 35½ million cars all over the world. The whole world is concerned in this business of making, selling, and operating automobiles.

The automobile, with its customary swiftness, has placed its stamp on the far countries; changing customs, standards of living, and even the landscape. Travel formerly consisted of hitching a cart to a bullock, mounting a camel, or hailing a jinrikisha, and then proceeding at a leisurely pace to a destination. The bullock cart is a favorite in places out of touch with civilization, where communication or a trip to the nearest village or railhead comes very near to being a holiday event. But with the coming of the automobile all of that has been changed. The owner now visits the railhead weekly and often takes the whole family. Their mode of living has changed and even their apparel. The husband has a radio and his wife wears silk stockings. His next investment is going to be a truck, that he may get all of his bananas down to the railroad in time for shipment. This is typical of many places and many people. Communication is more frequent and reliable, the cost of marketing products is lower, and individual viewpoints are broader.

Let us take as another case, India, the so-called treasure-house of the Orient. It is a long trip to India from London through the Mediterranean and the Suez Canal, down the Red Sea, around the Arabian Peninsula, and out into the wide Gulf of Arabia—the boat must detour this gigantic land blockade. Now things are being done differently. A fleet of automobiles starts from Beirut, on the western edge of the barrier, crosses the Syrian flats baking in the sun, enters Damascus, traverses Mesopotamia, and arrives in Bagdad the Magnificent. From there our traveler may board the train to Basra or take the steamer to Bombay. And he arrives nine days earlier than by the water route.

When the new scheme of travel was inaugurated, the automobile in its jaunt across these vast plains became a true ship of the desert. There were no roads, no helpful signs—nothing but a straight unbroken horizon ahead. So the driver consulted the sun, or at night the North Star, lashed the steering wheel in a definite direction to keep the car in its true course, set the speed for nearly a mile a minute, and proceeded to direct his energies to keeping his passengers entertained or to watching for Bedouin bandits.

That is romance—romance of a practical sort, the same brand of romance that travelled with the covered wagons across the Great American plains. But it is of a more modern type. It belongs in the age of the telephone, express liner, and radio. There is even a new type of wagon train or caravan. It is composed of half a dozen cars that invade the remote provinces, make the acquaintance of the natives, and educate them to the uses in their daily lives of this new method of transportation. And one of the large companies maintains a show boat which travels up and down the Irrawaddy from Rangoon to Mandalay demonstrating and explaining its wares.

American manufacturers have discovered the world's needs and have sent their products to the ends of the earth. First there were plows, sewing machines, and typewriters, and now automobiles. They are to be found wherever humanity exists. They have crossed the seas, penetrated the jungles and climbed to the roof of the world.

Mr. James D. Mooney, who heads the world's largest overseas sales organization, compares two epochs with the observation that "selling automobiles to cannibals is better sport than grubbing for silver in Nevada or raising oranges in California." And that is probably the same outlook that the Forty-niners had, only they probably thought that digging gold in California and fur-trading with the Comanches was far better sport than tilling a rocky New England hillside or working in a bank in New York.

It is just the spirit of pioneering that is again cropping out. It is something in the blood of the American people that forces them to attempt the seemingly impossible. This time they have set their hands to a tremendous task. They must educate, convince, and assist people to learn, the whys and wherefores of the automobile, its advantages and uses. And these people are scattered all over the world. The frontier now is not a part of a continent. It is the jungles of Africa, the glaciers of Iceland, and the mountains of South America. The work is progressing, however. If you took a trip around the world you would see American cars in every port, however remote. But there are millions of people who do not possess cars, people out of touch with civilization. Those people must be reached and their daily lives motorized. That is the job of these new pioneers—"to erase the World's last frontier with the rubber tires of American automobiles."

CHAPTER XI

THE PUBLIC PULSE

After all is said and done, what does the automobile represent? "A tremendous manufacturing achievement," says one. "A remarkable business achievement," says another. And they are both right. The automobile has established itself in the lives of the American public, the names of the cars themselves are known to every household. New models are awaited every year with eager interest. The automobile show is a definite yearly event, a sort of fair where thousands gather to inspect the yearly changes to admire the new color schemes. Interested people from the ages of ten to seventy surround each exhibit. A certain portion of the American public is interested in the doings of the automotive world and that portion represents more than 50 per cent of the whole.

In the preceding chapters we have gone over a few of the things that led to this condition. The automobile is a manufacturing achievement. During the short space of thirty years it has probably done more to change general manufacturing methods than any other one thing in all the preceding centuries. It has literally taught the entire manufacturing world—and we might even include agriculture in that—how to make two blades of grass grow where one grew before. It has brought about the assembly line, the huge stamping presses and the time reduction, from weeks to hours, for applying the finish.

But some people say the blessings the automobile has conferred have not been unmixed with evils. Our industry, along with others, has been blamed for the mechanization of things. And it has been said that it is mechanization that has separated the worker from his individuality and left in its place, monotony. Now monotony is the most terrible curse in the world, whether it is monotony of employment, environment, or products. The man who accuses the automobile industry of sponsoring a wearying duplication of work does not always take into consideration the shortened hours of labor and the means the automobile has given him to take the utmost advantage of this time for recreation and relief from a set of environments. Let us consider products. Mechanization is not to be blamed for the majority of the evils that might be attributed to our present industrial system. It is far more likely to be mentalization, this idea that we can keep on doing the same thing indefinitely.

These new elaborate production methods are simply a means of converting ideas into goods. The error lies in concentrating upon the method of conversion or production rather than upon the things to be produced. The fault does not lie in the machine but rather in the man. There is nothing more stupid than the idea that one can set up a machine and produce three times as much as the market can reasonably absorb and then expect to sell all of those things at the same price. That is stupidity, not mechanization. The production machine we have produced is a versatile one, and is just as useful a tool of man today as it ever was, if properly used. Production, however, must be controlled. We cannot reasonably expect to continue to make the same thing over and over. The simplest way to assure safe production is to keep changing the product—the market for new things is indefinitely elastic.

This new scheme of things, however, brings into importance matters which would never have bothered our forefathers. A young man, who was married a few months ago, lives in a modern apartment house where existence has been made so easy that his heaviest domestic duty is to turn on a few radiators when he gets up in the morning. He does not even have to light a fire in the kitchen range or to fish out a drip-pan from under the ice box, because his cooking is done by electricity and his refrigeration is forced up to his apartment from a central plant in the basement eight floors below.

But when this young man's father set up his household some thirty-five years ago, he had all manner of tasks to perform before he went to his work down town and again all manner of tasks after he reached home at night—tasks which his son might find very complex indeed. He had wood to split, fires to make, a cow to milk, a horse and chickens to feed, and a garden to hoe.

Our young acquaintance drives effortlessly from place to place in his automobile, which is a complex thing, but nevertheless much easier to care for than his father's horse. His wife buys most of the food they eat in semi-prepared form, but his mother, during the early years of her married life, canned, baked, and butchered endlessly.

The point is obvious. In the old days, when the world was simple, life was complex. Nowadays we are surrounded with intricate things, yet the business of living has become simpler. It is the world—society, if you wish to call it that—which has grown more complex, not the life of the individual. Whether or not the new manner of living is more desirable than the old way is a different matter. It depends to a large extent on what use the modern man makes of the leisure time which all of these devices have given him.

The only really complex element in the life of this young man is his absolute dependence upon his job. If his father had been thrown out of work, he could have scraped along indefinitely with his cow and his chickens and his half-acre truck-patch. But our modern industrial world for the most part has no such second line of defense. That is why it is so essential that we keep *all* the wheels turning *all* the time.

This new industrial world has been taught a very severe lesson. It has been forcefully impressed upon it that the unchanging product is not the source of power to keep the wheels of industry constantly moving in spite of the lubricant of increased industrial efficiency. The answer to the situation lies in new products to fill new demands. America must be built. The operation of it will take care of itself.

When this new industry sprang into being it had a profound effect on business and marketing methods. It brought into popularity the so-called "time payment plan," which is called by some one of the principal foundations of America's high standards of living and called by others, a curse of a nation. When you touch upon the whys and wherefores of the automobile and the billions of dollars spent each year on them, people ask, "Where do all of the people get the cash to pay for them?" The answer is, they do not. They let the credit companies do that. When approximately a billion dollars is handled each year in this manner, and the shrinkage, or actual loss for repossession, is less than one-tenth of one per cent, one begins to realize that the man who buys a car on time-payment really wants it. In his mind he puts it on a parity with the other necessities of life—food, clothing, and shelter. Life today is arranged so that without an adequate means of individual transportation, business, agriculture, and the daily routine of existence, would be seriously handicapped and, in many cases, cease to function.

This new scheme of buying, however, has also been threatened. The same fundamental pitfall lies ahead of it that lies ahead of the industries—markets are not indefinitely elastic for the same goods. The time-payment system, like all organized business, is successful if there is sufficient public demand or desire for a thing. It will always be good if it is not abused, if man does not attempt to force the public to consume unvarying products in unlimited amounts. It has become a tendency, because of the lack of variety, to "sell" the public. The people will not be "sold" indefinitely. They must be educated to the worth of an article. If there are enough new articles they will buy of their own accord.

Mr. Edison as usual saw below the surface of things and, although he fully recognized the automobile as a business and manufactuturing achievement, he believed that it its effect upon the world was more far-reaching.

"Next to the World War, the automobile has done more to make America a nation of thinkers than any other invention or agency. The great value of the automobile is not the fact that it has made it easier and quicker and cheaper to go to places, but the fact that it has inspired several million people to go. It has set their gray matter to work. It has revealed to them how petty and meaningless their lives were becoming. . . . Most of us view the automobile principally as a great business and manufacturing achievement. It is—but it is a greater educational achievement. In the beginning we were a pioneer people—a restless people. But when things came easier for us we began to lose our restlessness. The automobile is helping to restore it. And that is one of the most healthful signs of the present generation. Restlessness is discontent—and discontent is the first necessity of progress. Show me a thoroughly satisfied man—and I will show you a failure.

The wheels of progress—especially those of the automobile—have worked results which may be called miracles. But their service has been to raise the *thinking capacity* of society."

Mr. Edison was right. The automobile has been a breeder of ingenuity but fundamentally it brings us back to our previous point. In 1900 the automobile was a new product offered to a world which was surfeited with the existing methods of individual transportation—the horse and the bicycle. It is an example we cannot afford to overlook. The people need new things today just as they did at the turn of the century. The world is not a kaleidoscope of old things which can be repatterned without fundamental changes. It is a new structure built upon new products and new industries.

What is it the public wants? That is hard to say. In the last decade, what new product was offered to the public? The answer is obvious—the radio. In the last ten years thirteen million homes have been equipped with radio receivers. All because it was something new, something entertaining, something instructive, and above all else, something people wanted. What the new things will be is difficult to say. We do not know what the world is going to look like a generation hence or even a dozen or fifteen years hence but just a glance about us will include a number of things which obviously need changing.

For instance, there is the climate. You say we cannot be anything about that, but there is a great deal that can be done and probably will be done in the very near future. There is no reason why people should suffer more from high tempertures than from low, or why our dwellings and business buildings and factories should be permeated on humid days by an atmosphere that is literally dripping. A step has already been taken to insure bodily comfort in spite of the climate. Artificial cooling is found in our best moving picture theatres and in some of our public buildings. But the surface has hardly been scratched. If it was possible to purchase at a moderate figure a compact machine, which at a cost of operation not too high would cool the air in the dwelling, would not every householder be a potential customer?

As another field for future developments, let us consider the recent New York drive for silence. For a number of years highway engineers have have been experimenting with rubber-block paving but its expense has always been a drawback. With the possibility of synthetic rubber in the offing, however, who can say but that our future streets will be made of this material? The whole field of transportation would undoubtedly be revolutionized.

The railroads also cannot escape change. Sleeping compartments will be entirely altered to give the patrons more comfort, more privacy, and better hygienic conditions.

In a previous chapter we have touched lightly upon the highway problem which confronts us. Someday in the not too far distant future a great express highway will traverse the continent and compared to the capacity of the highway of today, it will carry an almost fabulous stream of traffic, travelling well over a mile a minute. The vehicles themselves will probably look no more like our cars of today than our latest models resemble those of 1900. The internal combustion engine is becoming more versatile every day. Cars will be ridiculously simple things to drive, offering the utmost comfort under all conditions of weather.

Whatever the future may hold, whether it is dehumidifiers, rubber pavement, express highways, or synthetic fuels that we can put in our gas tanks when the long prophesied fuel shortage arrives, there will be new things and therein lies the future of our country.

An English visitor to these shores recently remarked that "every ten-room house in America has eleven rooms and sometimes twelve."

Pressed for an explanation of his statement, the visitor furnished it: "Why practically every house in your country has an extra room. The room is mounted on four wheels and it has an engine to drag it all over the shop, but it is another room, just the same."

This shows what a hold on the people a new product can have—how a new thing can fit into our civilization. That is the lesson of the automobile. The world wants new things, new ideas, new products, new opportunities. All of these units, when combined, will build up our civilization to a new plane of perfection.

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