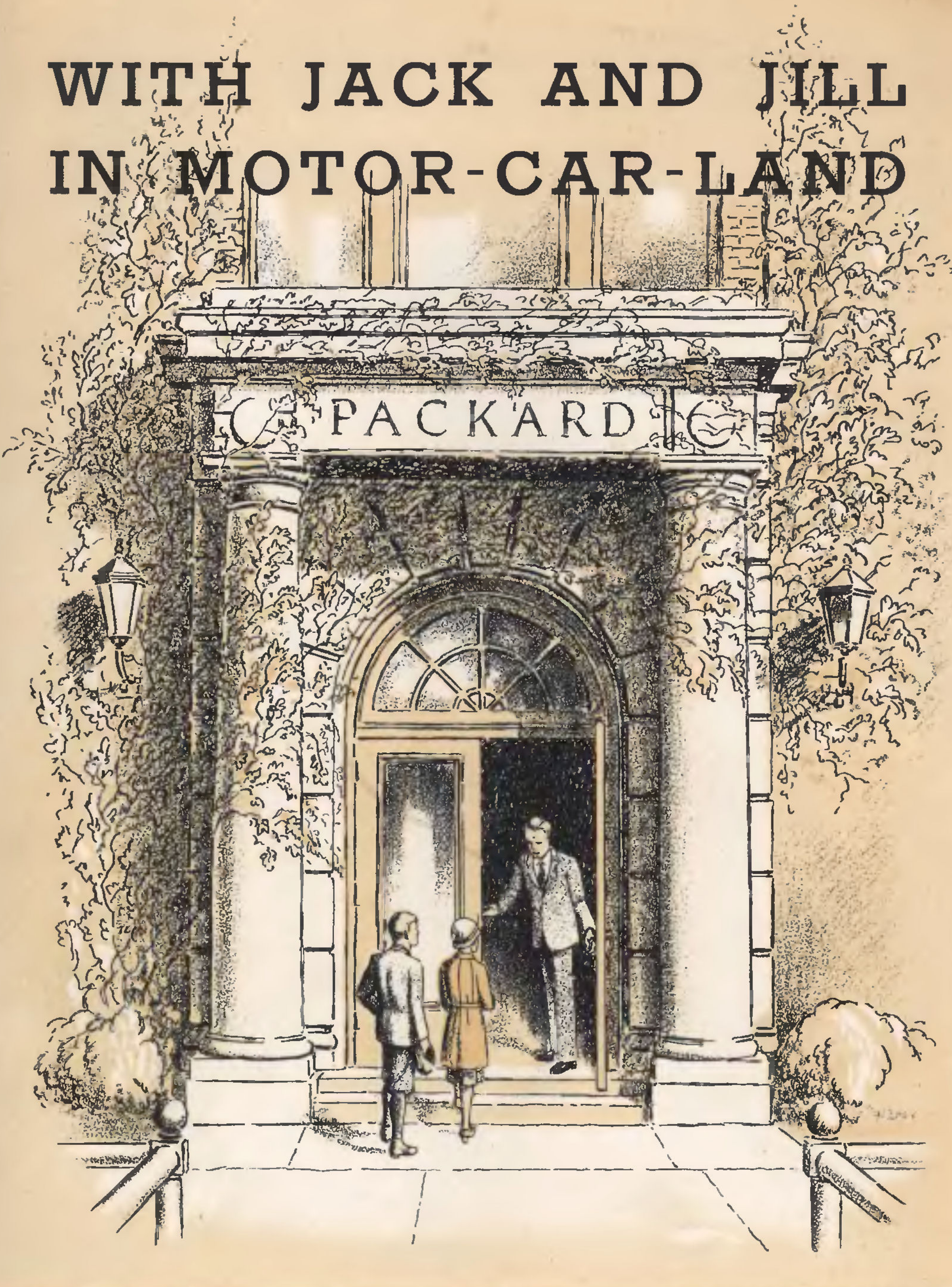
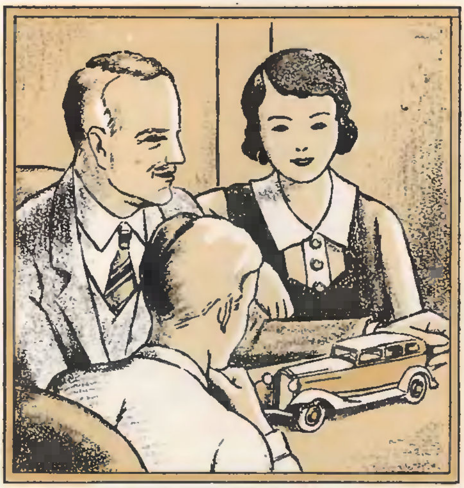
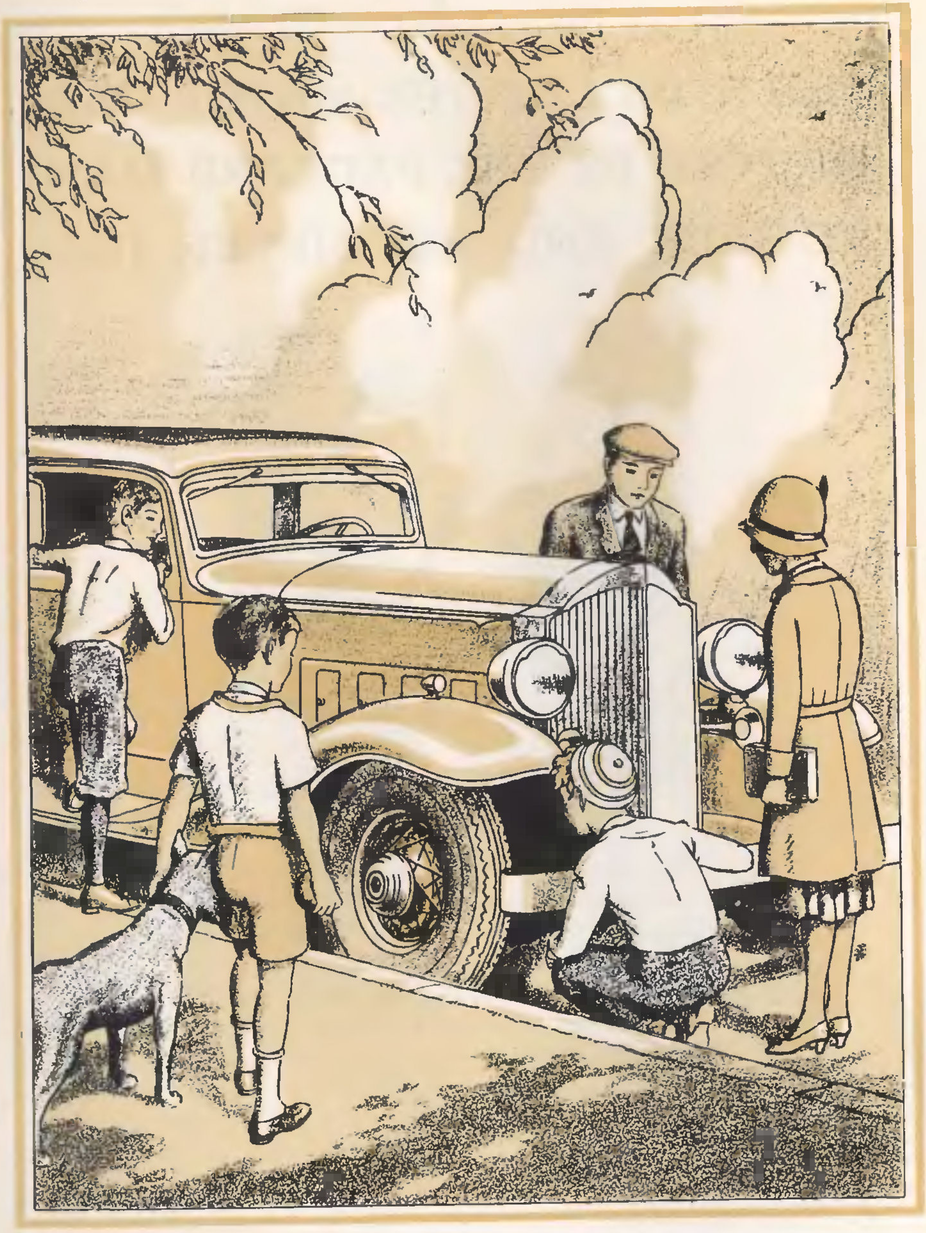
WITH JACK AND JILL IN MOTOR-CAR-LAND



THE STORY OF THE MOTOR CAR AS TOLD BY THE PACKARD MAN TO JACK AND HIS SISTER JILL

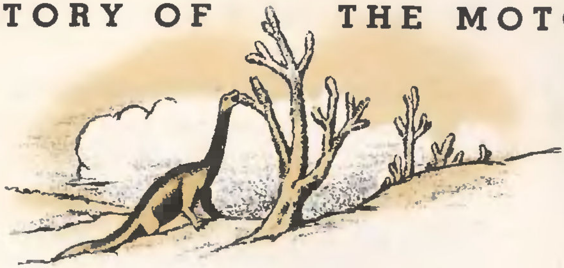


Not every boy and girl can sit down with a famous engineer, as did Jack and Jill, to learn all about motor cars. For that reason the story, just as Jack and Jill heard it, has been printed here so that you and other boys and girls, too, may learn how automobiles came to be made and what makes them go.



Everyone from childhood up is curious about motor cars. It seems that every boy and girl, as well as grown ups, admire Packard cars and want to know about them.

THE STORY OF THE MOTOR CAR



CHAPTER I: *First We Had to Have Gasoline*

A LONG time ago, millions of years ago, great forests of trees and other vegetation covered the earth in such places as are now the states of Pennsylvania, Ohio, Texas, California, Oklahoma, Michigan and other parts of the world also, such as Roumania and Mexico, some parts of South America, and many others including probably a great number we don't yet know about.

There were no saw mills in those days to cut the trees up into lumber because there weren't any people on the earth then. The trees themselves were not much like those we have today. The other vegetation, too, was different. There were ferns, perhaps as tall as great oaks. There were palms, strange giant flowers and other tremendous plants. All of this plant life grew thicker than that of any tropical jungle today. The earth was warmer in those days and all plants grew faster and bigger.

Fearful beasts of tremendous size roamed through these great jungle-like forests. They had to be big to be able to reach up and nip off the leaves of the trees for food. Most of them, too, had long necks so they could reach farther. Anyone who has been in a natural history museum knows what some of them must have looked like because in such museums are shown reproductions of such animals as the dinosaur. Besides these great creatures there were also the mighty brontosaurus—the thunder lizards which roared like thunder—and many thousands of other kinds equally as big. They over-ran the world.

The earth, which still more millions of years ago had started as a great molten mass, kept cooling off more and more. The climates changed. The food supply for the great beasts grew short and they died.

Glaciers of the ice age helped bury the materials from which petroleum was made.

The trees and the plants of course, through many thousands of years, had been shedding their leaves. The leaves kept falling to the ground like leaves do now. The trees themselves and the other plants also kept falling and new ones kept growing up.

It made a great mass of decaying vegetation on the ground that kept growing deeper and deeper until finally in some places it was hundreds of feet deep. The bodies of untold millions of animals were added to this mass as they died.

Some scientists believe that the water of the lakes or oceans washed in sand and dirt and covered over the bodies of the animals and the great carpet of decaying vegetation that covered the ground. Some of them believe, also, that millions of fish and untold billions and billions of little bugs that lived in the water were added to the mass.

As the earth kept growing cooler the hard crust cracked in many places and let forth great streams of melted rock, just like volcanoes sometimes today pour out molten lava. This rock, melted by the tremendous heat deep down in the earth, just like iron ore in a blast furnace, still further covered the plants and trees, burying them deep with the bodies of the dinosauria (that's the plural of dinosaur, by the way), the thunder lizards and other animals.

Along came great masses of ice sliding down from the North Pole. They were giant glaciers of the ice age you learn about in high school. They covered everything again, burying all the old vegetation still deeper with the earth and rocks they shoved along ahead of themselves. The world changed and still more layers of earth were added. It locked the old vegetation in the ground, in some places thousands of feet deep.

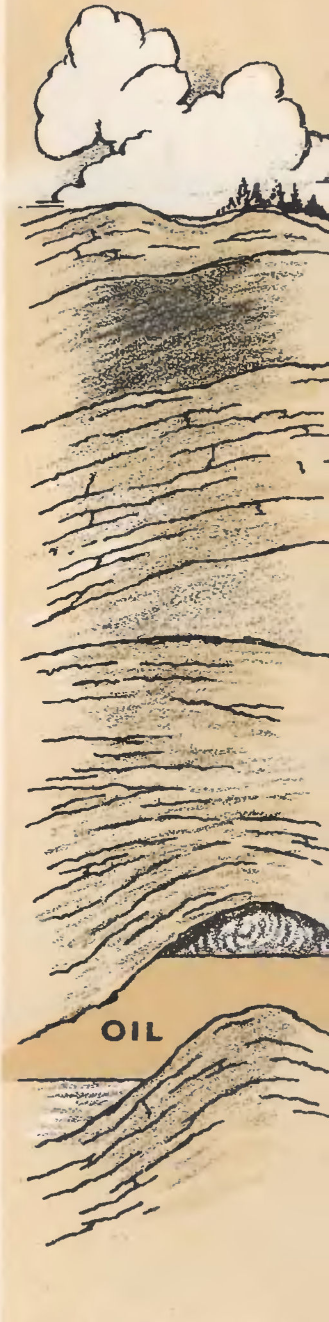
The weight of the earth under which it had been buried put a terrific pressure on the great mass of fallen vegetation sealed up tightly deep down in the ground. At the same time great heat from the hot center of the earth was also applied. The trees, grass, ferns and other things were cooked in their air-tight oven for millions of years.

Baked in its tremendous oven, the great dish is believed finally to have been turned into coal and petroleum. It is thought by scientists that heat came to the earth from the sun to make the trees, ferns and other vegetation grow and that the baking and pressure preserved this heat in the form of coal and oil, so that we today could use it to keep us warm and to make all the power the world now needs for so many purposes.

Somebody must have known when the world was being made that people would need stoves and furnaces to keep them warm; that they would want power to make things run and that most everyone in the world would especially want automobiles in which to ride swiftly from one place to another on the surface of the earth. And then He must have started cooking this mammoth dish, just like mother, knowing the family is going to want strawberry jam in the winter, begins cooking and canning strawberries in summer.

At any rate when the cooking was completed, deep down in the earth was the coal for men to dig up today and the petroleum for them to pump out of the ground and convert into gasoline to drive the world's motor cars and do many other kinds of useful work.

Men now drill down into the ground, sometimes



Many layers of earth formed a lid for the cooking that gave the world gasoline.

Men drill thousands of feet down into the earth to obtain crude oil.

several thousand feet, to obtain this petroleum, or crude oil. It is pumped from these deep wells and then sent sometimes thousands of miles through pipes to great refineries where it is treated with heat to convert it into automobile fuel.

People knew about petroleum as long ago as the days when the Tower of Babel was being built in Babylon. It was used in making cement for the Tower. It wasn't thought to be of any value for any other purpose, however, until Roman times. Then it was found floating around as scum on the water of small lakes. Romans discovered it would burn and it was used in lamps. Nero might even have seen the music for his fiddle by the light made by one of these oil lamps. However, petroleum gives off an oily odor when it burns and people didn't like that very much. It smelled up the whole house when Romans burned oil in their homes for light.

Back in 1635, settlers in Pennsylvania dug wells into which petroleum seeped from the surrounding rocks. The oil was scooped up out of the wells and used principally as a medicine. Mother will tell you it still is used for many medicines. Maybe you can remember yourself sometime when you burned a finger and mother put oil or petroleum salve on it.

Early Pennsylvania people also thought the odor of burning crude oil offensive and while they knew it would burn they refused to use it for lighting their homes. They preferred home-made candles.

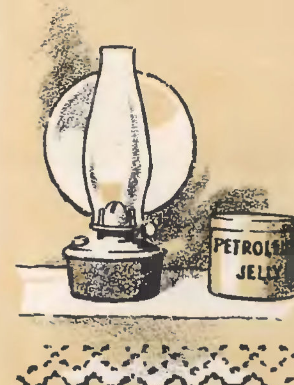
More than 200 years later in 1853, only ten years before the Civil War, it was suggested that petroleum might be of real service as a lubricant, for oiling machinery and such things. That was when oil refining started.

Besides medicines, good lubricating oil was obtained through distilling petroleum.

It was found just a short time later that a thin, almost colorless liquid, also obtained from refining the petroleum, made a satisfactory light when burned in lamps with a wick. This liquid was called coal oil because at that time it was thought petroleum was a sort of first cousin to coal. One of the difficulties about it was that it seeped through most any kind of a can it was put in. This trouble was ended with the use of glass cans. About every home then had lamps throughout the house and in the woodshed or cellar was a tin, jug-shaped affair which had a glass jug inside the tin and a spout from which the oil could be poured into lamps.

The lamps in which the oil was burned were the kind that grandfather used for light when he studied his lessons at home. In those days people couldn't just walk into a room, turn a switch on the wall and have lights. The lamps had wicks made of cotton that had to be trimmed every night with the scissors to cut away the burned part of the cloth. And before anyone could have a light in the house a lighted match had to be touched to the wick of the lamp. If you didn't have a match you didn't get a light.

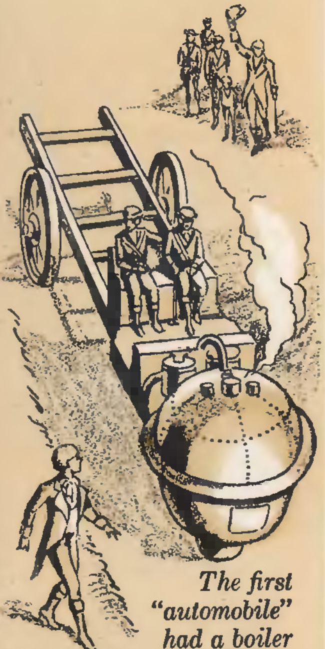
The oil was still further refined in trying to get rid of some of the offensive smell which still clung to it and in doing this naphtha or gasoline was made. However, it was thought to be of no value and there was much trouble experienced in disposing of it. It used to be carried on barges out into the ocean and dumped overboard. Now, as everyone knows, the gasoline is valuable and there isn't much use for the coal oil, or kerosene as it is now called.



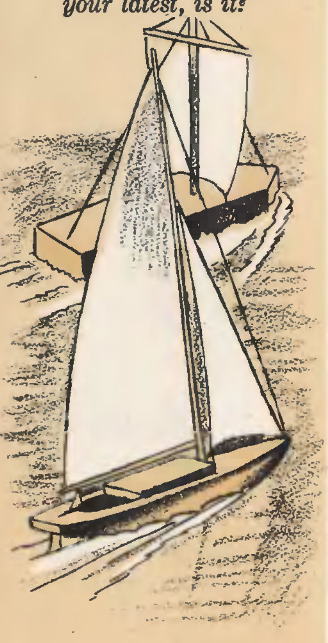
Petroleum in your grandfather's day was used only to make medicines and oil for lamps.

Ask dad if he remembers coal oil cans with potato stoppers on the spouts.

Gasoline once was thought worthless. It was hauled out to sea and dumped.



The first "automobile" had a boiler like a kettle. It was a crude affair. All new things are like that. Constant striving makes them better. Remember your first boat? Not much like your latest, is it?



CHAPTER II: *The Grandfathers of Automobiles*

Some years before this over in Europe a number of men had been working on carriages which could be run with engines instead of horses. Three or four big wooden-wheeled wagons had been built with steam engines to drive them. They had big boilers which burned coal to make the steam for the crude engines.

Such heavy, cumbersome affairs shook the houses when they chugged along the road at a mile or two an hour, spitting flames and smoke from the smoke stacks. They scared not only the horses, dogs and other animals but they also frightened the people.

Most people didn't think they were very practical because they couldn't move fast and besides that, they were all the time breaking down and being hauled off the road by horses. They were important, though, for they became the grandfathers of the locomotives that haul passenger and freight trains on all railroads today.

These old wagons with their queer steam engines also were the first automobiles. However, they were not the kind of automobiles anyone would like to ride in now unless just for the fun of it. They were crude, just like everything else is at first. Everything today probably is different than it was when it was first made by the inventors—the men, dad can tell you, who are the first ones to make something that was never made before.

You know yourself the kite, or the sail boat or anything else you might make today, would look far better than the one you made when you were just a young boy in the first grade. That's what is meant by development. Men make things that are crude. The next ones they make are a little better and they keep on making the same things until they are so much better they cause the first ones to look funny by comparison.

There was a long time during which man continued to use horses and buggies for traveling short distances, while the locomotives were improved more and more for the railroads to carry people between towns and cities. The old steam engines were made better and this made travel on the railroads better and people could go greater distances.

This improvement in the steam engines for railroads, steam boats and for many other things was so great that men got to thinking again about using them in self-propelled carriages. So carriages once more were fitted with boilers and engines, only this time oil was used instead of coal for the boilers. This fresh attempt to make steam horseless carriages wasn't very successful. Several of them were built but everyone thought some kind of an engine better fitted for the work than a steam engine would be necessary before people could ride around the streets without horses to pull them.

Inventors and many other people in America and many countries of Europe were trying to make such a new kind of engine. Gasoline had been thought of by many in connection with these efforts to find a new method of generating power.

Everyone knew that heat will make power. They had known for a long time that heat will cause anything to expand. It was used to make water expand into steam and this expansion, when confined in boilers, produced pressure to drive a piston up and down in the cylinder of a steam engine.

Gasoline was considered as a possible source of power because inventors knew that it would burn with an intense heat. It was known also that it would explode,

For a time man forgot about horseless carriages but he continued to improve locomotives. This engine from Civil War days burned wood under its boiler.

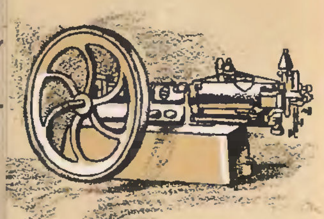
James Watt studied his mother's tea kettle and discovered the power of steam.

Air, expanded through heat from burning gasoline, ran the old-time naphtha launches.

if set on fire while bottled up in some kind of container.

Hot air engines were tried. They ran like steam engines on air expanded by the heat created by burning naphtha which, you remember, was what gasoline was first named. This kind of engine proved of no value for a horseless carriage although it was used a lot for running small boats. Grandfather and perhaps even dad can tell you about the old naphtha launches.

Finally a man by the name of Brayton in the United States and a Doctor Otto in Germany succeeded in making engines run by burning, or exploding, gasoline in their cylinders. This was the start of the gasoline engine. It marked man's discovery of a way to make great use of the bottled up petroleum which Somebody put into the earth in storage many millions of years ago in preparation for the time when everyone in the world would want to ride around in automobiles.



Dr. Otto's first gasoline engine. It was the grandfather of the world's automobile motors.

Of course, it wasn't exactly a simple matter to build the first gasoline engine.

There had to be some way to mix the gasoline with oxygen which would let it burn. Then the gasoline and oxygen, or air, had to be confined in a cylinder with a piston or some kind of an arrangement for utilizing the heat and then before each burning, or explosion, occurred there had to be some way of setting fire to the gasoline.

This last part of the job was the hardest to figure out. However, some time before, electricity had been discovered and it was known that electricity could be made to cause a spark of intense heat.

An electric spark is the "match" which sets fire to the mixture of gasoline and air.

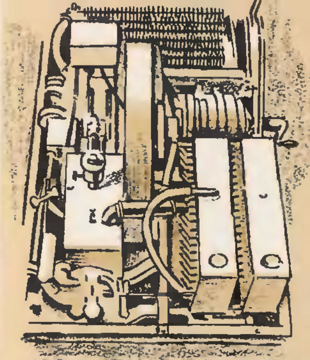
This was as important in bringing about today's automobiles as the discovery of petroleum. There wouldn't be any automobiles if there wasn't such a thing as electricity, for it is electricity which provides the "lighted match" to set the gasoline to burning, or explodes it.

The engines of Doctor Otto and Mr. Brayton were not much like automobile engines today and for that matter neither was the first engine Mr. Packard built way back in 1899. These engines would be most amusing by comparison, for instance, if placed alongside the engine of one of the latest Packard cars or set up in Gar Wood's *Miss America X* beside one of the great 1600 horsepower Packard motors that drive the first boat that ever went more than two miles a minute.

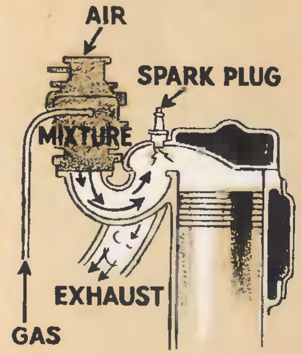
The theory of the engines, however, is the same, just as the principle of the first steam carriage that ever turned a wheel is the same as that of the most modern railroad locomotive.

The principle of it is really very simple. Gasoline from a tank is fed into a cylinder with air in just the right amount to burn, or explode. This mixture of gasoline and oxygen, or air, is compressed by a piston shoving it up against the top of the cylinder. The mixture is ignited by an electric spark after it is compressed. When it explodes it expands into many times its original volume. The wall and top of the cylinder can't move to make room for this expansion but a movable piston which forms the bottom can move. This piston is forced down. By means of a connecting rod fastened to it, the piston, in descending to make room in the cylinder for the expanding gas, turns a crank just like one's foot, through power generated by the muscles of the leg, turns the pedal of a bicycle. A boy on a bicycle is like a two-cylinder engine. Each leg is a connecting rod.

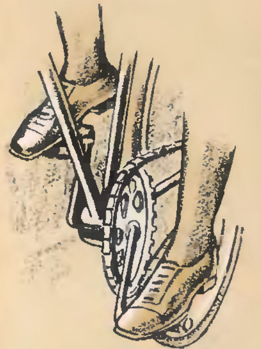
Thus power generated by the heat created through the gasoline burning in the engine cylinder is harnessed up so that it can be transferred to the wheels of the car and make them turn.



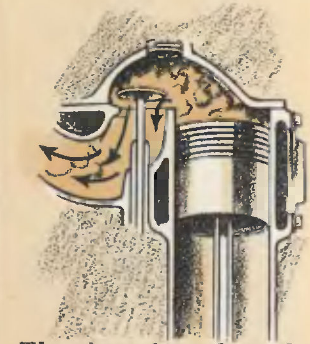
In the engine of the first Packard car, crude as it now looks, first appeared many features used now on all automobile engines.



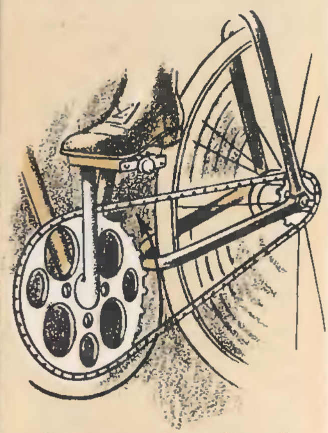
The simple principle of the gasoline engine: air and gasoline compressed in a cylinder, a spark and a piston do the work.



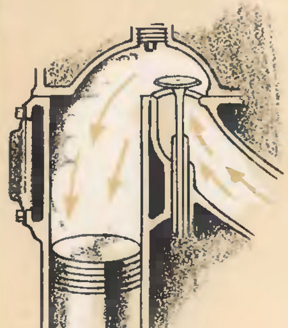
A boy on a bicycle might represent a two cylinder engine. Each leg is a "connecting rod."



The piston forces burned gases out of the cylinder through an open valve.



Momentum carries the piston up like a boy's foot on a bicycle pedal.



This illustrates how an engine "breathes in" air and gasoline vapor.

After an explosion occurs there must, of course, be some way to get the burned gases, or smoke, out of the cylinder so that a fresh charge of gasoline and air can be gotten in for the next explosion. The force of the explosion sends the piston down so hard that momentum carries it back up in much the same manner that one's foot on the pedal of a bicycle comes back up to complete the circle in pedaling a bicycle. As the piston rises in the cylinder it forces the burned gases out through a valve which opens just at the right time to let the gas escape.

CHAPTER III: *Engines Breathe Just Like People*

This operation in a gasoline engine is much the same as that of a human being breathing. Just like a human, a motor must "breathe" to "live."

A human doesn't have to hurry much in his breathing, except when he is running or otherwise indulging in hard exercise. Even then his breathing, by comparison with a gasoline engine, is slow. Man breathes by vacuum. The muscles of his chest, by contracting, expel the used air from his lungs. The muscles then expand, creating a partial vacuum. Fresh air rushes in to fill the vacuum, which completes man's breathing operation.

An automobile engine's breathing is more complicated. The reason is because it is so much faster. A human being breathes about 18 times a minute. However, the engine of an automobile like the Packard Twelve, for instance, takes 24,000 breaths a minute when the automobile is going 80 miles an hour.

In the automobile engine the piston comes up and forces out the dead air, or exhaust gas. Then the piston goes down and in descending, creates a partial vacuum. Air rushes in to fill this vacuum, picking up gasoline vapor on the way as it passes through the carburetor.

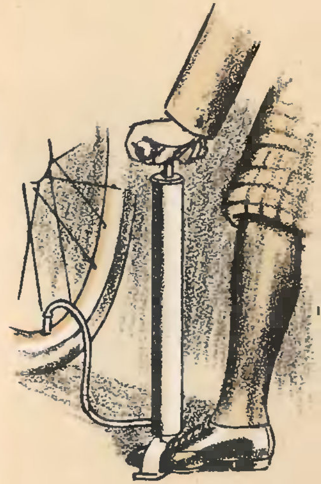
After the piston has reached the bottom of the cylinder and completed the job of sucking air and gasoline in, just like sucking an ice cream soda into one's mouth through a straw, it goes back up and compresses the air and gasoline vapor just like a plunger in a bicycle pump compresses air in the pump cylinder when it is shoved down in the cylinder, only in this case the plunger or piston crowds the air up against the top of the cylinder into a very small space.

Just at exactly the right time a current of electricity is released into a spark plug and causes a spark to jump across a gap in the plug. This spark sets fire to the gasoline, exploding it with a force that sends the piston down on its power making stroke.

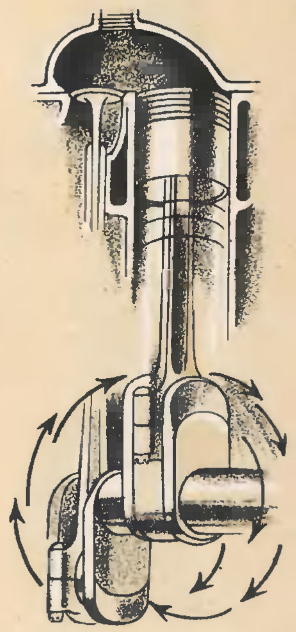
Thus it will be clear that there is an explosion in each cylinder of a gasoline engine for every other revolution of the crankshaft to which the pistons are fastened through the connecting rods. In an eight-cylinder engine, therefore, there are four explosions for every revolution of the crankshaft and in a twelve-cylinder motor there are six explosions. The crankshaft keeps turning around from the force of these explosions and this turning motion is transferred to the wheels of the car.

With the car it is driving going at top speed, a twelve-cylinder engine's crankshaft revolves about 4,000 times a minute. Therefore, there are 24,000 explosions a minute in the engine, or 400 per second.

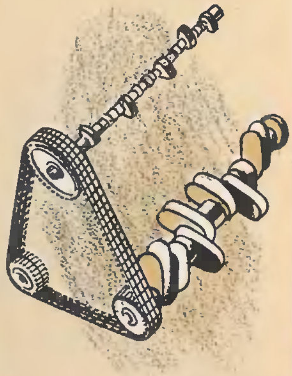
There are not many things in the world in which there is so much real activity as in a modern automobile engine running at wide open throttle. Nearly every operating part moves at terrific speed and yet all must be in perfect unison. If one were to travel too fast or too slow by even the tiniest part of a second, plenty of trouble would result.



The piston compresses air and gasoline mixture like the action of a bicycle pump.

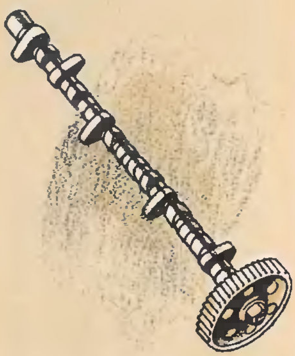


Everything hurries in a motor. The crankshaft often revolves 4000 times a minute.



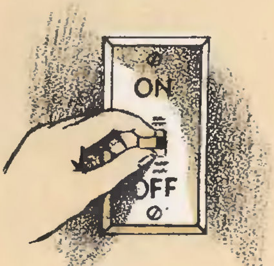
The crankshaft, like a watch mainspring, is the master timing unit.

Timing of the movements of all parts of the engine runs back directly or indirectly to the crankshaft just as the timing of all the wheels and gears which make the hands on a watch travel at exactly the right speed runs back to the main spring. A gear, or toothed wheel on the front end of the crankshaft is used to drive, through a chain or set of gears, another shaft known as the camshaft. This latter shaft is used for the direct driving of many of the operating units which must be kept in perfect time with each other.



Knob-like projections on the camshaft make the valves work.

Knob-like projections extend all along the camshaft. When the shaft turns, these knobs, as they come around to the upper side, raise the valves which open to let gasoline and air into the cylinders, close to let the piston compress the mixture of gasoline and air and open to let out the exhaust. Each knob on the camshaft is placed in exactly the right spot to open its particular valve at exactly the right time.



Electric switches in a motor frequently click on and off 24,000 times a minute.

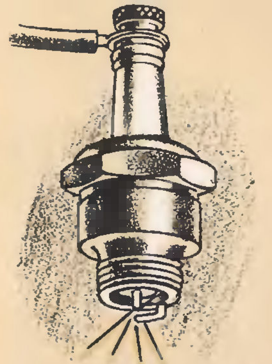
A gear on the camshaft drives what is known as the distributor. This is the central switchboard of the electric power plant which is a part of the engine and which provides the electric spark to set off the explosions in the cylinders. Electricity is carried by cables from the battery to the distributor. Here what are known as breaker points keep opening and closing the electric circuit just like an electric switch on the wall of a house can be made to turn the current for electric lights on and off. Only in the automobile distributor the switch is turned 24,000 times a minute when a 12-cylinder motor's crankshaft is revolving 4,000 times a minute.

Just at the instant the "switch" is operated, a revolving piece in the top of the distributor completes a circuit running to a spark plug from one side of the "switch" or breaker point so there are really two switches in the distributor. At exactly the right time both switches are operated and the electric spark rushes through to the spark plug. In that part of the plug extending into the cylinder the electricity finds a break in the wire, a gap about 25 one-thousandths of an inch wide. It leaps across this gap and as it does so it makes a flash of hot flame. This sets fire to the gasoline.

Electricity is queer stuff. There are many things about it that no one yet knows fully. When it goes out from the place where it is made or the battery where it is stored, it is always in a great hurry to get back home. Some people believe it won't even venture out unless it knows it can get back.

If you will look at the electric light wires running into your home you will see there are at least two of them. One of them carries the electricity into the house and the other is the "track" on which it runs back to the power house after it has done its job of making lights or browning the breakfast toast. Sometimes there are three wires running into a house, the extra one being used to carry in a heavier current for such things as electric irons or electric stoves. Perhaps you will notice only one wire for the street cars but that doesn't mean the electricity doesn't get back to the power house just the same after making the street car wheels go around. It returns through the rails the cars run on, getting to the rails through the steel wheels.

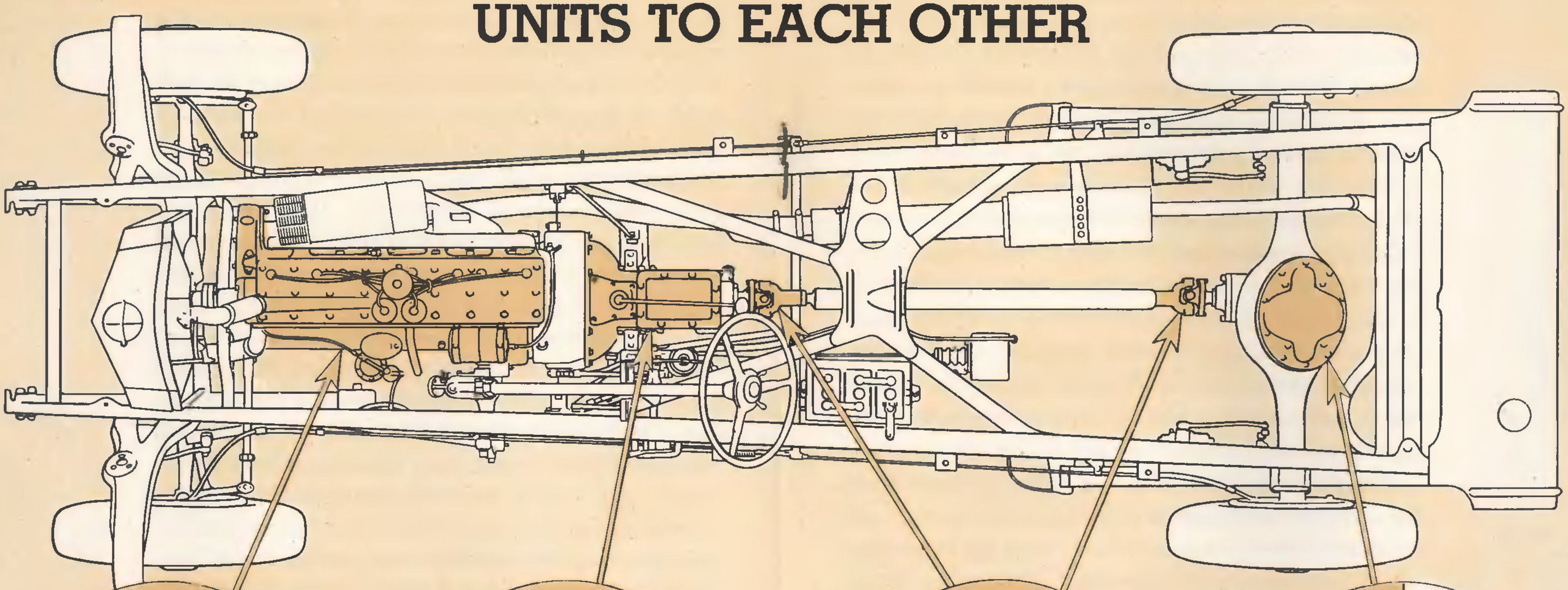
Electricity in an automobile goes out over wires from the battery in which it has been stored up for future use after being made by the generator. After it has completed its work of making the sparks in the cylinders or caused the lights to operate, it gets back to the battery or to the generator through the steel frame of the car. It travels at a speed of 11,160,000 miles a minute.

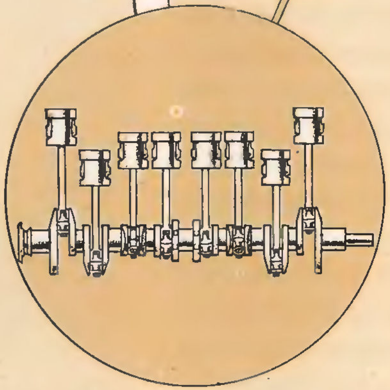


The spark plug causes electric sparks to set off the explosions.

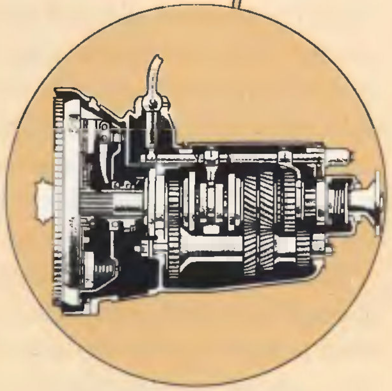
Electricity has to have a clear road back home before it will venture out.

THE PACKARD CHASSIS AND RELATION OF ITS OPERATING UNITS TO EACH OTHER

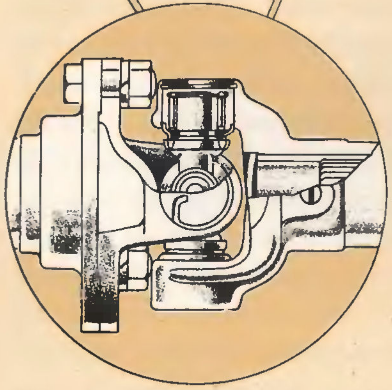




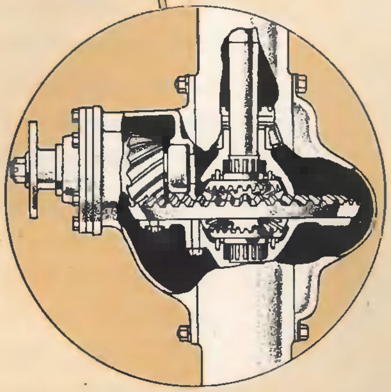
The crankshaft, pistons and connecting rods inside the motor.



Transmission, flywheel and clutch, showing quietly operating gears.

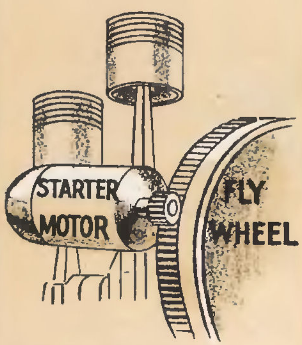


Universal joints; one at each end of drive shaft.



The differential and other rear axle gears and shaft.

Switches have to be "thrown" exactly on time to give the electricity clear tracks to all of the spark plugs.

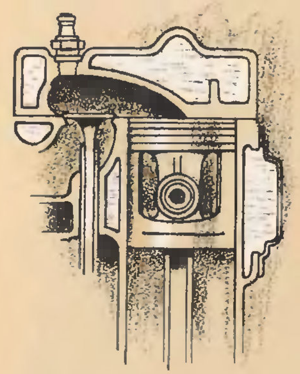


The starter uses electricity from the battery to set the motor of an automobile running. It works on the fly wheel.

Keeping in mind this speed at which the electricity travels, it might help one to realize the job done by the automobile distributor if we were to consider a railroad passenger train rushing along the rails at 60 miles an hour. While it is going at a snail's pace as compared with the speed of the electric current, the railroad men take no chances with any switches in the track ahead of the train. They are closed long in advance of the time when the train is due. Of course if one of these switches was not closed on time to make a clear track for the train the result would be a wreck. In an automobile two of the "switches" have to be set to give a clear track from the battery to the spark plugs, for the electricity shooting along at the same speed as that at which light travels. And this has to be done 24,000 times a minute for each "switch."

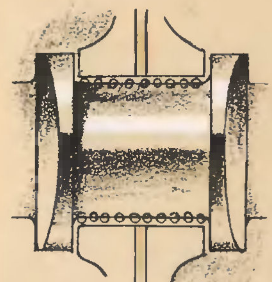
The whole electric system of a car is just like a plant for supplying electricity to a city, only, of course, much smaller. There is a dynamo to create the electricity, which is known as the generator. Then there is the wiring system which carries electricity to the lights and to the spark plugs and there is a storage battery which stores electricity made in excess of that needed for running the car. Electricity in this battery is needed to operate a starting motor to set the engine in motion, for of course there can be no electricity made by the generator unless the motor is operated to run it.

Naturally, with all the explosions going on inside an engine it gets hot. There is more heat generated by the burning gasoline than can be converted into power. There has to be some way, therefore, of getting rid of this excess heat. This is done by circulating water around the outside of the cylinders in a water tight space provided for it. The water picks up heat from the hot metal of the cylinders and since the water is constantly in circulation, it carries the heat along with it to the radiator. Cool air passing through the radiator around small pipes through which the hot water is circulating, cools the water so that it can return and carry more heat away from the cylinders.



Water circulating around the cylinders carries away excess heat.

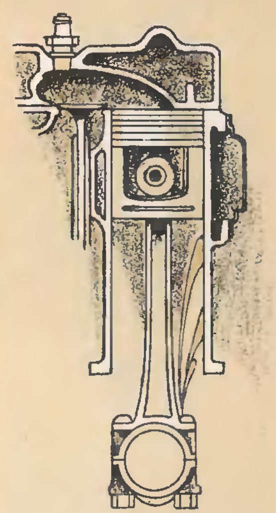
Because many parts of an engine rub against each other at such high speed, oil is an important problem in a motor. Oil acts as a cushion against two rubbing surfaces just, like a lot of tiny balls of fat, keeping them from actually touching each other and thus reducing friction. Every moving part of an engine must have a constant supply of oil or it would wear out quickly.



Like little balls of fat, lubricating oil keeps the rubbing surfaces apart.

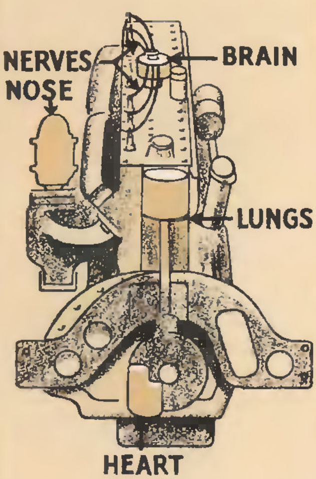
Pipes carry oil all through the engine from a pump. In a Packard engine oil is sent under heavy pressure into holes drilled through the crankshaft. This oil lubricates the shaft bearings and squirts into holes drilled lengthwise through the connecting rods. Oil is carried through the rods to the piston pins which hinge the pistons to the rods. There is a space of only one ten-thousandth of an inch between the piston pins and the bronze bushings in which they fit. A film of oil one ten-thousandth of an inch thick fills up this space.

One of the biggest oiling problems in gasoline engines is the lubrication of the cylinder walls. There has to be a film of oil between the pistons and the cylinder walls to prevent wear. Every time the piston goes down, however, flames from the burning gasoline burn off the oil on the walls. This complicates the problem. In the engines of Packard cars a jet of oil, just like a stream of water



In Packard cars oil is sprayed on cylinder walls, greatly reducing wear.

The action of a carburetor is much like that of sister's or mother's perfume atomizer.



An automobile motor has what might be called a brain, nerves, nose, lungs and heart.

shot from a squirt gun, is thrown onto the walls of every cylinder at every revolution of the crankshaft. This keeps wear to the minimum.

The carburetor of an engine might be called the motor's nose. It is the thing with which the engine breathes. Air sucked into the cylinders rushes through the carburetor as fast as 74 miles an hour. The rush of air picks up fine particles of gasoline from spray nozzles and carries them along just like the air from a rubber bulb picks up fine particles of perfume in the perfume atomizer on mother's or sister's dressing table.

Just as the carburetor might be called the engine's nose, the whole engine might be likened in many ways to the human body. The distributor could be called the engine's brain and the wires to the spark plugs the nerves. The oil pump is the heart that sends life giving oil, just like blood through a system of "arteries" all through the engine. The cylinders are the lungs into which oxygen is sucked to give the motor life.

To make the automobile move over the ground there must be, of course, some means of transferring to the wheels the power which has been developed in the cylinders and conveyed to the crankshaft.

This is not such a simple task because of the fact that the engine must be operating to develop any power at all.

The power of a steam engine is generated outside of the cylinder—in the boiler where the steam is generated. Power in a steam locomotive, therefore, can be applied directly to the driving wheels with the locomotive at rest.

The power of a gasoline engine, on the other hand, is developed in the cylinder. The engine of an automobile must be started and then there must be a wait sufficient for the engine to get going fast enough to develop enough power to move the automobile. Because of this, there must be a means of engaging or disengaging the application of power from the engine to the wheels and also of applying the power gradually.

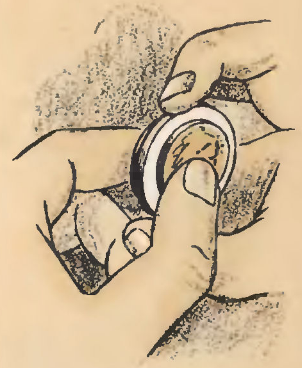
The automobile is, therefore, provided with a clutch. Here might be a good way to understand the action of the clutch. Hold two smooth pennies with a nickel between them between a thumb and forefinger. Press lightly with the thumb and finger against each penny and it will be found that the nickel can be turned around freely. Press heavily and it will be found that turning the nickel will turn the pennies too.

Friction does this. As the pressure of the fingers makes more friction between the nickel and pennies, all are held tightly together so that they will turn together.

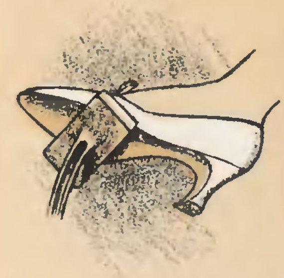
The automobile clutch works this same way. Powerful springs press two friction surfaces so tightly together that they turn as one piece. At the same time they can slip against each other a little and so they let the power of the engine be applied gradually. A light touch of the foot on a clutch pedal in the car compresses the springs and holds the two surfaces apart so that the engine can run freely.

One of these friction surfaces of the clutch is fastened to the fly wheel which is bolted to the end of the crankshaft. The other is fastened to a short shaft which runs in a gear box, or the car transmission. Through this second friction surface the power is carried through the transmission and thence on back to the wheels. There are, however, several important details on the way.

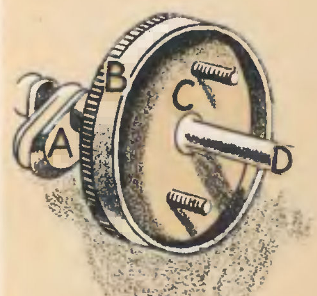
First is the transmission. It is sometimes called the arithmetic box because it multiplies or divides the speed of the car's wheels. Because the engine must run fast to develop its greatest power and because great power sometimes is needed when the car



How a clutch works. Two smooth pennies and a nickel show the action.



Light pressure of a foot compresses springs and separates friction surfaces of the clutch.



The principle of the clutch. A is the crankshaft, B is the flywheel, C the clutch friction plate and D sends power to the transmission.

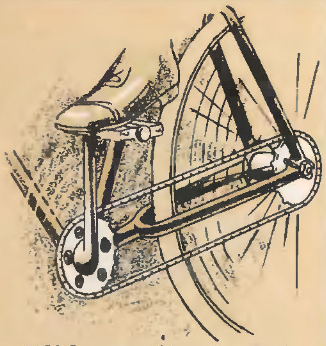
is running slowly, there has to be some way of allowing the engine to run at a faster speed while starting the car in motion, for instance, or in climbing steep hills. This is done by the gearing in the transmission.

As the speed of the car increases, the reduction—or "dividing"—gearing between the engine and the rear wheels can be changed through shifting the transmission gears until the point is reached where the engine is moving fast enough so that it can develop enough power to propel the car when directly geared to the rear axle.

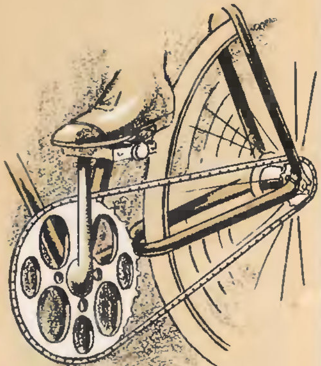
An idea of how this works out might be gained perhaps by considering the gearing of a bicycle. The bigger the bicycle sprocket wheel—the wheel driving the chain at the pedals—the higher the gear, if the cog wheel on the rear wheel remains unchanged. The higher the gear the harder it is to climb a hill and the slower the feet move in pedaling while riding.

The bicycle rider would have things much easier if he could change to a low gear when climbing hills, or trying to gather speed for a quick sprint.

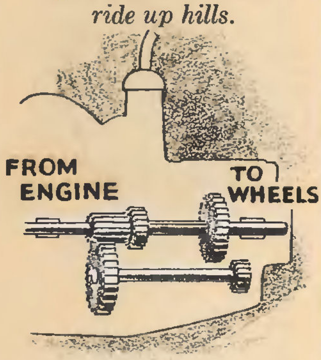
With a bicycle, the rider is the engine. He can develop power without regard to the speed with which he makes his legs go and, because he does not have to make his feet go around fast to develop his greatest power, the gearing makes the rear wheel go faster than his feet. He doesn't need a clutch, either, because he can apply his power to the rear wheel of the bicycle gradually. On the other hand, the motorcycle is more like an automobile in this and many other ways.



With a small front sprocket, the rider's feet must move rapidly. This would represent low gear on a bicycle.



A large front sprocket allows the feet to move more slowly. This high geared bicycle would be hard to ride up hills.



This illustrates the principle of the automobile transmission gears. High, or direct drive, is pictured.

CHAPTER IV: *How Power Goes to the Wheels*

After the power from the engine gets through the transmission the next problem is caused by the fact that the rear axle is constantly jumping up and down as it goes over bumps in the road while the engine remains in a fixed position. Therefore, there has to be a universal joint in the shaft that carries the power to the rear axle and wheels. The shaft has to bend up and down and, of course, because it is steel, it couldn't do this if there were just a straight rigid piece of steel extending from the transmission to the axle.

The universal joint makes a flexible coupling in the driving shaft that lets it bend, although it keeps on turning under the power coming from the engine.

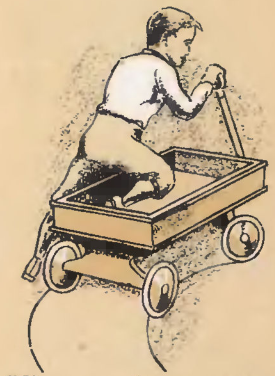
After the power from the engine has traveled through the clutch, the transmission, universal joint and driveshaft to the rear axle, about the last big problem of making the wheels go around is met. It lies in the fact that when two wheels on a single axle go around a corner one of them, the outside one, has to travel farther and therefore has to go faster.

In an old-fashioned wagon or buggy the wheels were just dragged along by the horses and for that reason could be attached to the axle in such manner that they were free to turn independently of each other. Therefore one wheel could go faster than the other in turning a corner. The same thing is true of any boy's express wagon in the way its wheels turn a corner.

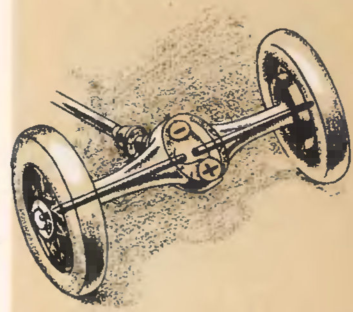
In an automobile, however, the wheels have to be turned by the axle shafts, these shafts obtaining their power from the driveshaft. Of course, if there were a single shaft to which both rear wheels were fastened, both wheels would always be turned at the same speed.

There has to be what is called a differential in the rear axle of the automobile. It is called a differential because it makes up for the difference in speed of the two wheels in making a turn, allowing one of them to run enough faster than the other to cover the greater distance.

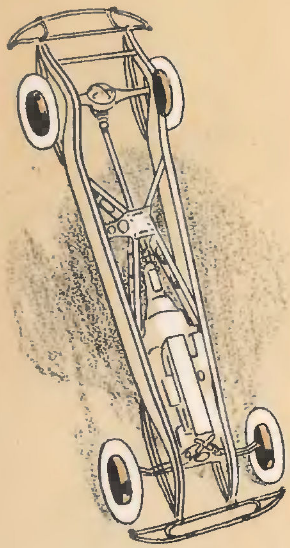
Universal joints, like links of a chain, allow a shaft to turn when "bent."



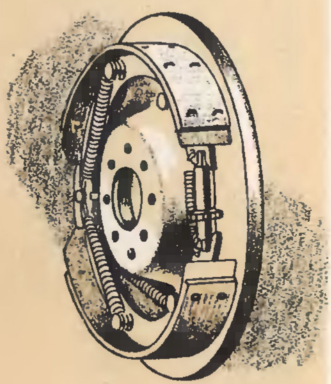
When turning a corner the outside wheel must go farther, therefore faster.



The differential subtracts speed from one wheel and adds it to the other.



Because automobiles can go fast, brakes must be powerful and reliable. There is one on each wheel.



Brake shoes are forced tightly against inside rims of iron and steel drums, causing friction which stops the car.

The differential might be called an arithmetic device, just like the transmission. Only the differential subtracts and adds. It subtracts speed from one rear wheel of a car and adds it to the other when one wheel wants to go slower than the other, as in turning a corner.

Of course, it is just as necessary to stop an automobile as it is to make it run. Because a car, like the biggest Packard for instance, weighs three tons and because it can easily go a mile and a half in a minute, it ordinarily would be a big job to stop it quickly. For that reason automobile brakes must be very powerful and they must be very reliable. Every boy who has a bicycle knows about brakes, of course. He knows how much easier it is to stop the wheel with a coaster brake than by back pedaling on a bicycle not equipped with coaster brakes.

On all four wheels of an automobile there are big steel and iron drums. They are like big frying pans with straight instead of slanting sides. Inside of these drums are the brake shoes which are like metal knuckles. At their ends are small pieces of steel that can be turned so they will pry the knuckles apart and so make them press hard against the inside rims of the brake drums. This pressure sets up such a friction or drag on the drums, that it stops the wheels to which the drums are fastened. Just to make it easier for the drivers, Packard cars are so equipped that vacuum power from the engine helps apply this pressure of the brake shoes, or knuckles, to the brake drums. That's the reason it's so easy to make a Packard stop quickly when you want it to.

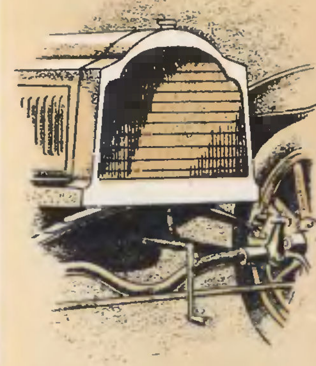
Appearance is a most important feature of today's automobile, just as is quietness of operation and comfort. So much study has been given to those points that it now is actually possible to obtain rest though driving out on the open highway. And everyone will declare that today's cars are better looking than ever before. They are much quieter while rolling along the road also. It is possible for two persons to hold a conversation without raising their voices in any degree while riding at top speed in a Packard car.

The Packard Motor Car Company has always felt a responsibility to protect the stability of the appearance of its cars even long after they have been in the hands of owners. This is the reason that it is not hard to recognize a Packard, no matter how many years old it might be, as it runs along the street.

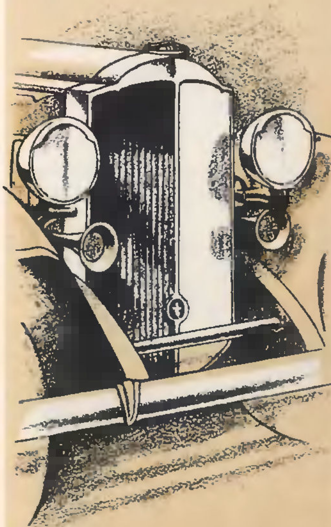
It was back in 1904 that the characteristic Packard hood and radiator lines, now well known throughout the world, were first created. They have been refined constantly since then but have always maintained their character. The Packards of today are, of course, much better looking than those of previous years but a 1904 Packard would be known anywhere today as a Packard.

This stability of appearance is what has made it possible for people to buy Packards and drive them much longer, making their cost less than that of lesser cars. They do not become obsolete in appearance. At the present time there are more than 250,000 Packards on the highways and more than $1,000,000,000 has been spent by people all over the world for Packard cars.

When a horse becomes tired and can't work very well any more, all that has to be done is to turn him out to pasture or give him a good rest in the barn with plenty of oats to eat. In a short time he is rested up and healthy again and he can work as well as ever.



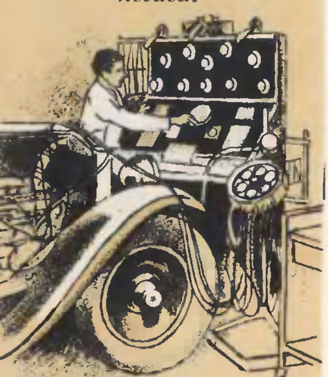
Packard protects stability of appearance of its cars. This was the car, made in 1904, in which the world-recognized Packard radiator lines first appeared.



The Packard radiator lines of today, refined and beautified but characteristically Packard.

Horses can repair tired muscles by resting in a pasture.

Motor cars must be cared for, so service stations are needed.



Packard uses scientific instruments to diagnose service troubles.

An automobile, however, cannot do this. When any part wears, the car itself has no way of building it up again. It can't rest its "tired muscles" like a horse. Then, too, some people are careless with automobiles. They forget about giving them enough oil or perhaps they are careless about driving and hit things. For this reason somebody has to take care of motor cars.

Great study has been given to the work of maintaining automobiles in the hands of the public. Cars are sold through branches of the automobile companies, through distributers and dealers. All maintain service stations where all work and adjustments to keep the cars operating properly can be made.

Mechanics and others who are employed in Packard service stations are trained by engineers and other experts of the Packard factory. A force of experts travels out from the Packard factory to give advice to the service men all over the country. The factory experts are constantly studying ways and methods of improving service work.

As a part of this effort to improve service the Packard company inaugurated a system by which nearly all service jobs on a car were standardized in both methods and cost. That means that a service adjustment on a car will be done in one place in just the same manner as it would be in another and the owner of the car knows in advance what the cost will be.

Just as with doctors in a hospital it is very necessary to have the troubles of a car diagnosed properly. It doesn't do a car any more good to have a service "doctor" say that what it needs is to have its valves ground when it really wants a new spark plug, than to have a doctor in a hospital decide a human patient has measles when pneumonia is the real trouble.

Because this is well known, Packard service stations have experts who scientifically diagnose the trouble when a car is not performing at its best. With the diagnosis made properly, the expert mechanics are able to do a better job and the owner of the car is sure its troubles are properly corrected.

Naturally, service work on a Packard is not needed much because of the fine way in which it is built. The first Packard was made in 1899 and ever since then the Packard company has been trying with all the skill and knowledge at its command to make its cars better. It's only natural that with an experience of 34 years Packard is able to build a fine car.

Not only in America has Packard always been regarded as the leader in the field of fine cars but it has been a favorite in foreign countries as well.

One well-known American writer who has spent much time abroad recently said that there are always two things for which he looks when traveling in foreign countries and which always make him feel good. They are the United States flag and the Packard car.

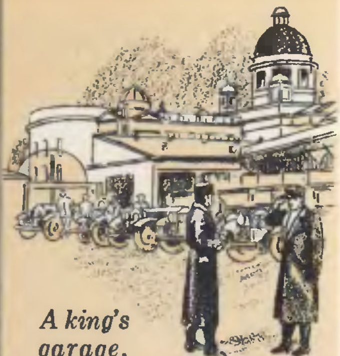
Packard cars are tested at the $1,500,000 Packard Proving Grounds where is located the world's fastest speedway.

CHAPTER V: *Elephants and Cars Go Together*

In out of the way places where there are not so many service stations Packards have always been favorites. As a matter of fact, Packard for a long time has exported more automobiles than all of the rest of the cars in its class combined.

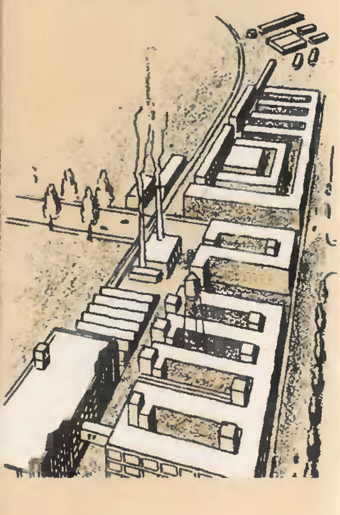
The writer who said he always looked for the Stars and Stripes and Packard cars said he thought Packards and elephants must go together in the "garages" of famous temples of India for, he explained, so many Rajahs have them both and use either one or the other when they want to go for a ride.

Elephants and Packards go together in many Rajahs' "garages".



A king's garage. Packards are favorites of royalty.

Eighty-one trades are represented in the mile-long Packard factory. Quality First is the watchword.



He was visiting a king one day, he said, and his majesty, after they had been talking only a short time, insisted on taking him out to the royal palace garage. There he found that all the king's cars, seven of them, were Packards. But that was nothing unusual for not only the king, the queen and the crown prince of another country drove Packard cars but all the members of the cabinet did also.

Probably many boys have thought of going into the automobile business when they grow up. There are plenty of opportunities for them, of course, for it is the largest manufacturing industry in the world today. Besides the great number of men who sell and service cars there are thousands engaged in the many different kinds of work of building them.

Just about every kind of work that could be imagined, for instance, has to be done in building a Packard car. There are 81 skilled trades represented in the Packard factory and about the only college-trained professions not represented would be dentists and ministers. At that, it wouldn't be difficult for any of several Packard men to preach a good sermon and one of the doctors in the hospital probably could pull a tooth.

The Packard factory in Detroit is more than a mile long and contains nearly 4,000,000 square feet of floor space. Even if you were back in the third grade you would know this is bigger in area than a large farm. It is a plant equipped with both men and machines that could make anything from a boy's musical top to a railroad locomotive.

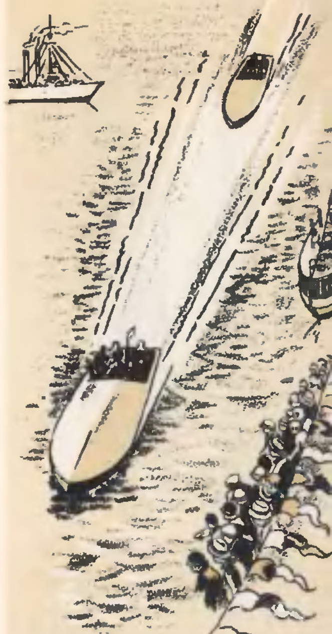
Often-times Packard has been called upon to perform tasks which apparently could be done by no one else in this country. Designing and building the engines for Gar Wood's wonderful racing boats that travel more than 100 miles an hour is just one instance of this.

Mr. Wood each year has successfully defended the challenge of Europe for the famous Harmsworth trophy, one of the most historical trophies in the history of international sport. The races which Wood has won against England and France have been contests of the finest skill in boat and engine building of Europe against the finest engine and boat building of America.

The justly famous Rolls-Royce company has been called upon to build the engines to represent England in these great racing classics which have attracted as many as 600,000 spectators. America has relied on Packard for the motors with which Gar Wood upheld the prestige of American skilled workmanship and each year Wood and his Packard engines in the famous *Miss Americas* have been the winners.

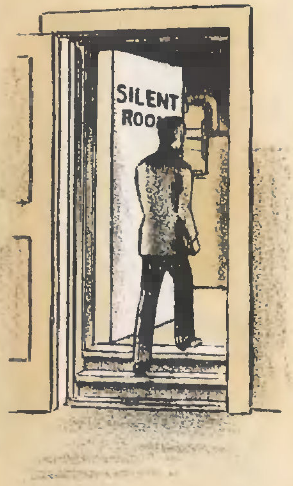
The engines of Mr. Wood's boats are, of course, not much like engines that drive automobiles. However, the same engineering skill and the same fine workmanship that goes into the making of the engines for the *Miss Americas* are employed in the designing and building of Packard cars. The men who do the work on Mr. Wood's engines work regularly at the fine task of building the Packard cars you see every day on the streets.

It is hard for some people to understand the need for the fine precision that goes into the building of a car such as the Packard. Often visitors at the Packard factories are amazed to learn of some of the precision instruments used. For instance, there are machines which measure noises in a car, just like the gas meter in the basement of your home registers the gas which goes through it. One man might say the engine of a car runs quietly while another might think it noisy. The acoustimeter, however, registers the exact volume of



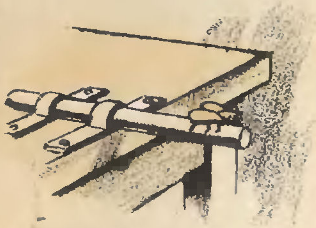
Year after year, in the world's greatest racing classic, Packard motors have maintained American supremacy against the world.

Packard engines in Gar Wood's Miss America X are three times as powerful as a modern passenger locomotive. They develop 6400 H. P.



No sound penetrates this Packard temple of silence and precision.

Packard uses an instrument that can measure one-millionth of an inch.



A fly's weight bends a steel bar one-millionth of an inch.

sound on a dial. It would be very easy for this machine to register the noise of a falling pin.

All of the bearings which go into a Packard car are tested with another sound recording instrument which is set up in a room that is absolutely sound proof. The walls, floor and ceiling of this room are 18 inches thick. They have 14 inches of earth packed in them to stop any noise from the outside. If any bearing is found in the test to be too noisy it is not allowed to go into the car. Of course, the better the bearing the less noise it makes while running. These tests insure that the best bearings only will be used.

And then Packard maintains a regular bureau of standards where all of the many thousands of gauges and testing devices are checked, some of the more delicate and finer ones daily. Here, there is an instrument which will actually measure one-millionth of an inch.

A millionth of an inch is so small a measurement that it is hard to appreciate just what it is. The scientist in charge of the Packard bureau of standards was asked to explain just how small it is.

"Well," he said, "Suppose you had a bar of the strongest steel one-half inch in diameter and suppose you anchored one end of this bar rigidly to a table allowing exactly six inches of the bar to extend beyond the table edge unsupported. And suppose a fly, just a common house fly, were to land on the extreme end of this bar. Well the weight of this fly would bend the bar one-millionth of an inch." "And," he added, "It would be easy for me to prove it."

The question is sometimes asked if it is really necessary to do such fine work in the building of an automobile. The answer might best be given by using the famous Packard slogan and saying "Ask the man who owns one." Because such precision goes into the building of Packards they can run longer and give less trouble when they go out on the streets and highways.

An automobile is expected to keep on running in all kinds of weather year after year and for many thousands of miles. Actually there are many Packard cars which have run hundreds of thousands of miles. The Pickwick Stage Company, of Los Angeles, California, had a Packard car which had run more than 1,000,000 miles. It is believed to have had the greatest mileage of any automobile in the world.

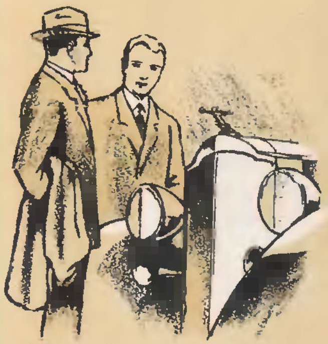
Motor cars to do this, to keep on being the pride of their owners and to give the maximum in comfort, ease of mind and performance, must be built as well as it is possible to make them. That is the way the Packard Motor Car Company tries to manufacture its cars.

Some day you are going to buy a car. We hope, regardless of what business you enter when you grow up, you will be successful and that you will be able to buy your first automobile quickly. Quite naturally, we hope your first car will be a Packard for then we know your others will be, too. You perhaps have noticed that when people once have Packards they continue to buy only Packards. We hope you will enjoy your Packard as much as we will enjoy making it for you.

And when you get your Packard we trust you will bring it to us, to a Packard service station, so that we may keep it always in perfect condition for you. This, too, we hope because, just as truly as we have said: "No one but Packard can build a Packard," no one can service a Packard as well as Packard.

When you get into your car and the simple pressing of a switch lets you, in luxurious comfort, dash away ten times faster than grandfather could go when he

A Packard car that travelled 1,000,000 miles. This is believed to be a world's record for automobiles.



Some day you too are going to buy a new Packard automobile.

We, better than anyone else, can keep your Packard perfect.

Packard cars "happened" way back in 1899 because two young men thought they could build a better car.

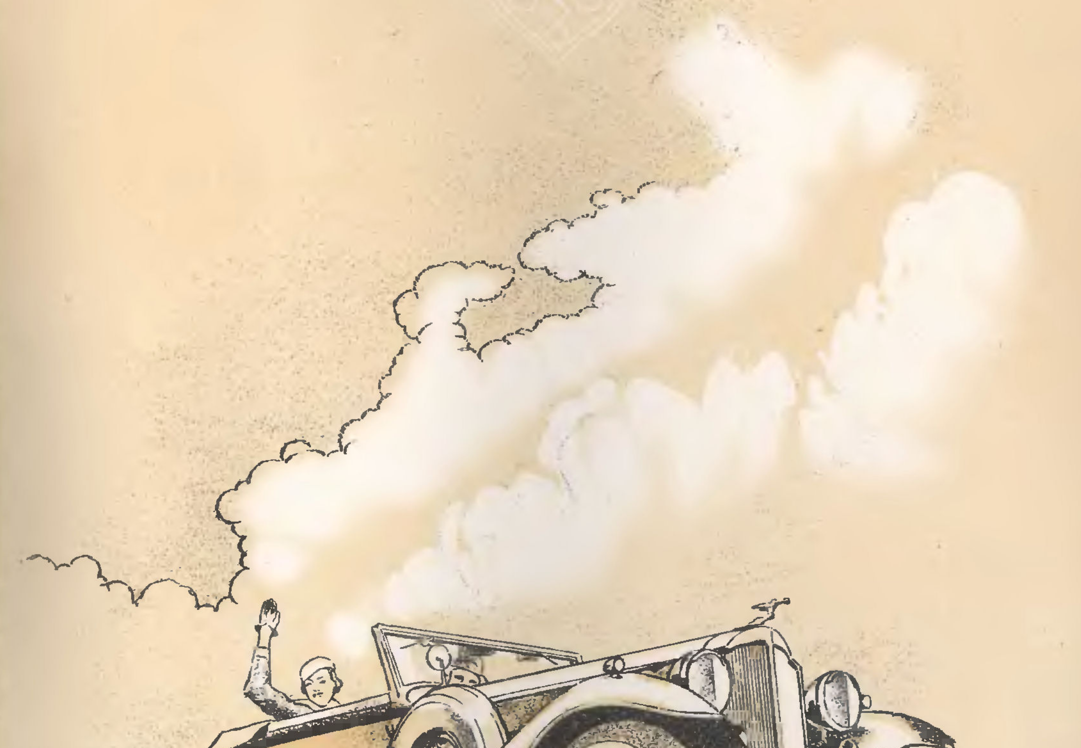
If we have overlooked anything you'd like to know, please write us.

was a boy, you should remember these early men who discovered the petroleum in Mother Nature's store house. You should give a thought also to those pioneers whose brains and whose work gave you your automobile. And you can't think of them without thinking of the two Packard brothers. Perhaps you would be interested, by the way, to know how the Packard car happened, because it did just happen, way back in 1899.

The Packard brothers, both successful young men, suggested to the manufacturer of an automobile they had bought, several ways they thought his machine could be improved. They were answered with the retort: "Well, if you can build a better car yourselves why don't you?" And that was just what they did.

The car they built was so successful that friends demanded they build cars for them. Soon they were in the automobile business. This business kept growing until finally it outgrew the little town where the Packards lived. It was moved to Detroit where it has been growing ever since until today the Packard company is the world's biggest builder of fine automobiles.

In this little book we have tried to tell you how Mother Nature, millions of years ago, provided for the fuel she must have known we would need for today's automobiles. We told you how man kept trying to provide himself with a better means of transportation. And we have endeavored to tell you something about the development of the motor car and what happens in the mechanisms of a car from the time you press the starting button until you step on the brakes and come to a final stop. If we overlooked anything which you would like to know, just write a letter to the Packard Motor Car Company, Detroit, Mich. We will gladly answer any questions you may care to ask.



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