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THE AUTOMOBILE.

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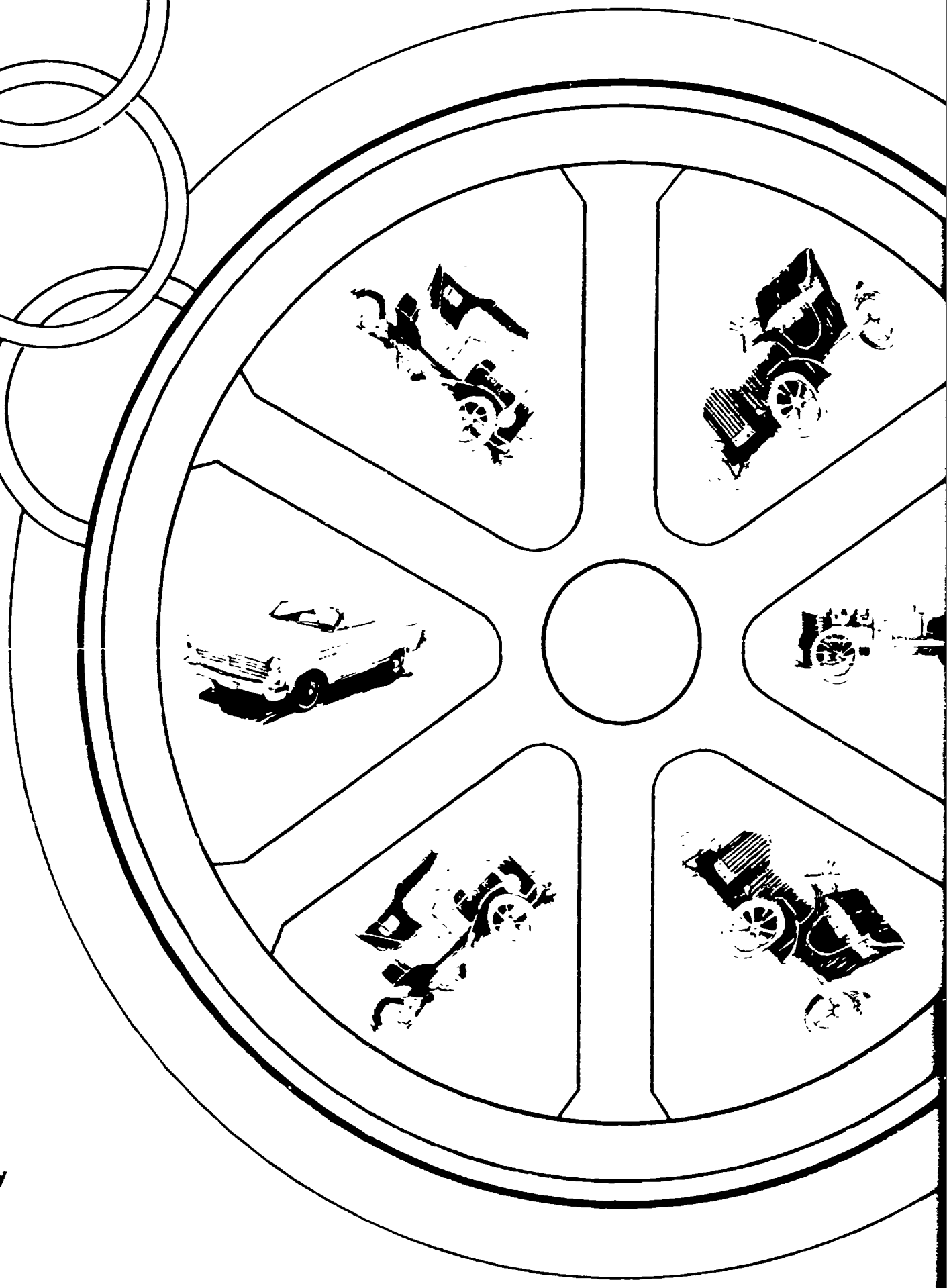
THIS EXPERIMENTAL READER WAS DEVELOPED AS PART OF A CURRICULUM PROJECT, DESCRIBED IN VT 004 454, WHICH PRODUCED AND TESTED MATERIALS WITH EIGHTH AND NINTH GRADERS IN SCHOOL SYSTEMS IN SEVERAL STATES. IT IS INTENDED TO HELP DISADVANTAGED STUDENTS LEARN BASIC PRINCIPLES AND CONCEPTS OF MECHANICS AND TO STIMULATE INTEREST IN READING. ILLUSTRATIONS AND TEXT EXPLAIN HOW THE MODEL T AND MODEL A FORD OPERATED. TOPICS INCLUDE THE CARBURETOR, AXLES, DRIVESHAFT, UNIVERSAL JOINTS, BRAKES, INTERNAL COMBUSTION ENGINES, LUBRICATION SYSTEMS, AND COOLING SYSTEMS. THE PROCESSES AND PARTS ARE ILLUSTRATED BY DRAWINGS. THE MATERIAL WAS ADAPTED FROM PUBLICATIONS OF THE FORD MOTOR COMPANY AND THE 1900-1918 ISSUES OF THE "SCIENTIFIC AMERICAN." OTHER RELATED DOCUMENTS ARE VT 004 455 THROUGH VT 004 471. (EM)

THE AUTOMOBILE



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T H E A U T O M O B I L E ,

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September 1965

INTRODUCTION

In 1910 many different types of cars were made. Most of the cars had the same kinds of parts, but some were a little different.

In this book, we will explain how the different types of cars operated. Old cars and new cars are based upon the same mechanical principles. If you understand how old cars worked, you will understand how our modern cars operate.

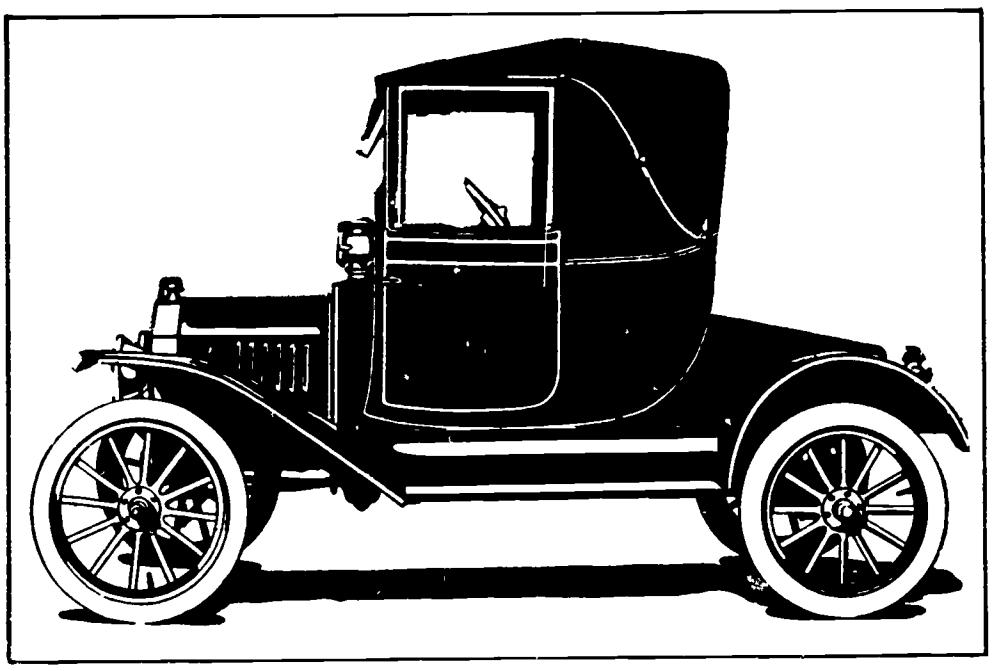
The old cars and the new cars are basically the same -- as you will see in this booklet.

TABLE OF CONTENTS

Part A. THE MODEL T FORD

Ford cars have been on the market for more than 65 years. The first mass-produced car was the Model T. By mass-produced we mean that many thousands of them were made. It was one of the most interesting and practical cars in its time.

This booklet explains how the Model T operated. This booklet also explains how to keep it in good working order.

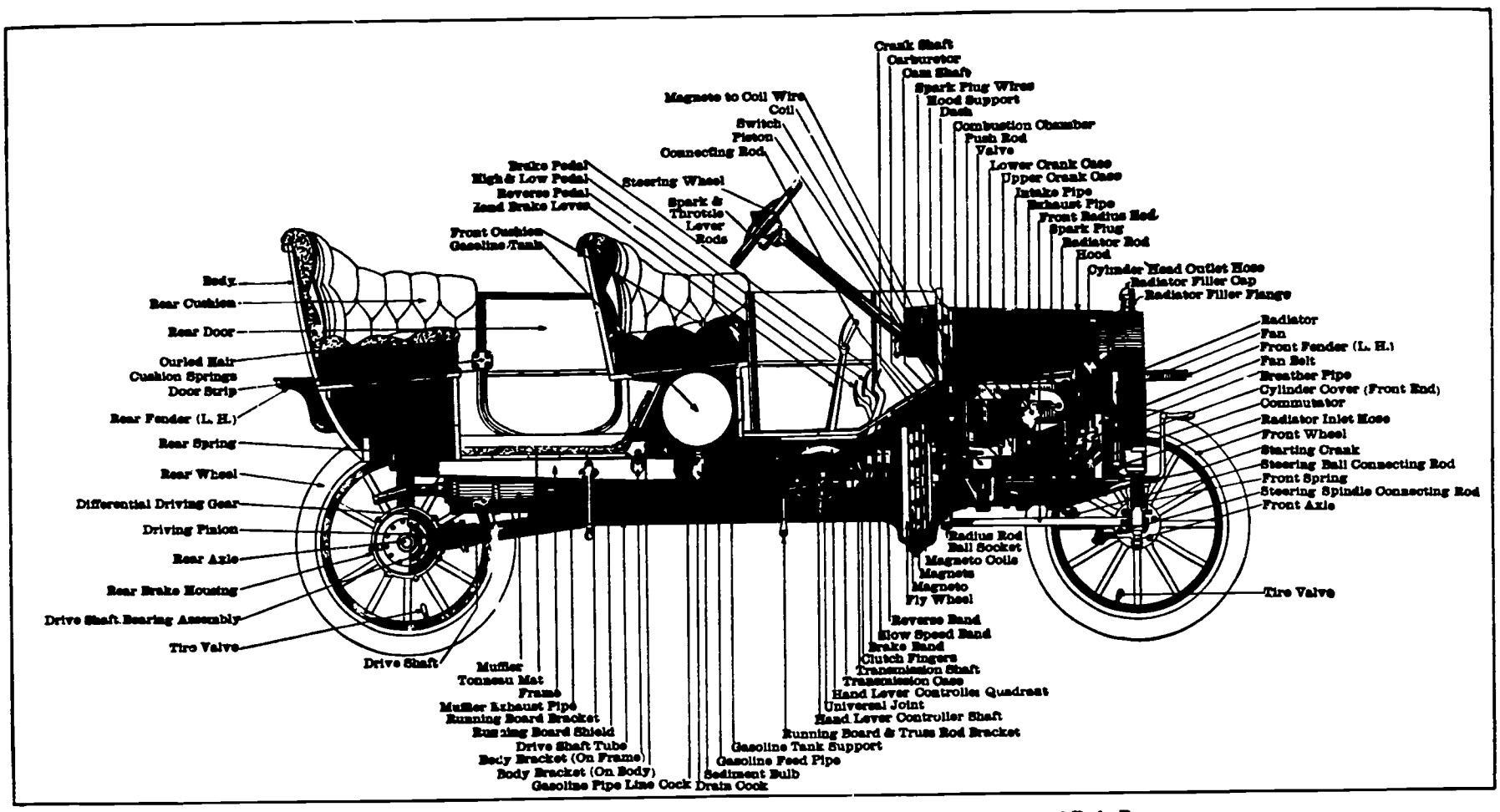


This shows a 1914 Model T Ford Coupélet.

How old is this car today?

Many people have owned these cars, and a few still own and drive them. Such cars are worth more now than when they were first made. They are <u>antiques</u>. Antique means very old.

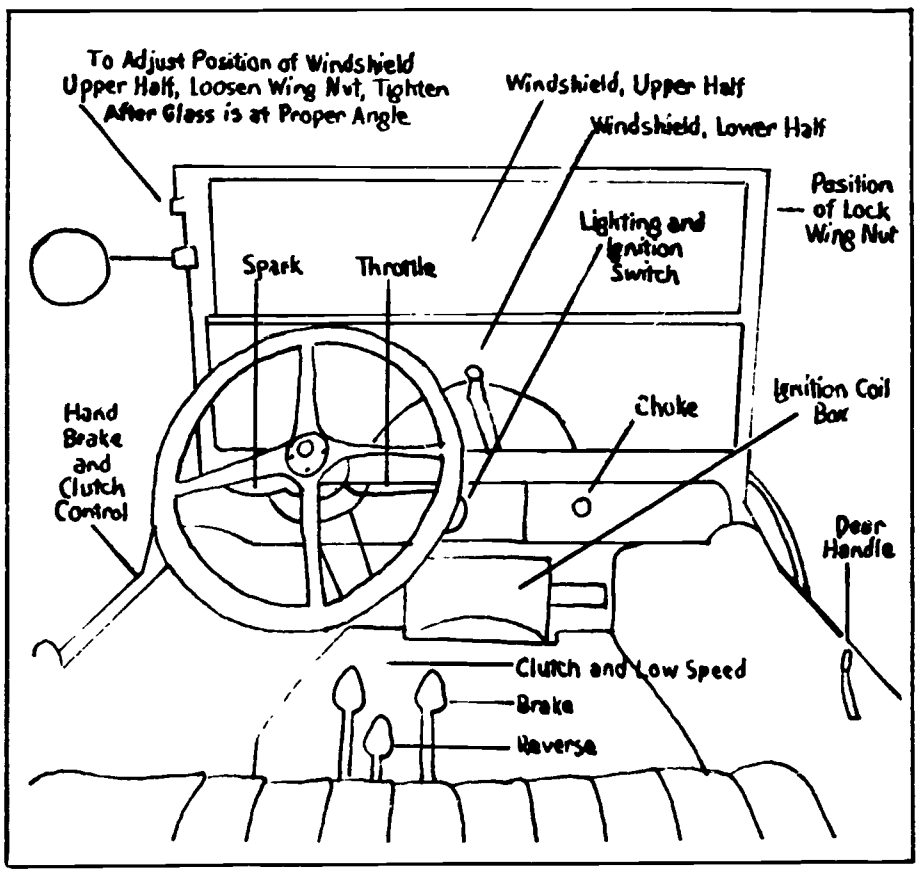
Many people are interested in these fine old cars, and perhaps you are, too.



Sectional View of Ford Model T Touring Car Showing Construction of Chassis and Body Parts.

Wouldn't you like to read more about the Model T Ford and what it was like?

This is how the front compartment of the Model T looked:



How different it is from modern cars! The mechanical ideas, however, are not much different from modern cars.

The Model T used the same type of instruments and levers, except for the clutch and gear controls used by modern cars.

LUBRICATION

When ready to start the car, about a gallon of oil should be poured into the crankcase through the breather pipe at the front of the engine. There are four drains in the flywheel casing or oil reservoir.

If oil runs out of the upper drain, there is too much oil. It should be allowed to drain out to that level. The oil level should never be allowed to fall below the lower valve. The oil in the crankcase automatically oils the cylinders, pistons, crankshaft, crankshaft bearings, connecting rod bearings, time gears, and transmission.

Oil cups are also connected to the engine for lubrication. The same oil used in engines should also be used in the oil cups. There are grease cups, too. You must fill the cover.

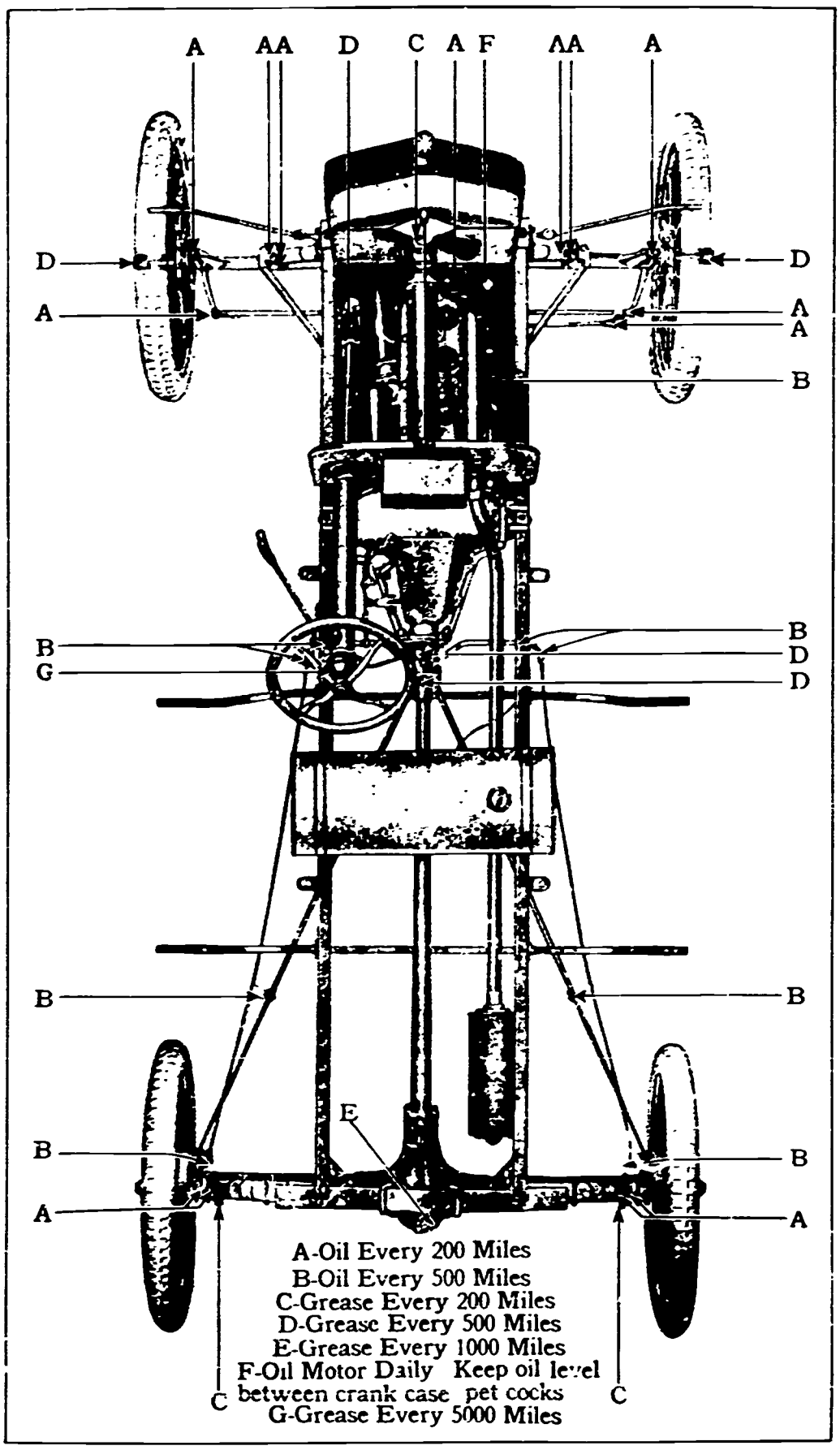
Under the cover, there is a space. Put grease in this space. The cover is screwed down. Then you unscrew the cover again, put the grease in, screw it back down, and do this two or three times.

You should put a drop of oil now and then in the:

1. Crank handle bearing
2. Fan belts
3. Pulley
4. Shafts

These should be examined often:

1. Axle
2. Driveshaft
3. Universal joint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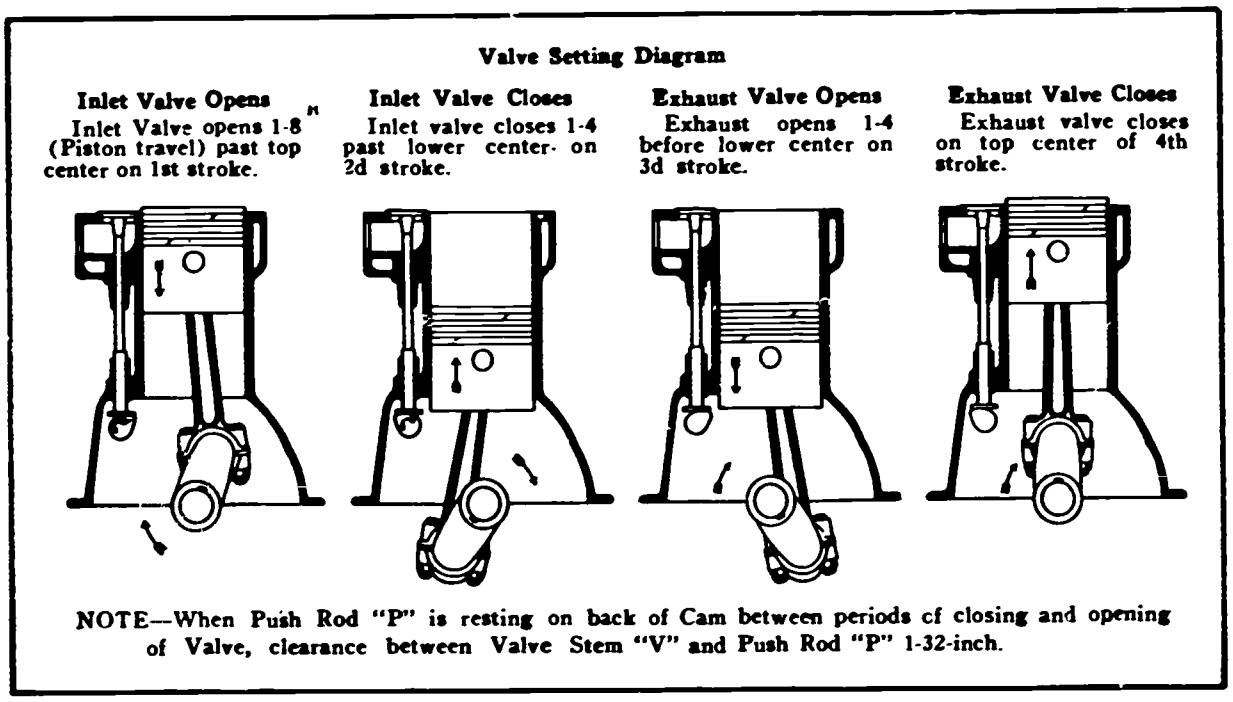
A-Oil Every 200 Miles
B-Oil Every 500 Miles
C-Grease Every 200 Miles
D-Grease Every 500 Miles
E-Grease Every 1000 Miles
F-Oil Motor Daily Keep oil level
between crank case pet cocks
G-Grease Every 5000 Miles

HOW THE ENGINE WORKS

The Model T Ford car engine is an internal combustion engine. This means that all the burning goes on inside the engine. A mixture of gasoline and air explodes in a cylinder.

But first, gas-vapor must get into the cylinder. The gas-vapor is a mixture of gasoline and air. The engine acts as a pump. The gasoline is drawn through an intake valve. After the cylinder is full of gas-vapor, the intake valve closes.

Once the intake valve closes, and the piston compresses the mixture, a spark from the spark plug ignites the gas mixture. The gas explodes. Inside the cylinder is a piston. The explosions occur very quickly. The explosions go on in all four cylinders. All the explosions do not happen all at once. The explosions occur in sequence. That is, the explosions occur in the cylinders, one at a time, in a definite pattern.



The Ford engine is a four-cycle engine.

The four operations are:

1. Suction ----------Stroke #1
2. Compression----------Stroke #2
3. Explosion----------Stroke #3
4. Exhaust----------Stroke #4

The pistons are connected to the crankshaft by connecting rods. The crankshaft is connected to the driveshaft by a series of gears. The driveshaft turns the wheels through the rear axles. The faster the pistons go up and down, the faster the crankshaft turns. The faster the

crankshaft turns, the faster the driveshaft goes.

> The speed of the Model T is controlled by three foot pedals and a hand brake lever. The pedal on the right operates a brake on the transmission. The center pedal operates the reverse. The left foot pedal acts on the clutch.

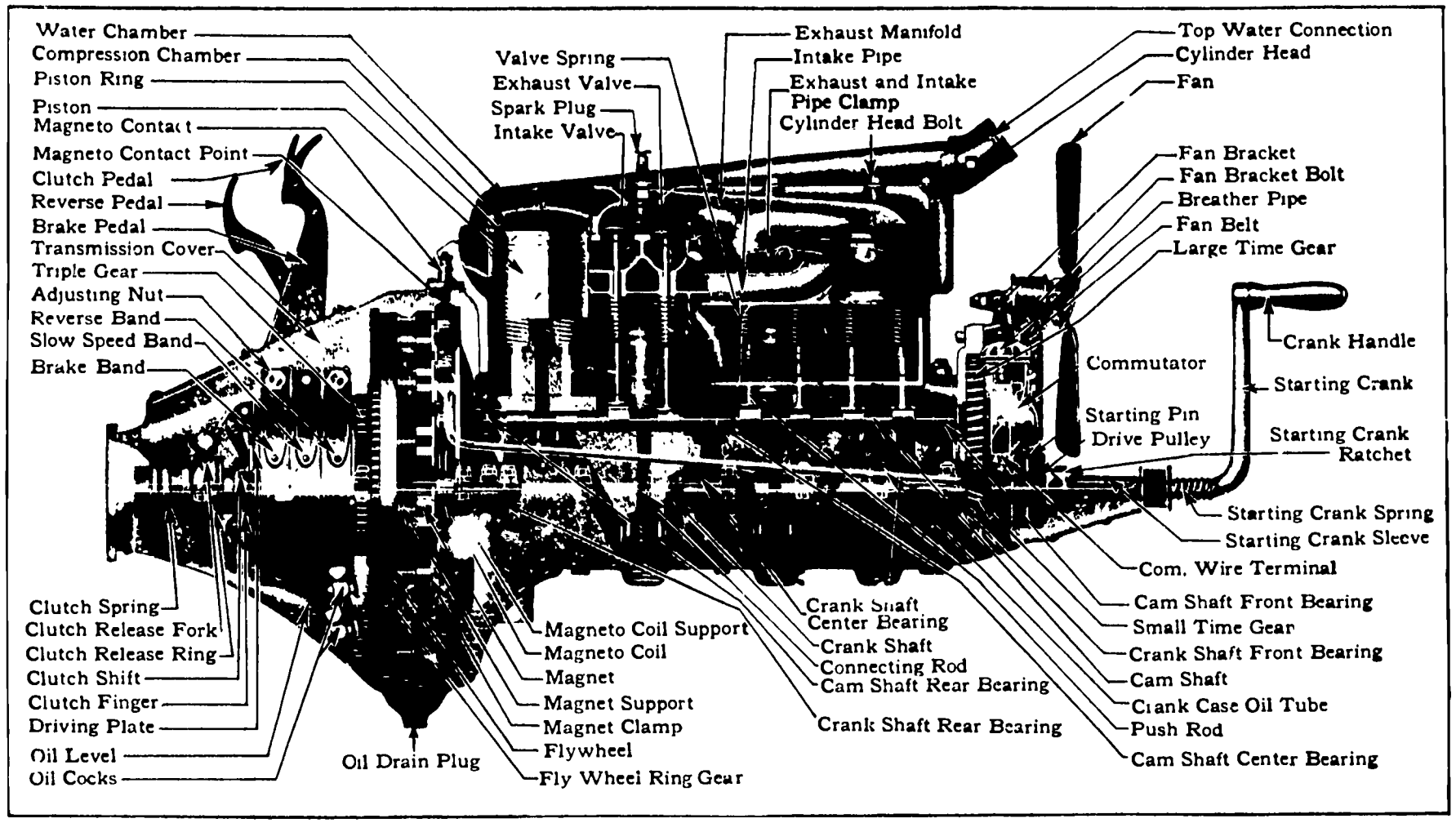
The hand lever is in neutral when it is straight up and down and the clutch is in a released condition. When pulled back, the hand brake lever operates the emergency brake. When thrown forward it engages high speed.

With the hand brake forward in high speed position, a light pressure on the clutch pedal releases the clutch. A full pressure on the clutch pedal throws in the slow speed. Gradually releasing the clutch lever makes it come back through neutral into high speed.

The Model T is started by opening the hand throttle and pressing in the clutch pedal. Pressing it in all the way puts the car into low gear. Once the car is in motion, letting up on the clutch pedal puts it into high gear. The Model T does not have a gear shift lever.

The car has to be brought to a dead stop to be put in reverse. It is reversed by disengaging the clutch with the hand lever and pressing in the reverse pedal.

A CROSS SECTION OF THE MODEL T ENGINE



SUMMARY OF SPECIFICATIONS FOR 1910 MODEL T FORD

Brakes - Two sets.

Clutch - Multiple steel discs, operating in oil.

Control - All speeds forward and reverse by foot pedals. Spark and throttle under steering wheel.

Cooling - Thermo-syphon and fan.

Final Drive - By carbon shaft with single universal joint to bevel drive gears in live rear axle.

Ignition - Ford magneto generator.

Lubrication - Combination splash and gravity system.

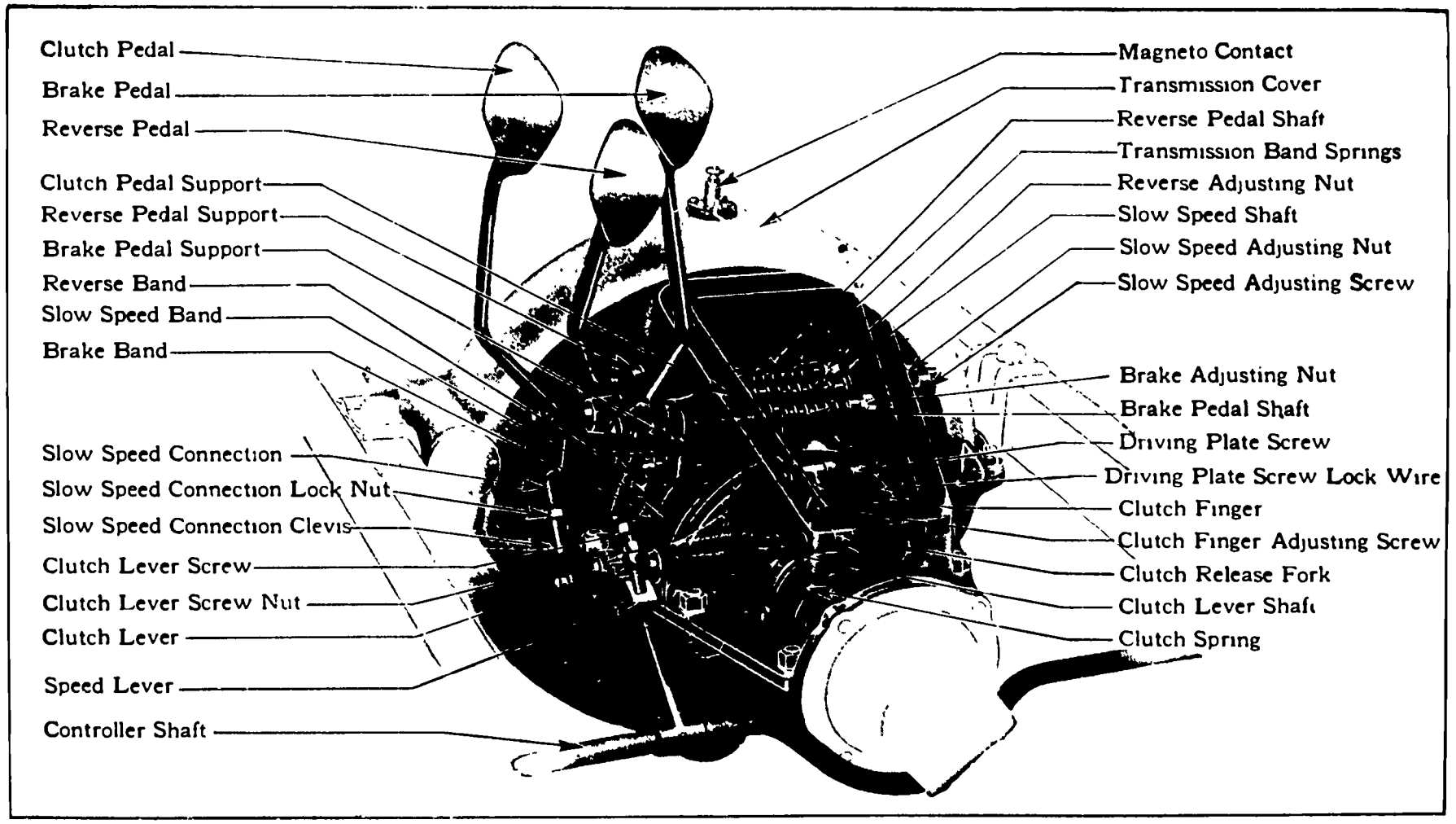
Motor - 4-cylinder, 4-cycle, 20-h.p., 3-3/4-inch bore, 4-inch stroke. Cylinders cast in one block with water jackets and upper half of crankcase integral.

Prices - Touring car, $950; roadster, $900; tourabout, $950, with full equipment; coupe $1050; town car, $1200, f.o.b. Detroit.

Transmission - New design Ford spur planetary, bathed in oil.

Wheel base - 100 inches; tread 56 inches.

THE TRANSMISSION OF THE MODEL T FORD SHOWING CLUTCH, REVERSE AND BRAKE PEDALS



COOLING SYSTEM

Burning fuel in the cylinders makes a lot of heat, which must be removed or the engine will burn up and be ruined. This will happen if a lot of the water is lost from the radiator.

The Model A Ford engine is cooled by circulating water through the water jacket which surrounds 1) the cylinders, 2) combustion chamber, and 3) valve seats. The water is circulated by thermo-syphon action.

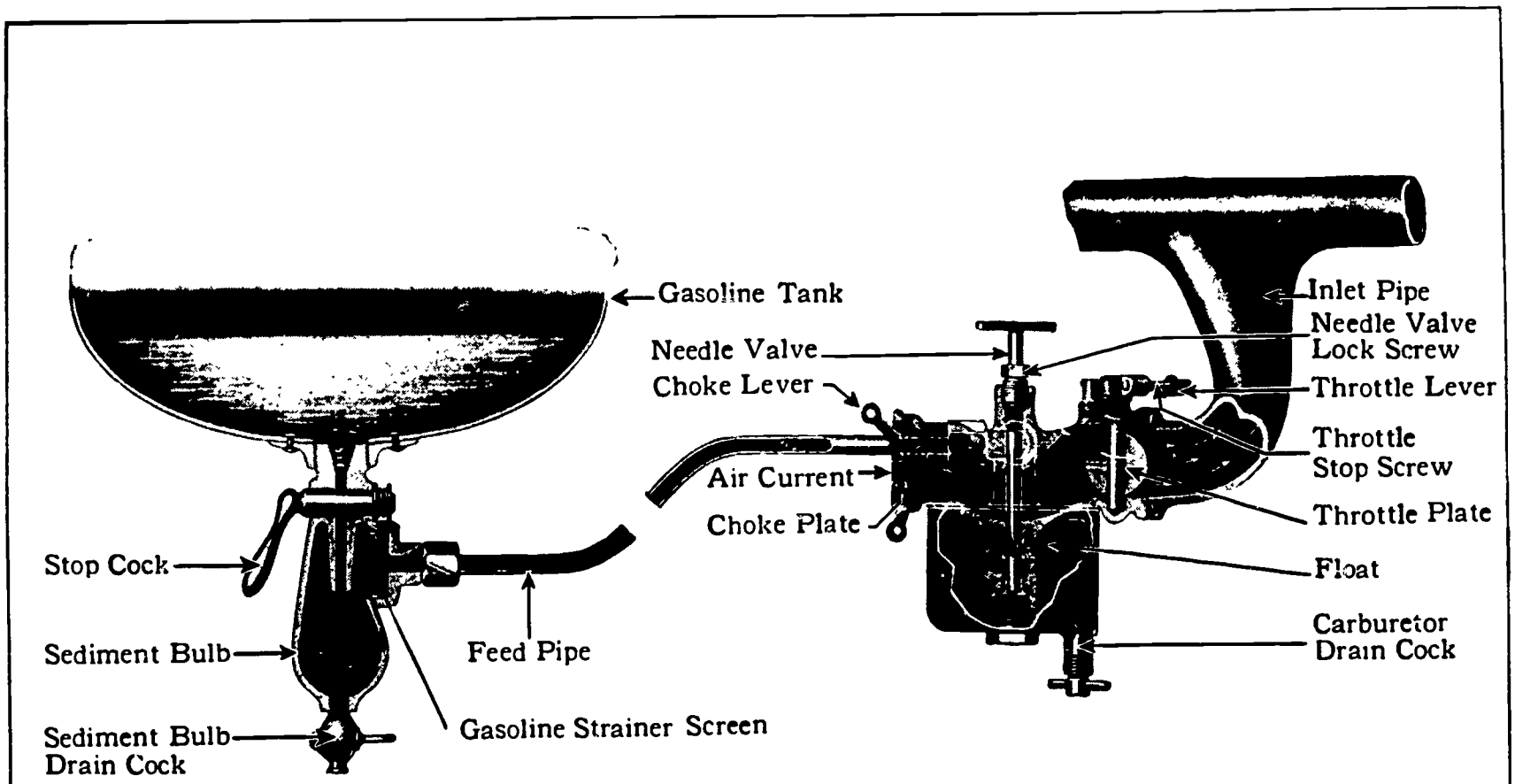
Thermo-syphon action means that hot water rises and cold water sinks causing the water to circulate without the need for a water pump. The water heated in the water jacket around the engine is cooled in the radiator. The cooler water from the bottom of the radiator flows to the bottom of the

water jacket. Here it is heated and then flows to the top of the radiator where it is cooled.

To aid the cooling, the water in the radiator goes through small tubes with metal fins attached. The fins help spread or radiate the heat. Two other things also help cool off the water in the radiator. One is that a fan is placed behind the radiator to suck air through it. The other is that when the car is moving, air goes through the radiator.

FUEL SYSTEM

The gasoline supply in the Model T Ford is carried in an iron tank under the front seat. This is joined to the carburetor by a simple pipe line of soft copper tubing.

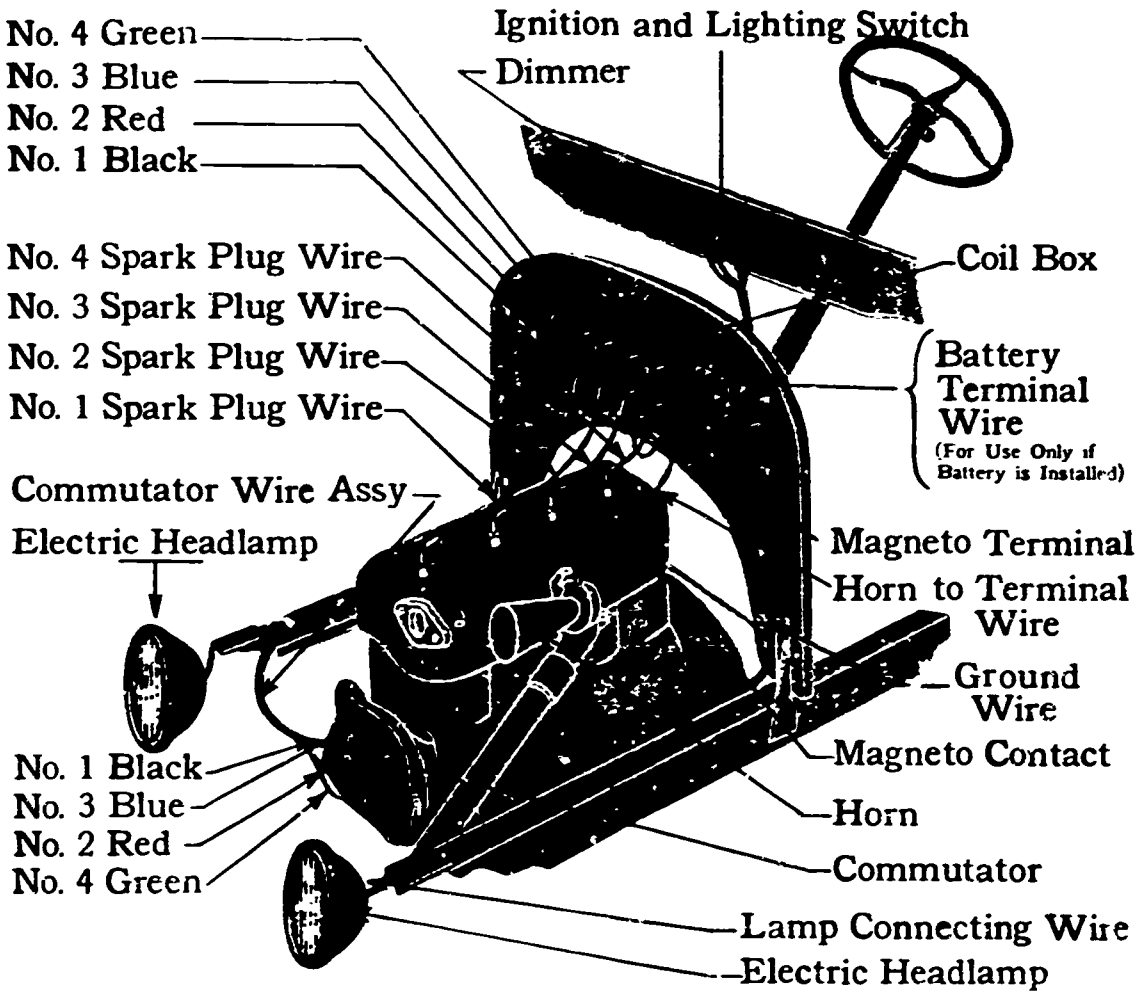


This cut illustrates the principle of Ford Carburetion.

The carburetor mixes gasoline with air to make a combustible mixture. Many methods have been used to obtain this mixture. In the Ford Model T, air is sucked into the cylinders by the pistons. This air goes through the carburetor and sucks up a small amount of gasoline on the way. This is very much like what happens in an insect sprayer. The throttle which is controlled by the driver is a disc in the inlet pipe which closes down when the driver wishes to slow down the engine. Look at the picture to understand what happens.

MODEL T FORD ELECTRICAL CIRCUITS

The electrical circuits in a modern car have become quite complicated. But the Model T didn't have any radio, or air conditioner, or even turn signals. There were no remote control window closers, and no two-way telephone systems in 1910. When you look at the wiring diagrams of the Model T below just think how much more complicated the diagram for a new car would look.



Actually, the electrical systems shown can be divided into two major parts. These are the ignition system, and auxiliary system. We will explain these two systems one at a time.

IGNITION SYSTEM

The purpose of the ignition system is to make the automobile run. The automobile will not run if there is no spark at the proper moment in the engine. Everything else in the ignition system is there to be sure that there i a spark.

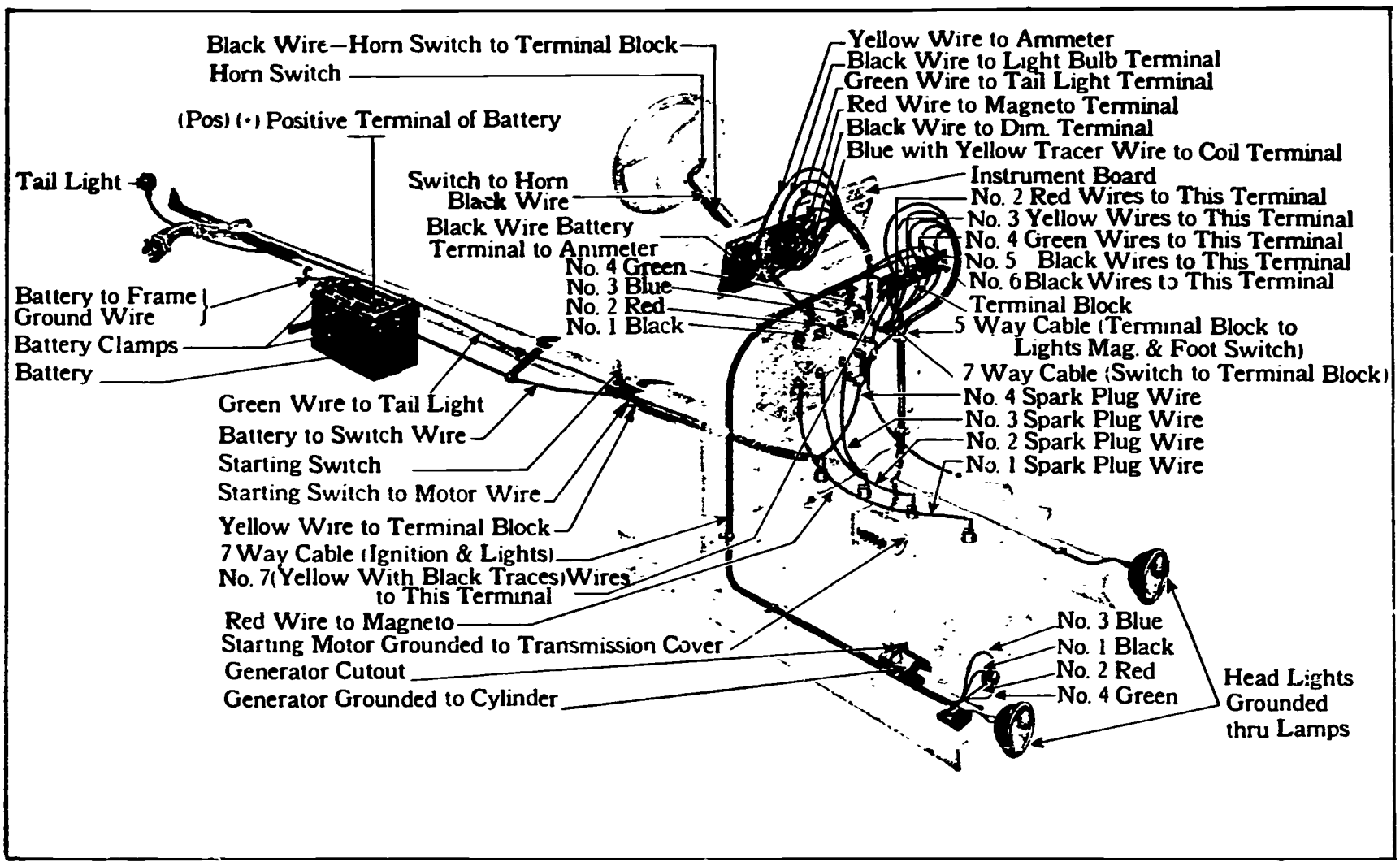
When the Model T is started, the current for the spark comes from the magneto. The magneto makes current because an armature is made to turn between the poles of a permanent magnet. The current is made stronger by using an ignition coil as well.

Later on, generators were added to give an improved electrical system.

Sometimes a battery was used in the Model T Ford. This stored the electricity and made the current flow more evenly. The battery could supply enough power for an electric starting motor. Before that time all cars had to be started with a hand crank.

AUXILIARY ELECTRICAL CIRCUITS

The other electrical circuits in the Model T Ford were few. There was the lighting circuit which supplied current to the headlights and tail light. There was only one tail light on the first Model T cars. Then there was the horn circuit. And there was a circuit for the windshield wiper.

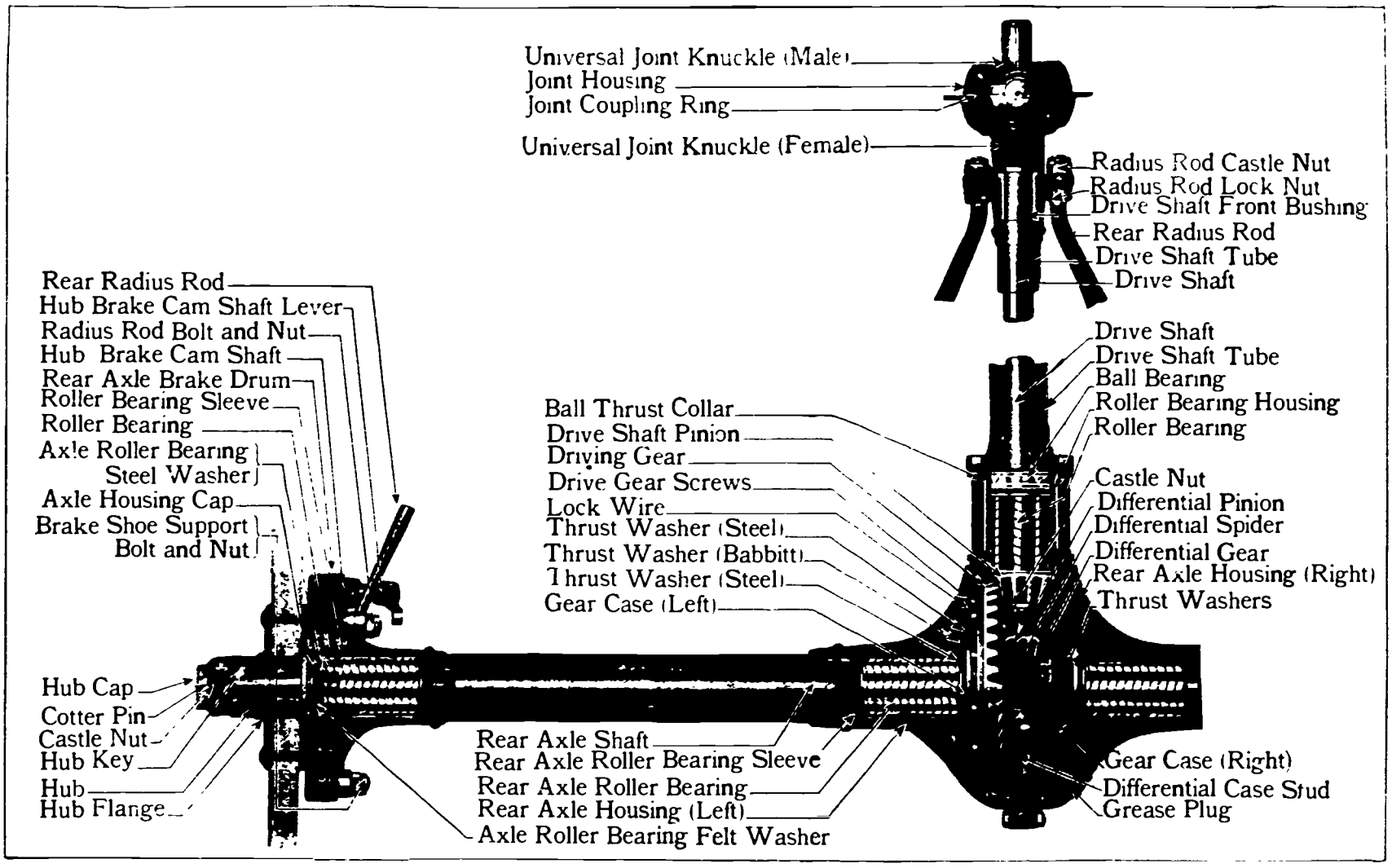


In order to keep these circuits straight, a color code was used. That meant that you could tell where each wire went by its color. For example, the yellow wire ran to the ammeter. The green wire ran to the tail light.

Most electrical circuits you will see have two wires. This is usually the way electricity is run to door bells, floor lamps, electric toasters, and other electrical appliances. In an automobile only one wire is used. The reason for this is that the frame of the car is used as the second wire. In other words, the current goes from the battery through the single wire to the lights, and then back to the battery through the frame. In this case, the frame is the ground. Notice that the diagram on page 21 shows that the headlights are grounded. Notice also that there is a ground wire from the battery.

REAR AXLE ASSEMBLY

The rear axle assembly has two purposes. One is to drive the car and the other is to support the rear end of the body.



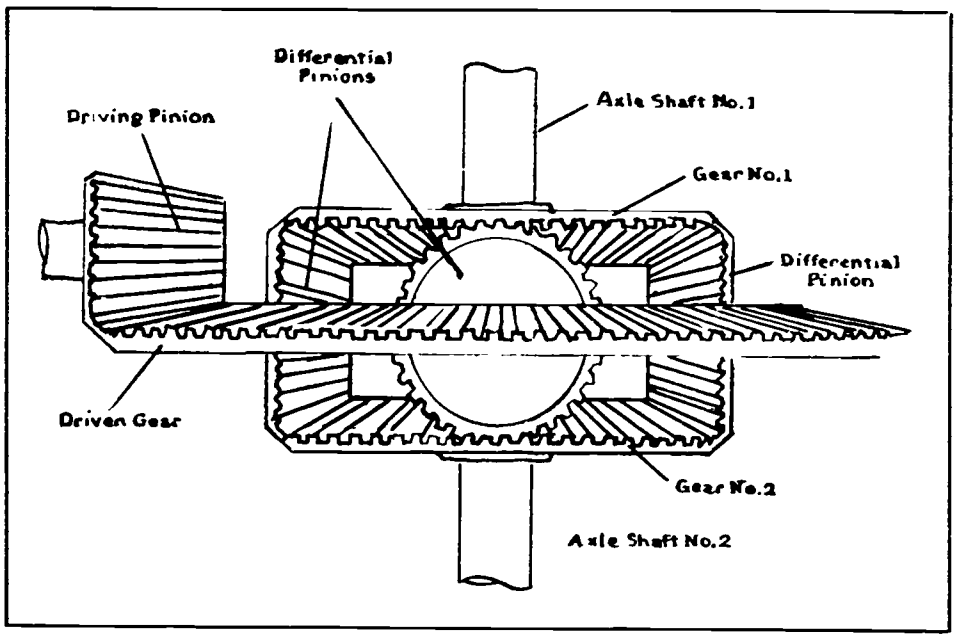
The following parts of the rear axle assembly are used to drive the car:

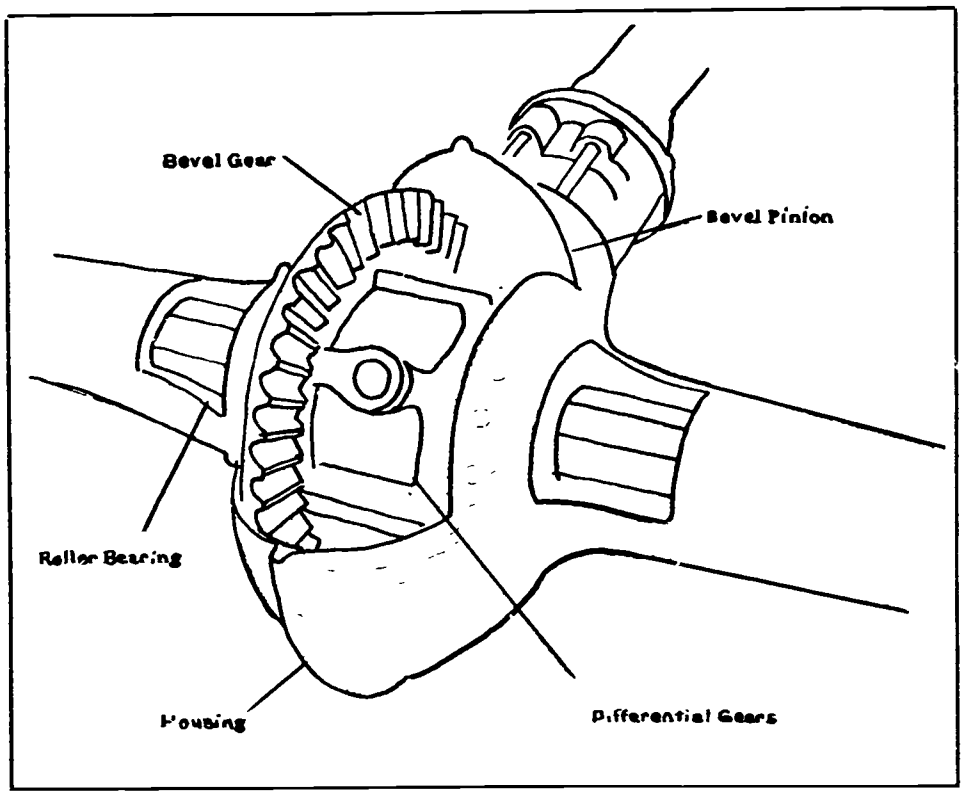
1. Driveshaft
2. Differential
3. Left and right rear axle shafts
4. Wheels and bearings
5. Brakes

The driveshaft connects to the transmission through the universal joint. The universal joint is necessary to allow the rear axle assembly to twist and bend as the car goes over rough roads.

The differential gears are at the end of the driveshaft. These gears change the direction of the force of the engine so as to turn the wheels. They are also designed so that the two rear wheels do not have to turn at exactly the same speed. When the car goes straight the rear wheels do turn at the same speed. But when the car goes around a curve, the inside wheel goes slower because it turns in a smaller circle.

The differential of the Model T was a bit different from the differentials used today. The Model T differential is shown below. This sketch shows the principle used in the gear train. The actual construction appeared quite different. A sectional view of the real thing is also shown.





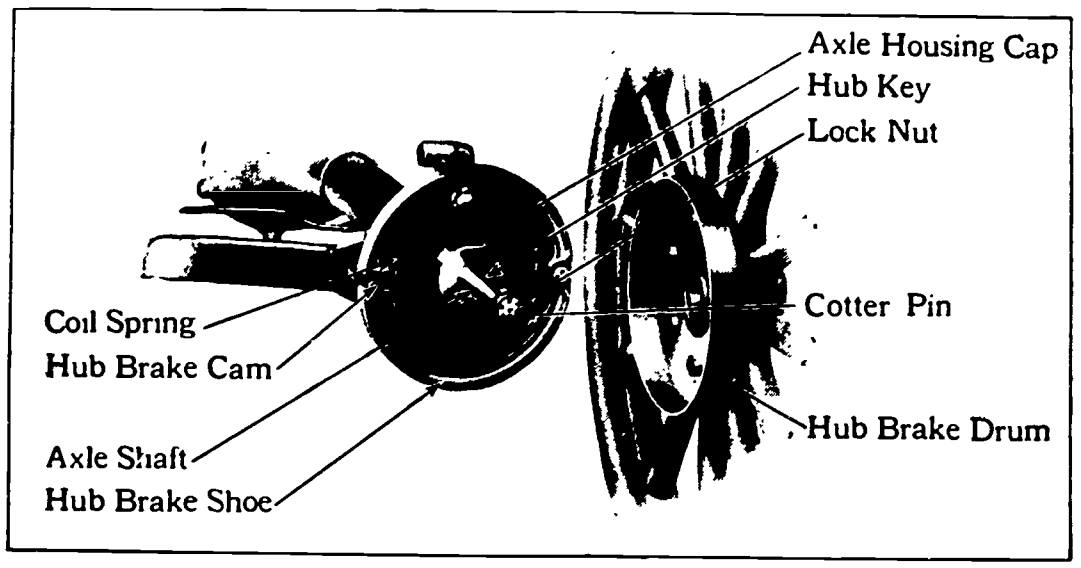
BRAKES

There are two brakes used in the Model T Ford. One brake acts on the transmission gears; the other brake acts on the rear wheel brake drums.

The transmission brake (also called the service brake) is the one normally used while driving the car. This is controlled by the right foot pedal. When the pedal is pushed forward, an asbestos fabric closes around the drum. The drum is part of the driveshaft used to make the rear wheels turn. So if the drum is stopped, the wheels will stop.

The emergency brakes have bands shaped like a letter C. When you pull the brake handle up, the metal bands press tightly against the inside of the drum. When you let the brake handle come back down, springs pull the metal bands away.

When the driver pulls the hand lever, the emergency brakes work. The hand lever stays in place so that the driver can leave the car and not worry about it rolling away.



The Ford Emergency Brake.

SPRING SUSPENSION

The body of the Model T Ford is separated from the wheels and frame by means of springs. This is how these springs looked.

FRONT REAR

The ends of the springs were attached near each wheel in front and back, while the body was attached at the middle. These springs were made up of a series of long flat pieces of steel called leaves. The leaves were piled on top of each other, with the longest one on the bottom and the shortest one on top. Usually there were seven leaves. See the diagram on page The leaves were clipped together so that they would not separate when the chassis frame bounces up from a big bump. Oil must be used between the leaves of the springs to keep them from squeaking.

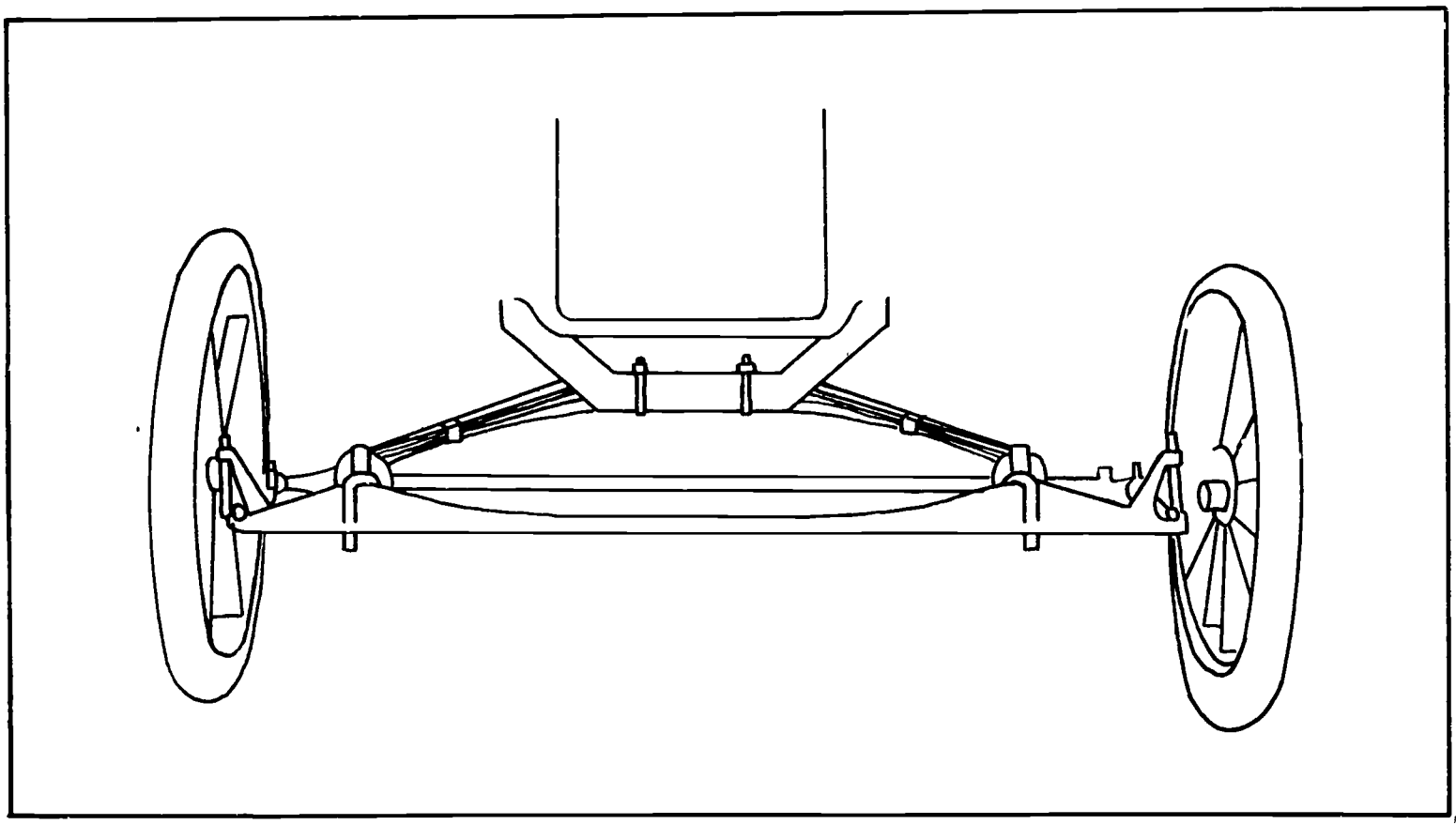
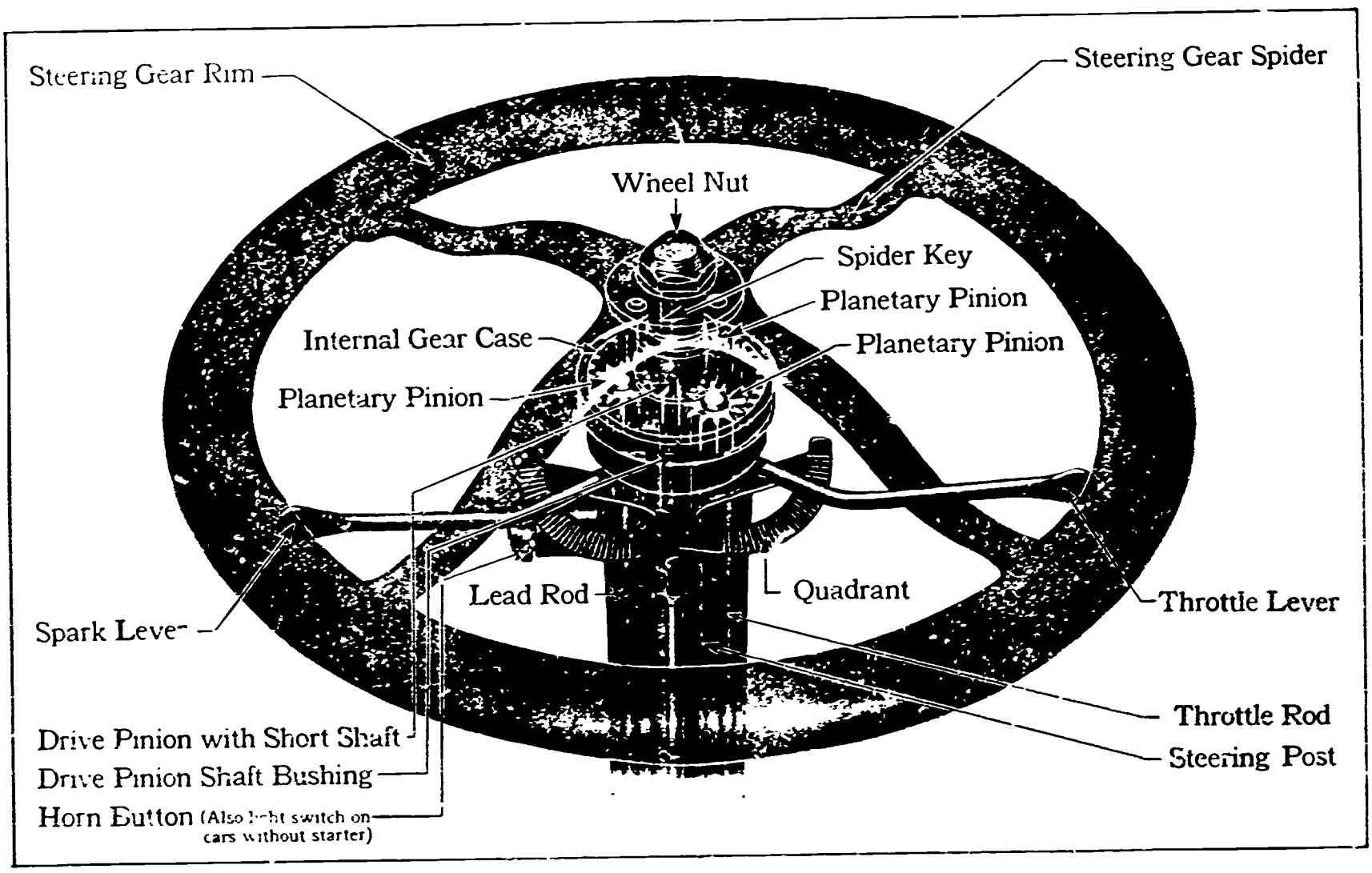


DIAGRAM OF THE SPRINGS ON MODEL T FORD

The Model T Ford used a transverse spring suspension system. The diagram above shows how the front springs worked. The back springs were similar but had a larger bow. The larger bow was to raise the spring above the differential, which was in the middle of the back axle

STEERING WHEEL

One of the unusual things about the Model T Ford was its steering wheel. Look at the next picture. You will see that many things are different in the cars today.



The first thing you may notice is that the throttle is mounted under the steering wheel. Modern cars have the throttle on the floor where it is worked with the foot.

The second thing is the spark lever. Modern cars use an automatic spark adjustment. But in the Model T Ford the driver had to adjust the spark to fit the driving conditions.

The third thing you may notice is the location of the horn button.

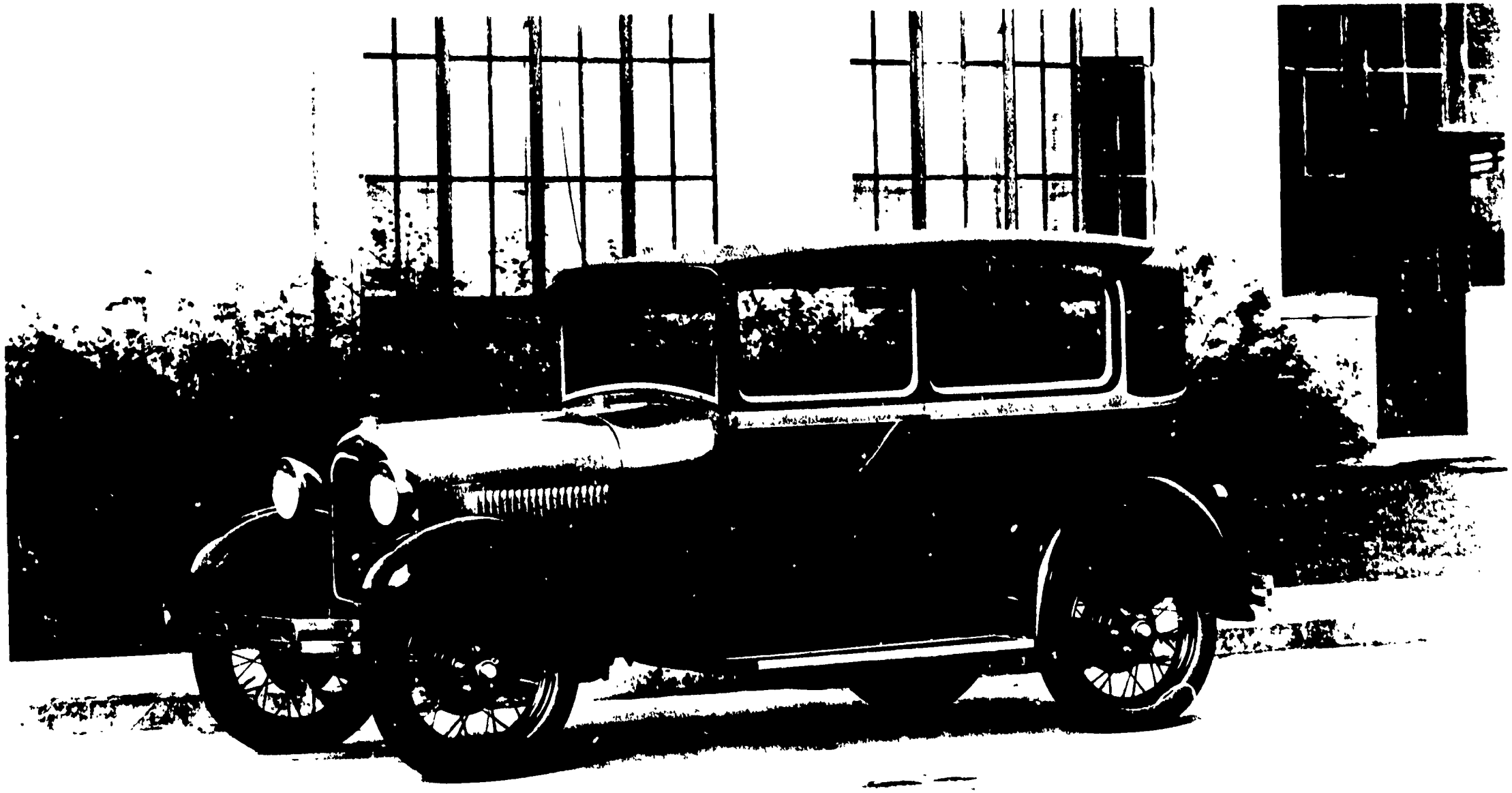
PART B. THE MODEL A FORD

After 18 years of production, Henry Ford replaced the Model T with the Model A. Although the Model T was a tremendous success, many improvements were made in the Model A.

The Model A was first produced in 1928 and was bought by many thousands of owners. Many different body styles were available, such as a sedan, touring cars, roadster, and coupe.

One of the distinguishing features of the Model A Ford was that the top of the gas tank was on the hood right in front of the windshield.

The picture of the 1928 Model A Ford on the next page shows one of the most popular models.



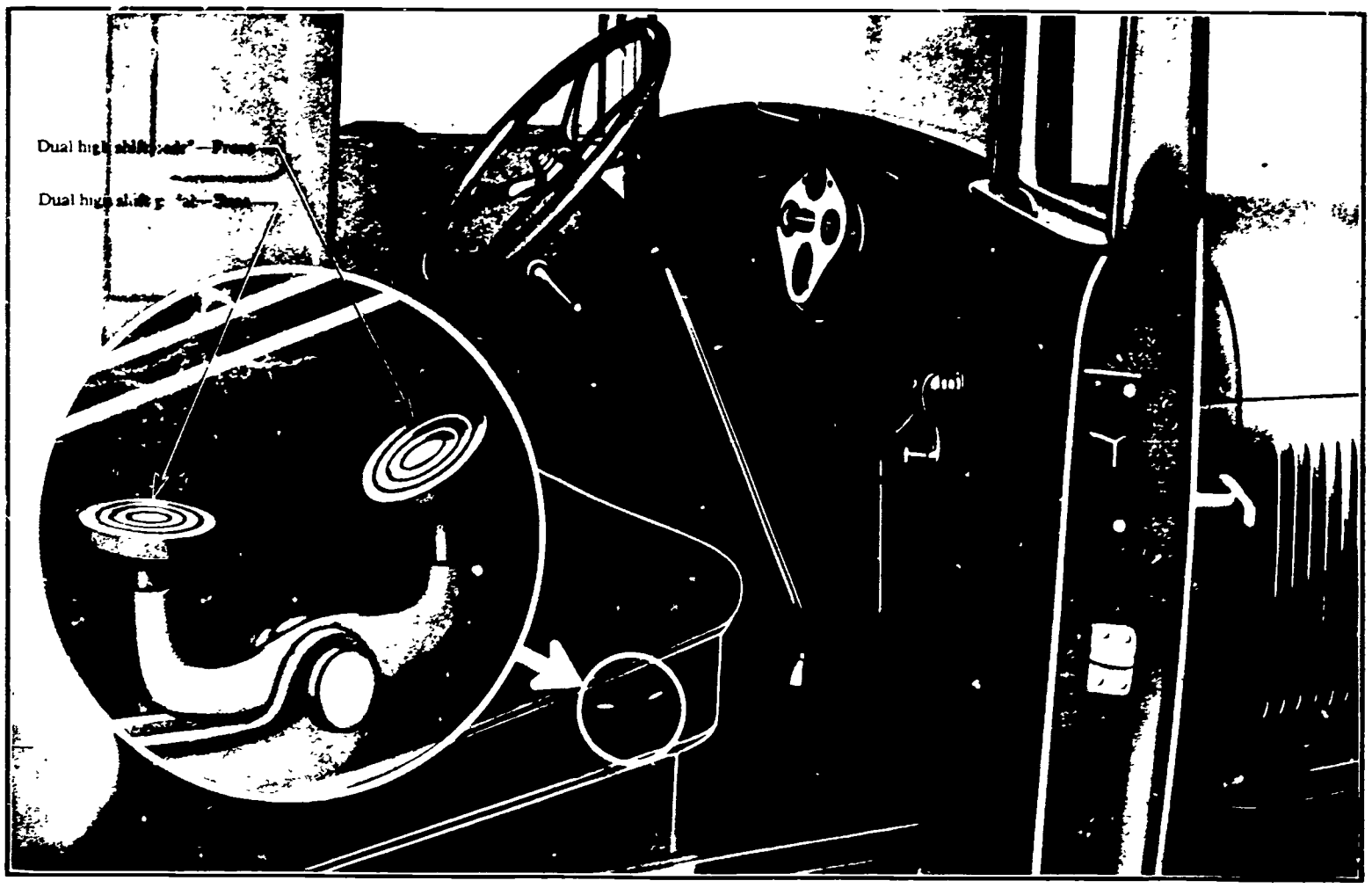
1928 FORD MODEL A TUDOR SEDAN

SPECIFICATIONS AND LICENSE DATA

Engine	Type of engine . . . . . 4 cylinder Cylinder bore . . . . . 3 7/8 inch Stroke . . . . . 4 1/4 inch Horse Power . . . (S. A. E. rating) 24.03
Transmission	Selective sliding gear type, three speeds forward and reverse.
Clutch	Single plate dry disc.
Brakes	Four wheel internal expanding service brakes operated by the foot brake pedal. Also an emergency or parking brake on both rear wheels operated by the e· ·rgency brake lever. The emergency bra es are entirely separate and distinct from the four wheel service brakes. Total braking surface 225 1/2 sq. inches.
Steering Gear	Irreversible, worm and sector type, ratio 11 to 1.
Oiling System	Engine lubricated by gear pump, splash and gravity feed. Oil pan capacity 5 quarts.
Cooling System	Pump and thermo-syphon. Capacity, 3 gallons.
Gasoline Tank	Capacity, 10 gallons.
Rear Axle	Three-quarter floating type. Torque tube drive. Spiral bevel drive pinion and gear.
Tires	30 x 4.50 Balloon.
Wheel Base	103 1/2 inches.
Turning Radius	17 ′, circle 34 ′.
Tread	56 inches.
Road Clearance	9 1/2 inches.

WHAT THE 1928 MODEL A FORD WAS LIKE

You may not know all the words used above, but this book will explain them to you. This book will explain the mechanics of the Model A Ford to you.



INSTRUMENTS AND CONTROL LEVERS

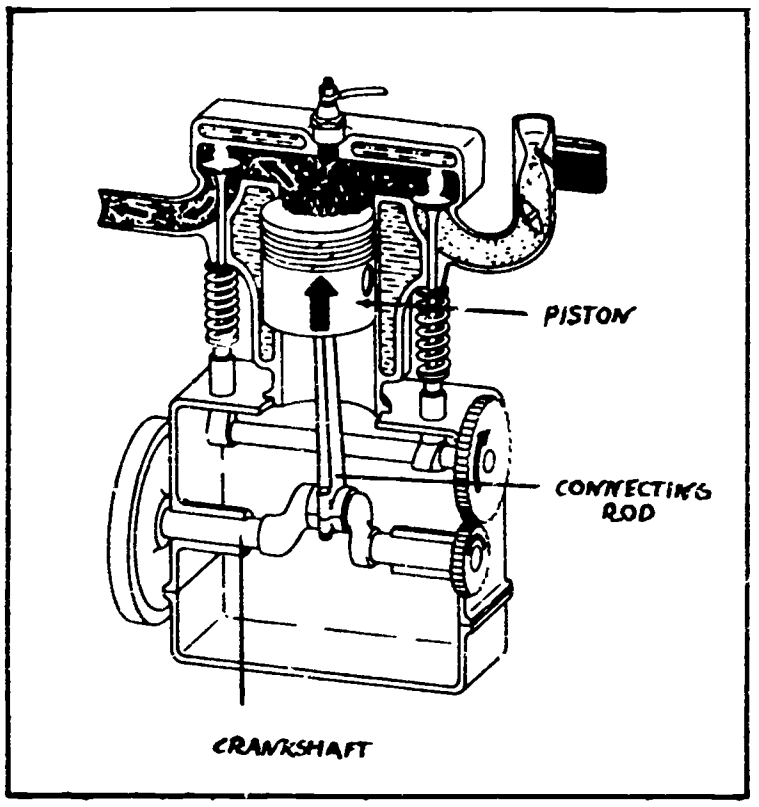
This is how the Model A looked inside. How different it is from the cars today! It is not very much different, however, in its basic mechanics. Today's cars have about the same instruments and levers except for the clutch and gearshift.

HOW THE ENGINE WORKS

The Model A Ford engine is called an internal combustion engine. Internal combustion means burning inside. The mixture of gasoline and air burns inside the cylinder. It doesn't just burn, it explodes!

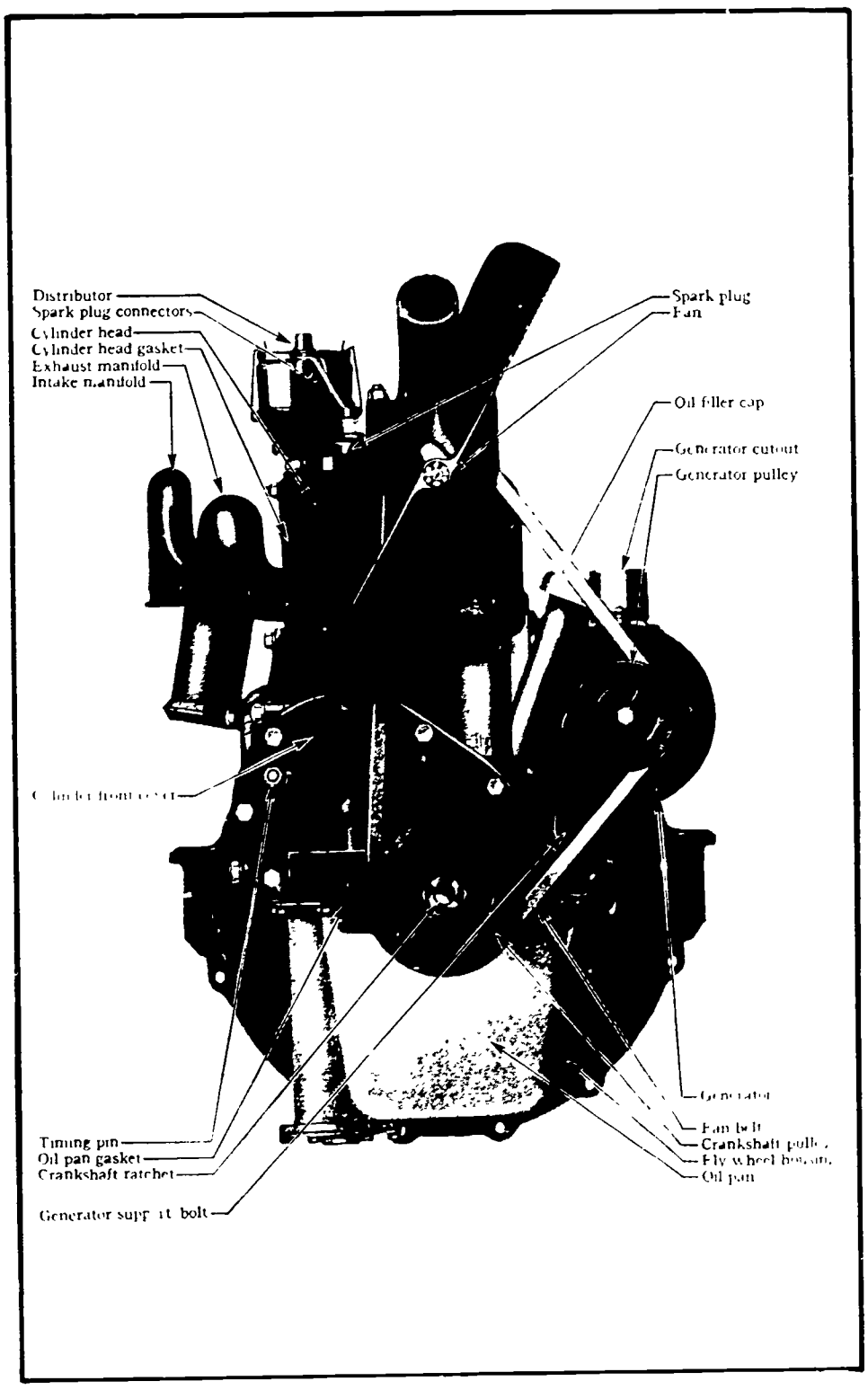
Each cylinder has windows that open and close. They are called valves. They open to take in gas and close when the explosion happens. A spark from the spark plug lights the gas and makes it explode. The explosion drives a piston down which gives the power to turn the wheels.

The cylinders have explosions one after another. When the car is moving, the explosions come so quickly they make a roar. You can't hear each explosion then, because the muffler reduces the noise.



PISTON CONNECTED TO CRANKSHAFT

The pistons inside the cylinders are connected to the crankshaft by the connecting rods. As the pistons go up and down, they cause the crankshaft to turn. This motion is carried to the wheels by the driveshaft.



FRONT VIEW OF ENGINE

This view of the engine shows many important parts of the engine. The mixture of gas and air, after being mixed by the carburetor, goes into the engine by way of the intake manifold. Can you find it in the diagram?

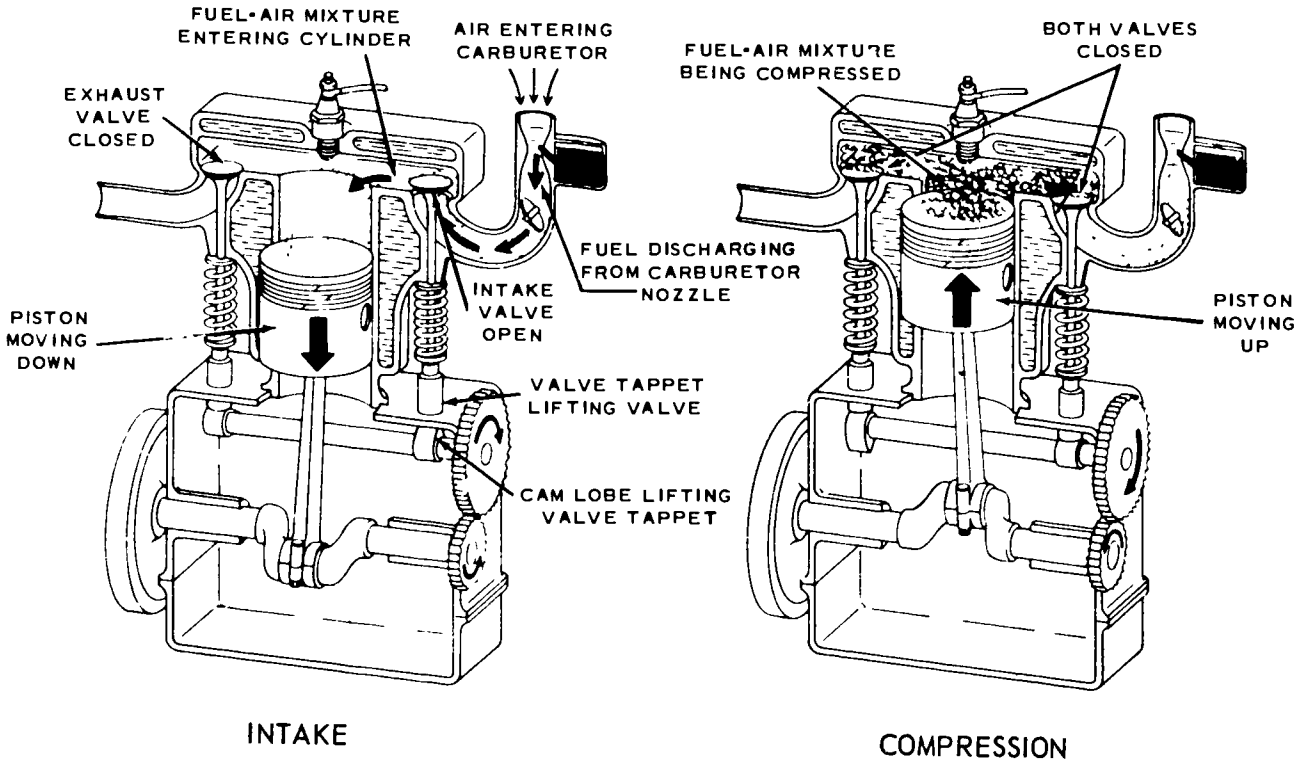
The gasoline and air mixture is sucked in as the piston goes down. At this time the exhaust valve will be shut and the intake valve will be open.

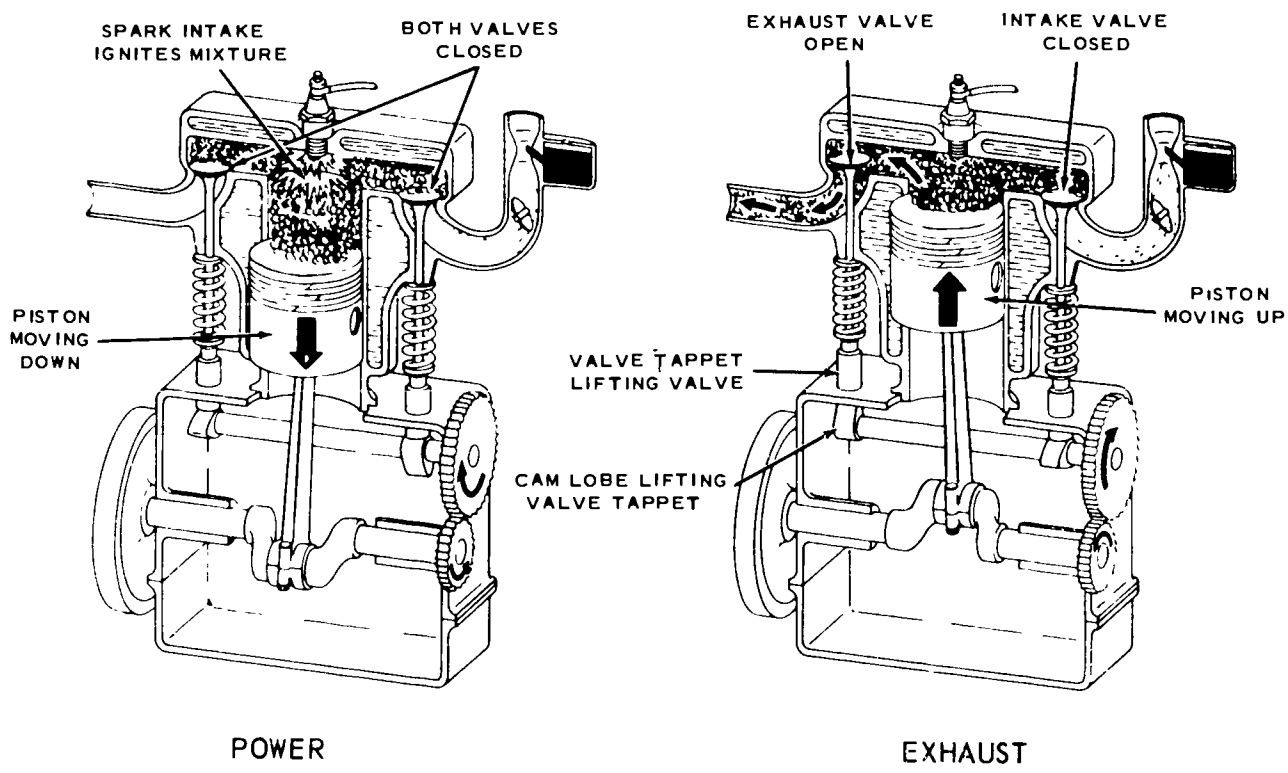
As the piston goes back up, the mixture is compressed while both valves are closed. Exactly at the top of the stroke, the distributor causes the spark plug to spark and light the mixture. If it fires too soon or too late, power will be lost.

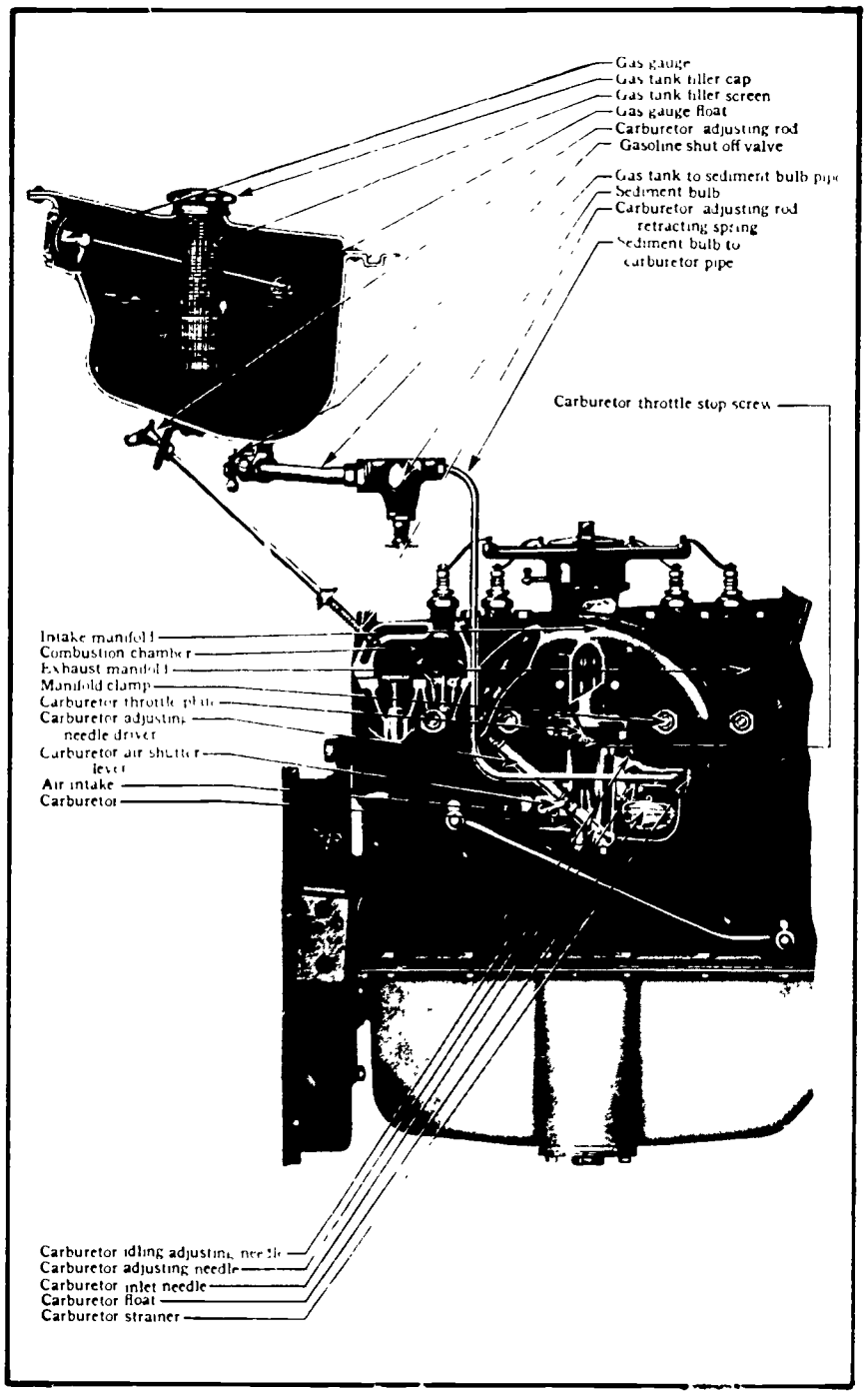
When the mixture of gas and air ignites, it explodes and pushes the piston down. This gives the power to turn the wheels. During this cycle, both valves will be closed.

During the next cycle the exhaust valve is open and the intake valve is closed. As the piston is pushed back up, the exhaust fumes go out the exhaust pipe.

The Ford engine is called a <u>four-cycle</u> engine because of these four cycles--1) intake, 2) compression, 3) power, and 4) exhaust.







THE FUEL SYSTEM

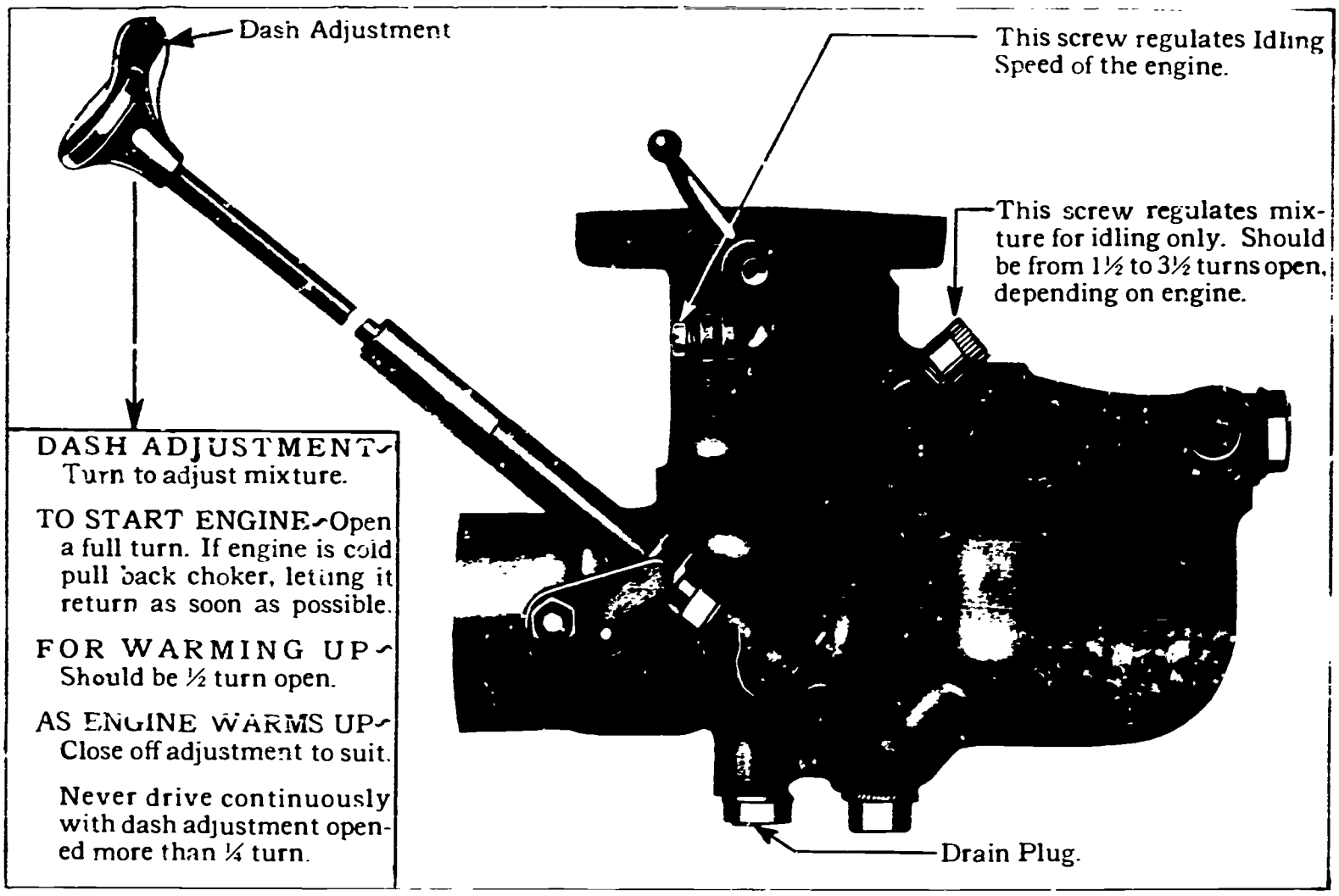
The gasoline flows by gravity from the tank to the carburetor. There it is mixed with air and drawn into the cylinders by piston suction. There must be exactly the right amount of fuel and air for the car to run well.

The amount of gasoline going into the carburetor is controlled by the float. The amount of gas mixture going into the intake manifold is controlled by opening or closing the throttle.

The richness of the gas mixture can be changed by turning the adjusting rod. A lean mixture gives long mileage. A rich mixture should be used for starting and warming up only.

Running with too rich a mixture makes too much carbon and causes overheating. It also wastes gas.

DASH ADJUSTMENT AND CARBURETOR



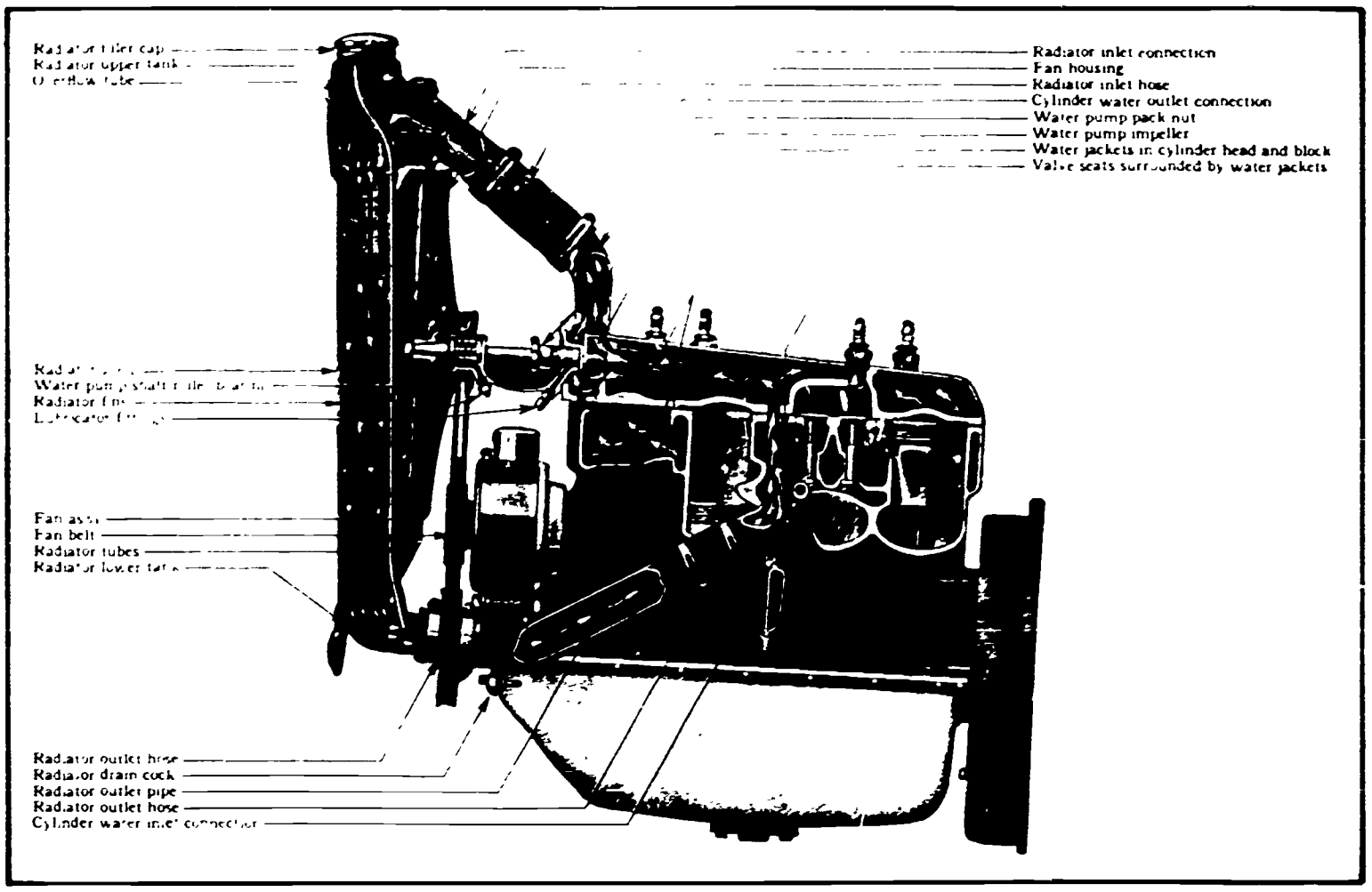
DASH ADJUSTMENT
Turn to adjust mixture.

TO START ENGINE
Open a full turn. If engine is cold pull back choker, letting it return as soon as possible.

FOR WARMING UP
Should be ½ turn open.

AS ENGINE WARMS UP
Close off adjustment to suit.

Never drive continuously with dash adjustment opened more than ¼ turn.



WATER-COOLING SYSTEM

When the fuel burns in the cylinders, much heat is generated. This heat must be removed or the engine will burn up and be ruined. This happens if all the water is lost from the radiator.

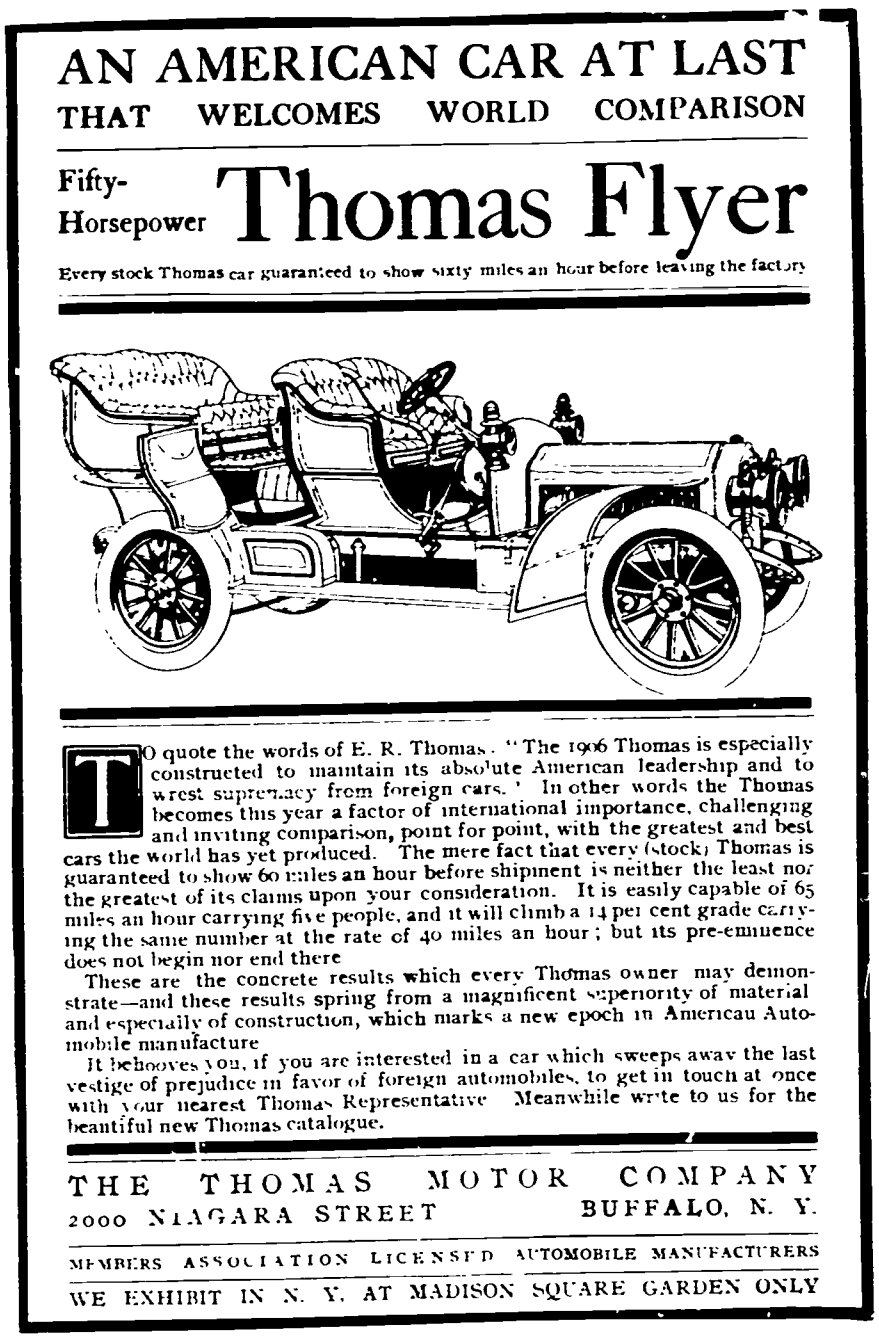
The Model A Ford engine is cooled by circulation of water through the water jacket which surrounds the cylinders, combustion chamber, and valve seats. The water is circulated by thermo-syphon action and a centrifugal water pump located in the front of the cylinder head. This is the same process as in the Model T.

The water pump draws the heated water from the engine into the upper radiator tank. This water then filters through the radiator. The fan behind the radiator pulls air through the radiator and cools off the water.

The water then goes through the engine to be heated by the cylinders and then cooled again by the radiator.

The fan is driven by a V-shaped rubber belt. The belt is shaped like a V to keep it from slipping on its pulley. It must be tightened sometimes by adjusting the generator support. The same belt runs the generator. The picture on page 38 shows this belt.

In the winter time antifreeze must be added to the water. This stops the water from freezing. If the water in the engine freezes, it will burst the tubes in the radiator and sometimes will crack the engine block.



AN AMERICAN CAR AT LAST
THAT WELCOMES WORLD COMPARISON

Fifty-Horsepower **Thomas Flyer**

Every stock Thomas car guaranteed to show sixty miles an hour before leaving the factory

TO quote the words of E. R. Thomas: "The 1906 Thomas is especially constructed to maintain its absolute American leadership and to wrest supremacy from foreign cars." In other words the Thomas becomes this year a factor of international importance, challenging and inviting comparison, point for point, with the greatest and best cars the world has yet produced. The mere fact that every (stock) Thomas is guaranteed to show 60 miles an hour before shipment is neither the least nor the greatest of its claims upon your consideration. It is easily capable of 65 miles an hour carrying five people, and it will climb a 14 per cent grade carrying the same number at the rate of 40 miles an hour; but its pre-eminence does not begin nor end there

These are the concrete results which every Thomas owner may demonstrate—and these results spring from a magnificent superiority of material and especially of construction, which marks a new epoch in American Automobile manufacture

It behooves you, if you are interested in a car which sweeps away the last vestige of prejudice in favor of foreign automobiles, to get in touch at once with your nearest Thomas Representative Meanwhile write to us for the beautiful new Thomas catalogue.

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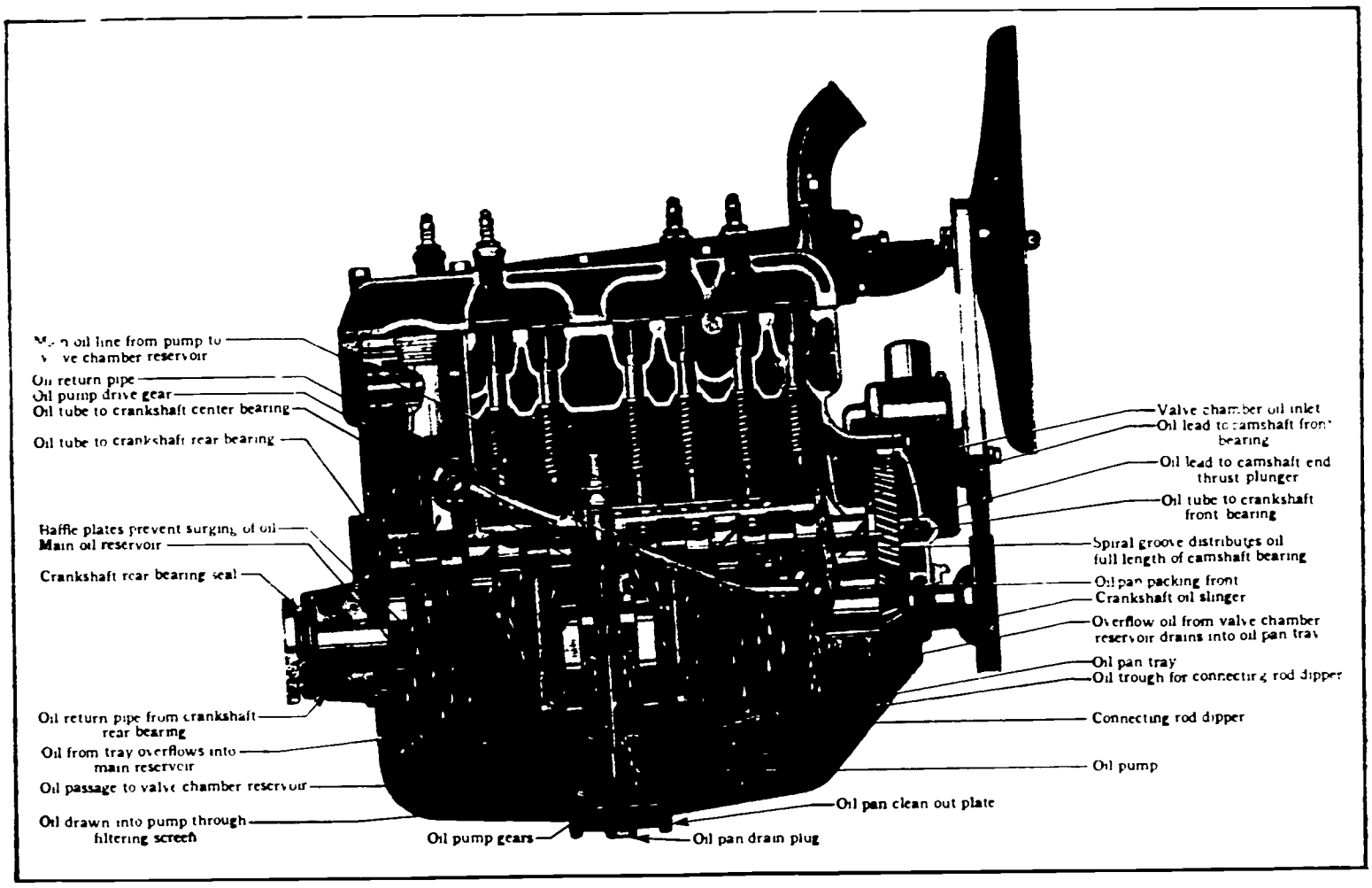


SECTIONAL VIEW OF ENGINE SHOWING LUBRICATION SYSTEM

This is the Model A engine. You can see all the parts. Can you find the valves? Can you find the pistons? The diagram shows all the details of the lubricating system.

The purpose of lubrication is to reduce friction between moving surfaces. When one metal part rubs against another, it will wear out quickly unless there is oil between the parts.

A lubrication system keeps oil between the surfaces.

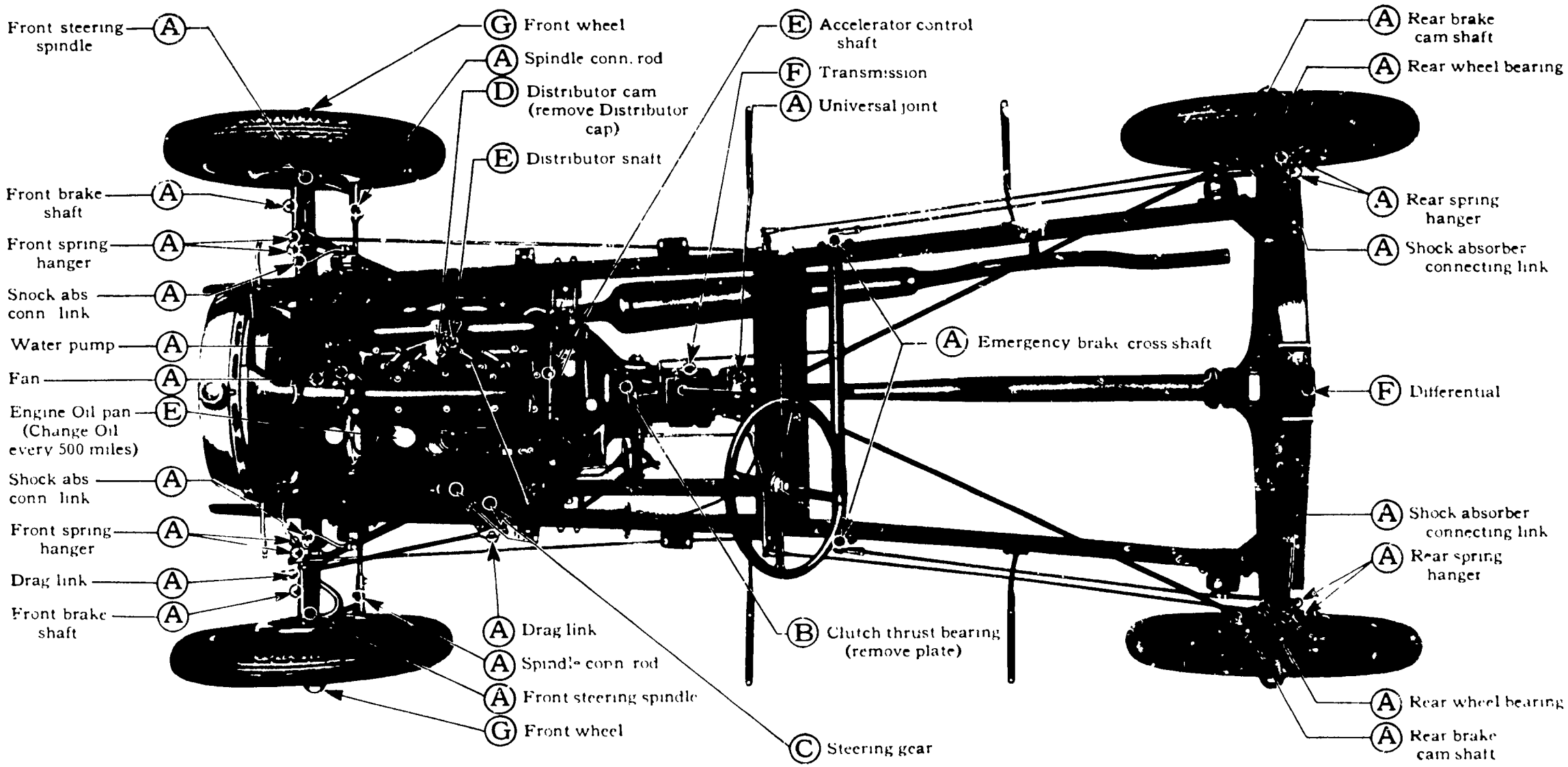
All parts of the engine are lubricated from the oil reservoir in the bottom of the engine. Some of it is splashed up over the moving parts by a connecting rod dipper.

An oil pump sends part of the oil to the top of the engine. Gravity causes it to flow over engine parts and then go back down to the reservoir.

Because of gravity, oil will flow down just as a ball will fall when you let it go. The same force of gravity does both things.

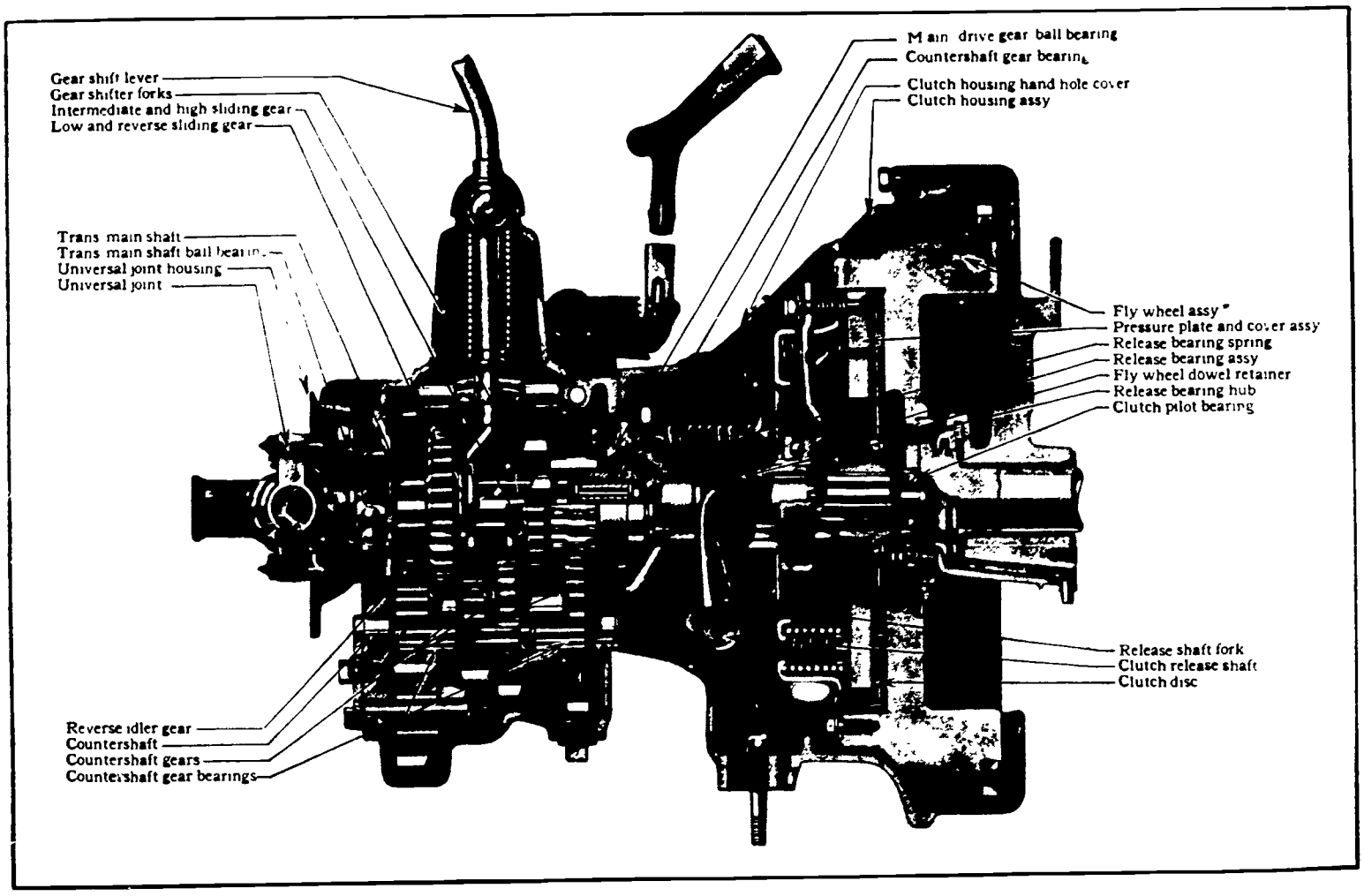
Most liquids get very thick in cold weather. Thick oil will not lubricate well. A lighter grade of oil should be used in cold weather.

OILING CHART



Ⓐ Grease every 500 miles (pressure gun)
Ⓑ Grease every 2000 miles (pressure gun)
Ⓒ Gear lubricant every 2000 miles
Ⓓ Clean and apply light film of vaseline every 2000 miles
Ⓔ Oil every 500 miles
Ⓕ Gear lubricant every 5000 miles
Ⓖ Pack with grease — every 5000 miles

TRANSMISSION AND CLUTCH OF THE MODEL A FORD



TRANSMISSION

When you shift gears you are shifting the gears in the transmission. These gears make it possible to go up steep hills and pull heavy loads. They also make it possible to back up.

The clutch connects the engine to the driveshaft. The two plates or discs in the clutch press against each other when the driveshaft is connected.

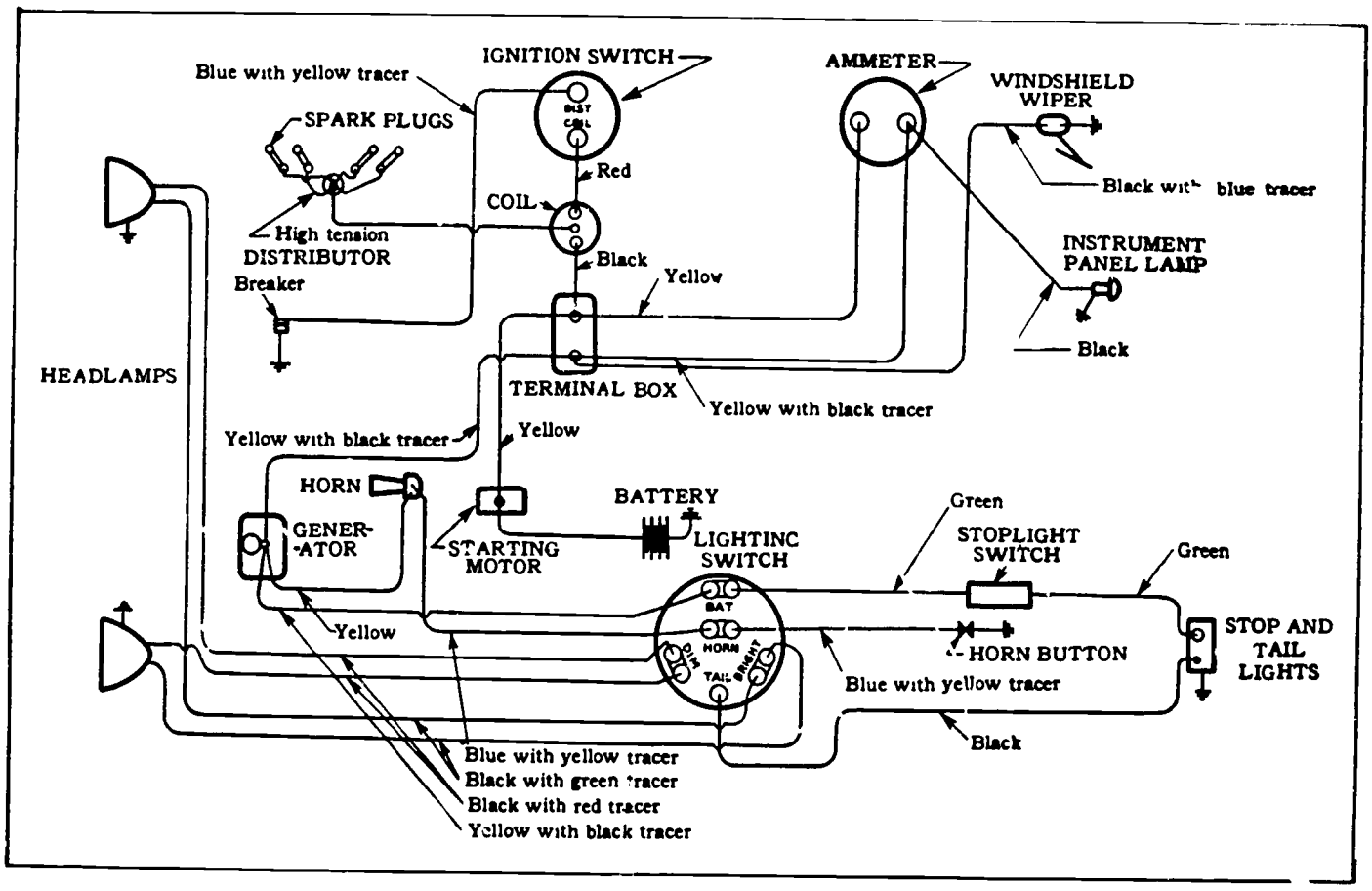
When you push in the clutch pedal it separates the two plates and disconnects the driveshaft. The engine can run this way without turning the wheels. When you press down on the clutch pedal, you can shift the gears.

The gears are arranged to give three speeds forward, and one in reverse. This is done by making the gears different sizes. The gears can also be in neutral. In this position the gears are apart. The wheels will then not turn even <u>when the clutch pedal is not down</u>!

Because of the gears, the engine can turn over faster than the driveshaft. When the engine is turning over at a set speed the driveshaft turns more slowly in low than in high.

The crankshaft will turn several times while the driveshaft turns once. The transmission makes it possible to start in low, shift to second, and then drive in high gear.

ELECTRICAL WIRING SYSTEM



The electrical wiring system of the Model A Ford car is shown in the drawing above. This is a typical automobile electrical circuit. Notice that it contains many smaller circuits.

Notice that the wires to the various parts of the electrical circuit are color coded. The wire running to the stop light is green. The wire running to the tail light is black. How many different kinds of color codes can you find?

The electrical wiring system of the Model A Ford has the following main parts:

1. storage battery
2. generator
3. starting motor
4. distributor
5. ignition coil
6. spark plugs
7. ammeter
8. horn
9. lights
10. windshield wiper

The first seven things listed above are really part of the ignition system. The ignition system is necessary to make the engine run. The car will run without the other four things, but they are required for other reasons.

The storage battery supplies electricity to start the car before the engine is started. The generator takes over the job of supplying electricity from the battery when the engine is running.

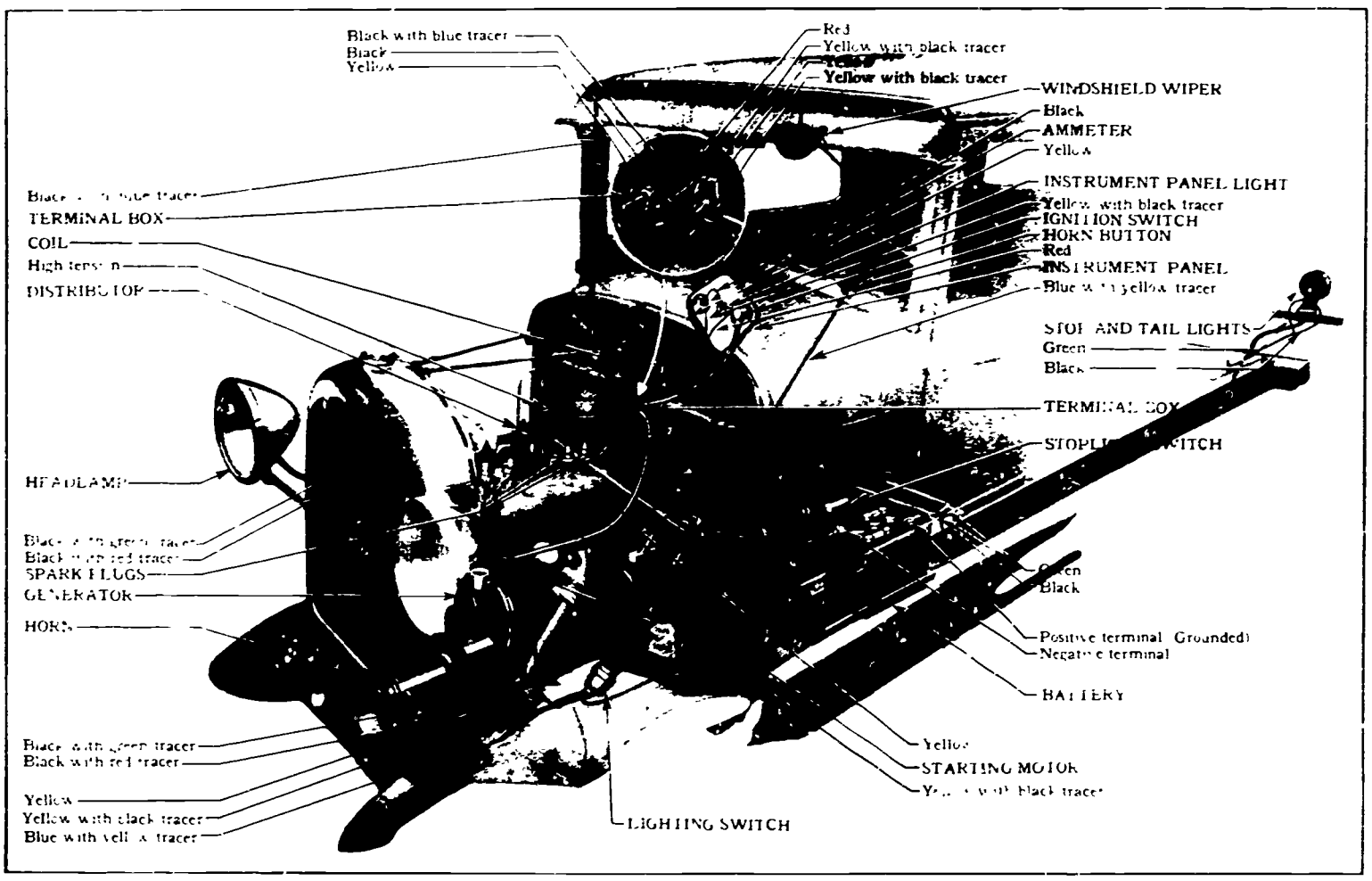
The starting motor turns the engine over so that the gas and air mixture is sucked into the cylinders and the spark can ignite it. When the engine has fired a few times, the starting motor disconnects. Before starting motors were used, automobiles had to be cranked with a hand crank to get them started.

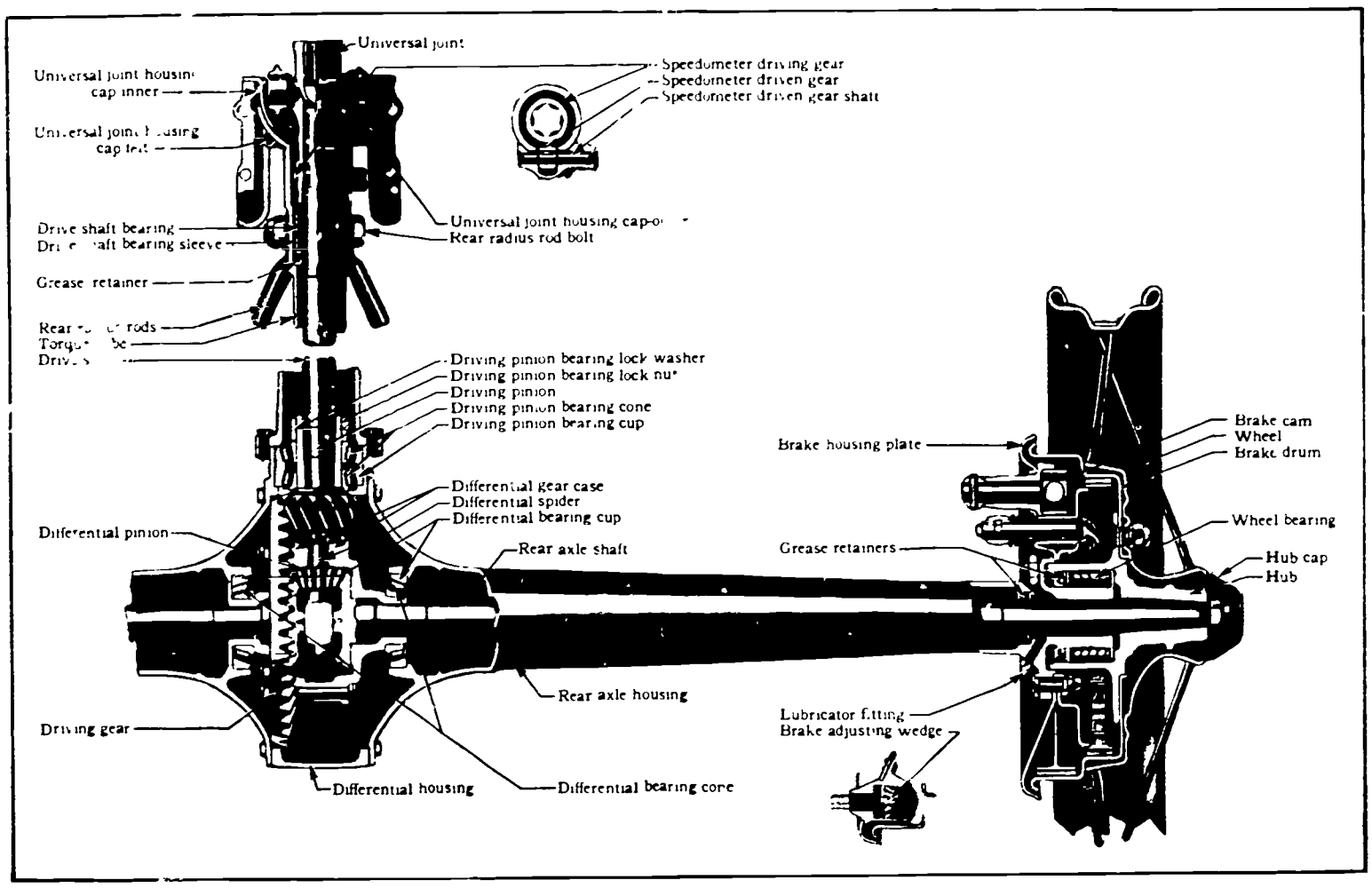
The distributor is a mechanical device which sends the electricity to each cylinder in time to fire that cylinder. The ignition coil, sometimes called the spark coil, builds up the voltage to the cylinders so as to make a hotter spark.

Spark plugs are used to get the spark into the engine cylinder to fire the combustible gas and air mixture. The spark is made by a high voltage current jumping a small gap.

The ammeter is located on the dashboard or instrument panel of the Model A Ford. It has a small needle which points to charge when the generator is charging the battery. The needle points to discharge when the battery is discharging. This could happen when the car lights are on and the engine is running slowly.

Below is another view of the electrical circuits of the Model A Ford showing their location relative to each other.





REAR AXLE ASSEMBLY

The rear end of the car is very important.

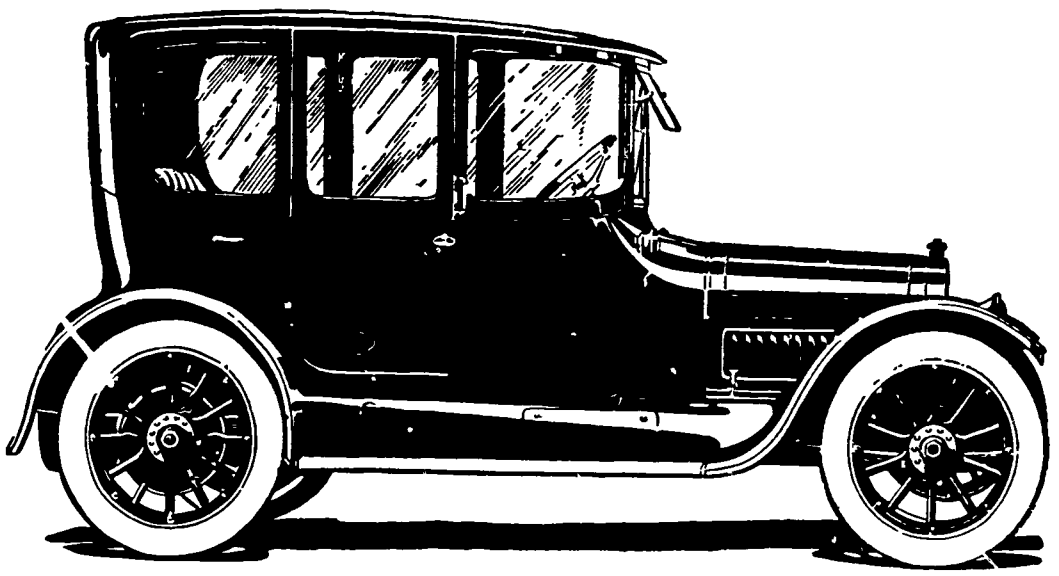
For one thing, the differential gear changes the direction of the power. This is done by bevel gears.

The differential gear allows one wheel to turn more slowly than the other. This keeps the car from skidding on curves. When turning, the inside wheel turns slower than the outside wheel. This is because it doesn't have as far to go.

SPRINGS AND SHOCK ABSORBERS

The Model A Ford has leaf springs to soften the road bumps. It also has hydraulic double-acting shock absorbers.

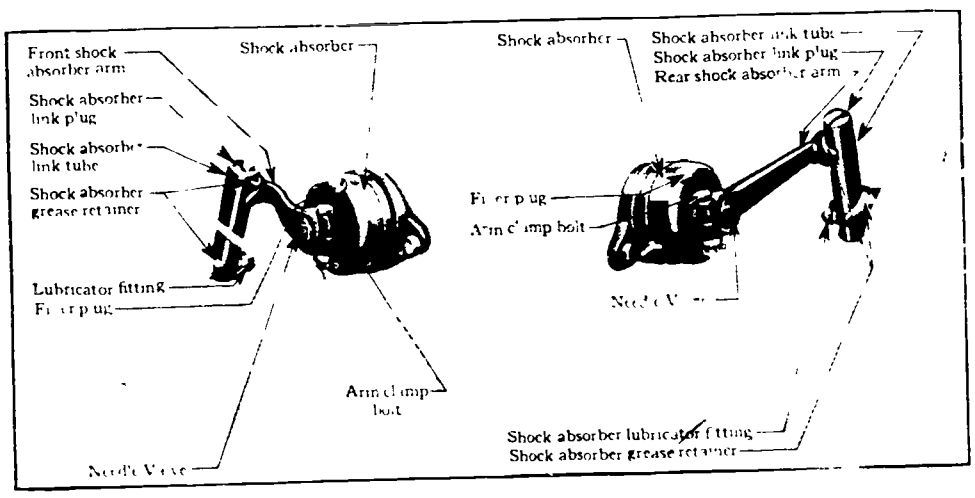
Here is how the shock absorbers work: A thick, syrupy liquid called glycerine is forced from one chamber into another by the movement of a lever arm. The up-and-down movement of the car pushes the glycerine through a needle valve. This cushions the shock of the movement and gives an easier ride.



SEDAN
(Five Passenger)
$2800 F. O. B. Detroit

The needle valve can be set to either increase or decrease the resistance. To understand what resistance means, imagine trying to pour water into a funnel. If the funnel has a marble in the nozzle, the water can't go through as fast because the marble is clogging the nozzle. In other words, it is resisting the flow of the water.

On hydraulic shock absorbers, the needle valve can be sticking out of one hole so far that the glycerine can't get into the other chamber as fast. This increases the resistance and makes a good shock absorber. The heavier the load, the more resistance that is needed.



Front Shock Absorber **Rear Shock Absorber**

BRAKES

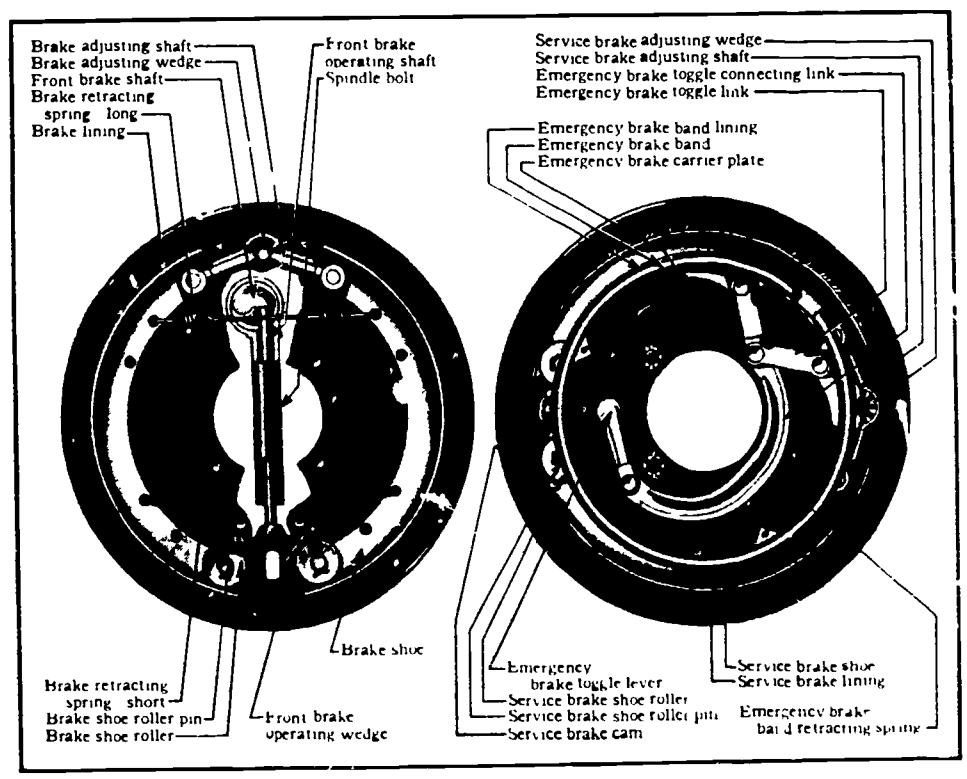
The brakes cause the car to stop or slow down. On the Model A Ford, it does this by pressing the brake lining against the brake drum. This causes friction.

The brake lining is made of asbestos. As the lining wears away, the brake shoes must be tightened, and the lining must be replaced once in a while.

The braking system has four internal expanding service brakes, one on each wheel. Internal means "from the inside." Expanding means to "spread out" or "increase." A balloon expands when you blow air into it. When you press down on the brake pedal, the brake shoes expand inside the brake drum. This causes the wheel to stop turning.

There is also an emergency brake in addition to the regular or service brake. It uses the same brake drums and brake shoes as the service brake.

It operates from a hand lever inside the front compartment of the car. It is usually used when parking. If the service brake fails, the car can be stopped by the hand brake.

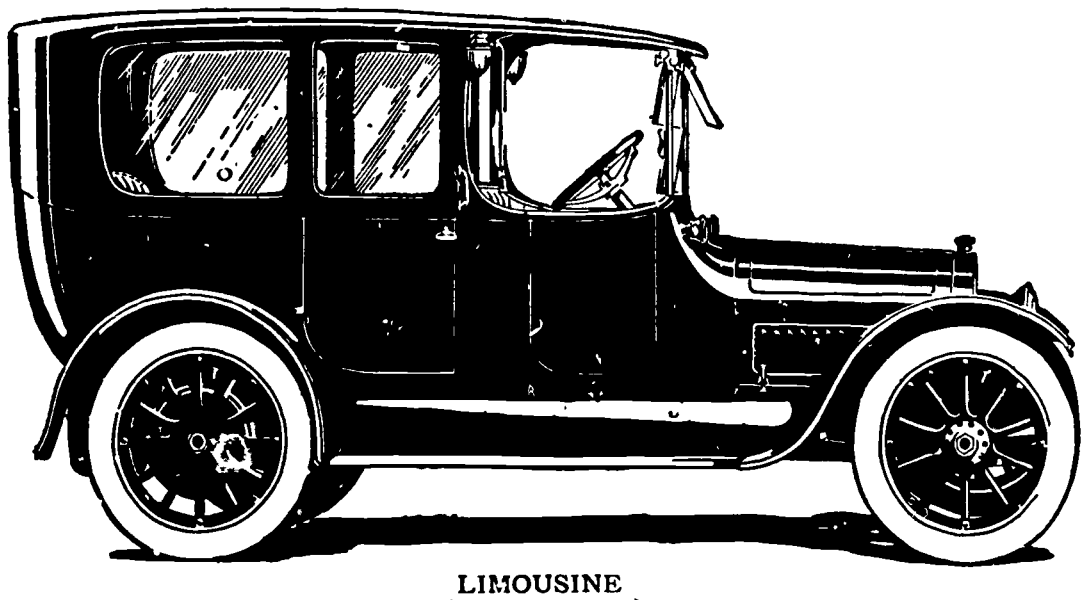


Front Brake **Rear Brake**

THE CHASSIS

The chassis of a car is made up of the frame, axles, steering assembly, brakes, wheels, and tires. On the chassis is mounted the body of the car and the engine.

The chassis moves over the road and bumps along. But the engine does not move so much. In order to allow for this differing motion, a universal joint is placed in the driveshaft.



LIMOUSINE
(Seven Passenger)
$3450 F. O. B. Detroit

PART C. OTHER OLD CARS

Parts A and B of this book cover two periods of about 25 years. Other automobile manufacturers brought out many other makes of cars. Just the names of all these manufacturers make an impressive list.

This section of this book will tell you about how some of these other cars operated. You will see that the basic principles are the same. Only the details of how the manufacturer goes about it is different.

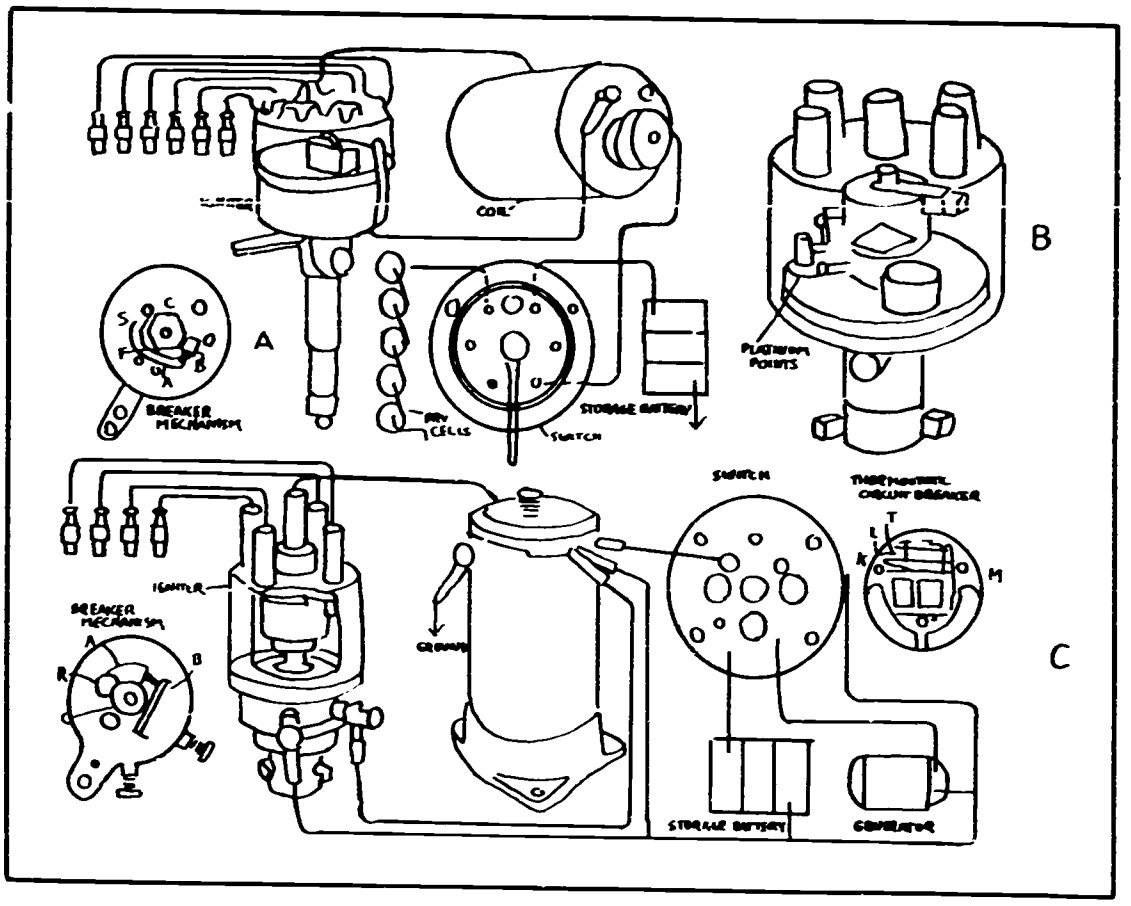
THE IGNITION SYSTEM

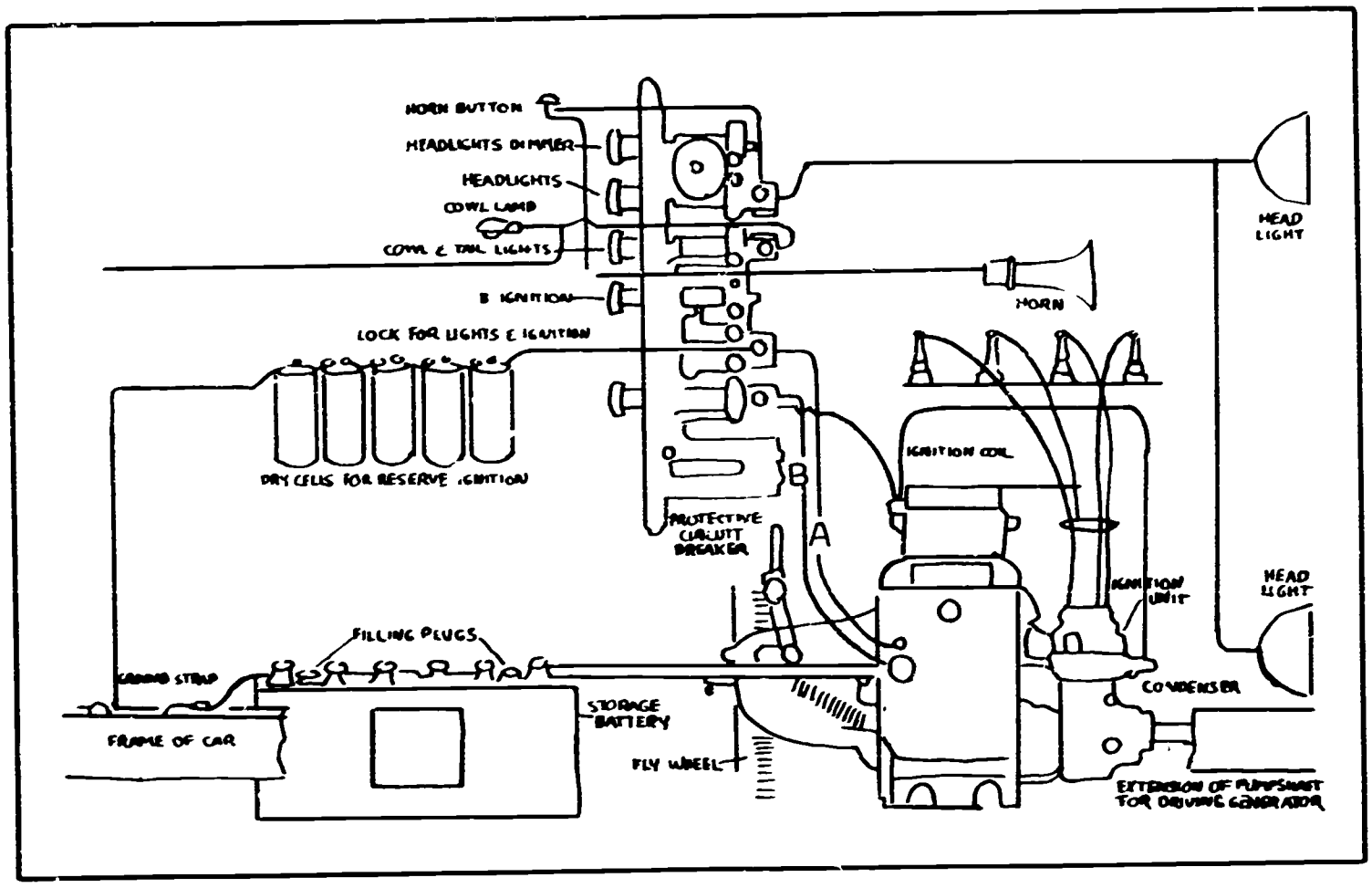
The ignition system is made up of a battery, an induction coil, and a timer.

The battery can be a set of dry cells or a storage battery to supply current for the ignition system.

The induction coil makes the power from the battery stronger. The power must be strong enough to make the spark jump across the air space on the spark plug. This is called a high tension system.

The timer control and sends out the current (electric power) to the cylinders at the right time.





Some early cars, such as the Locomobile, used a typical double ignition system. This type of system can be broken into primary and secondary systems.

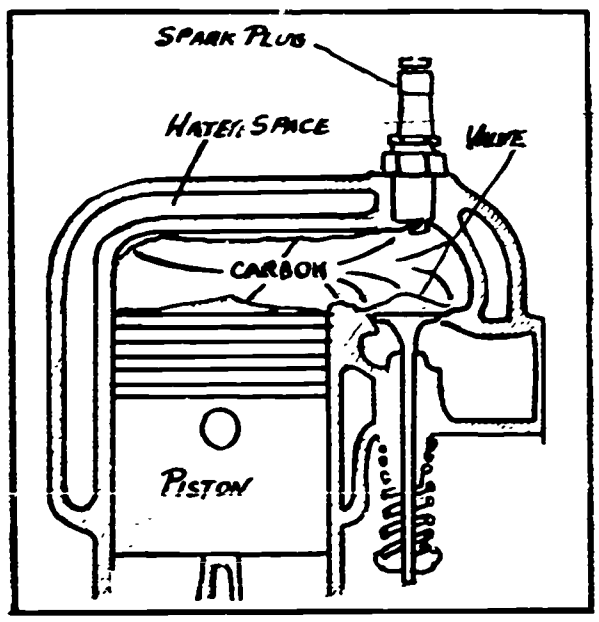
The secondary system directs the high tension current from the induction coil to spark plugs. If the wires are too close in the secondary system, a spark will jump out from one wire that does not have electricity running through it. This is called electrostatic action. Besides supplying the spark needed in the spark plugs, the wiring system supplies electricity for the headlights, tail lights, and dashboard lights.

VALVE TIMING

Timing on all machines is very important. The timing in each valve of a car must be exact. Valves open and close. It is important that they open when they are supposed to open and close when they are supposed to close. If the valve opens at the exact time that it is supposed to, it will have full power. If the valves open too soon or too late, much of the power is lost.

If a cylinder has an explosion too soon, the power is weak. Why is this? Because the piston has not yet pushed the air up high enough to make good pressure. This makes a weak explosion. The more pressure that's built up in the cylinder, the bigger the explosion. The bigger the explosion, the more power is made for the car. Remember, this explosion makes power. The power is what runs the car.

Each new car has a definite pattern for when the valves should fire. If the valve timing is wrong, the cylinders may work <u>against</u> each other instead of <u>with</u> the other. For example, think of soldiers marching down the street. When they are all <u>in step</u>, they move forward easily. But suppose two or three of them go "out of step." Then what happens? They start stepping all over and some may even fall. Once they get back <u>in step</u>, they can go forward easily again.

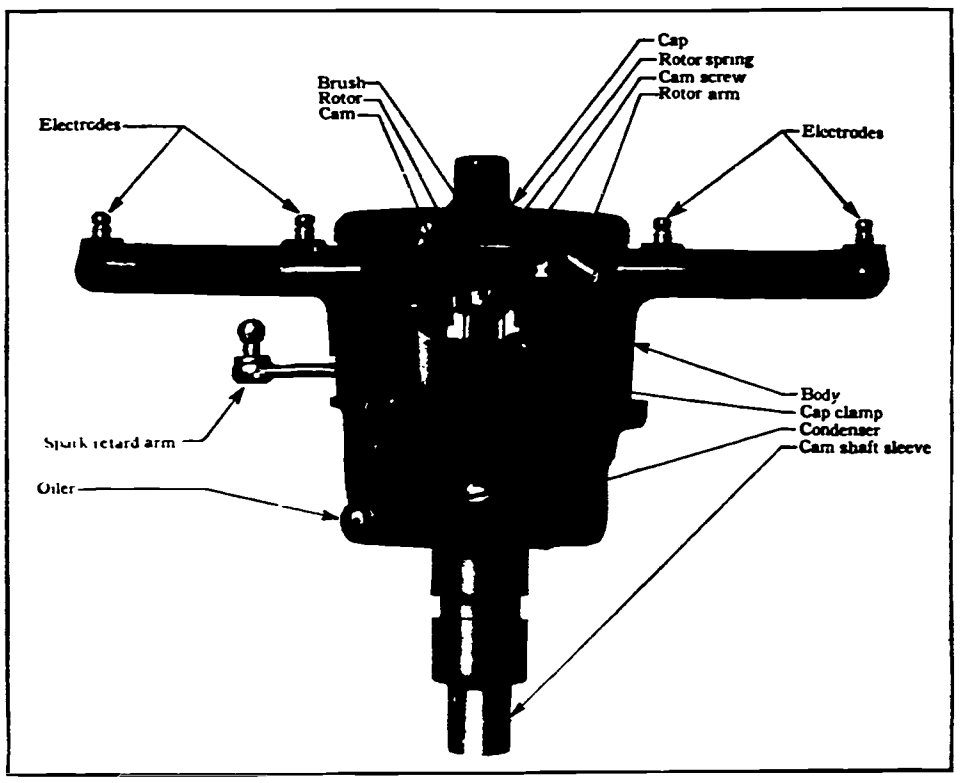


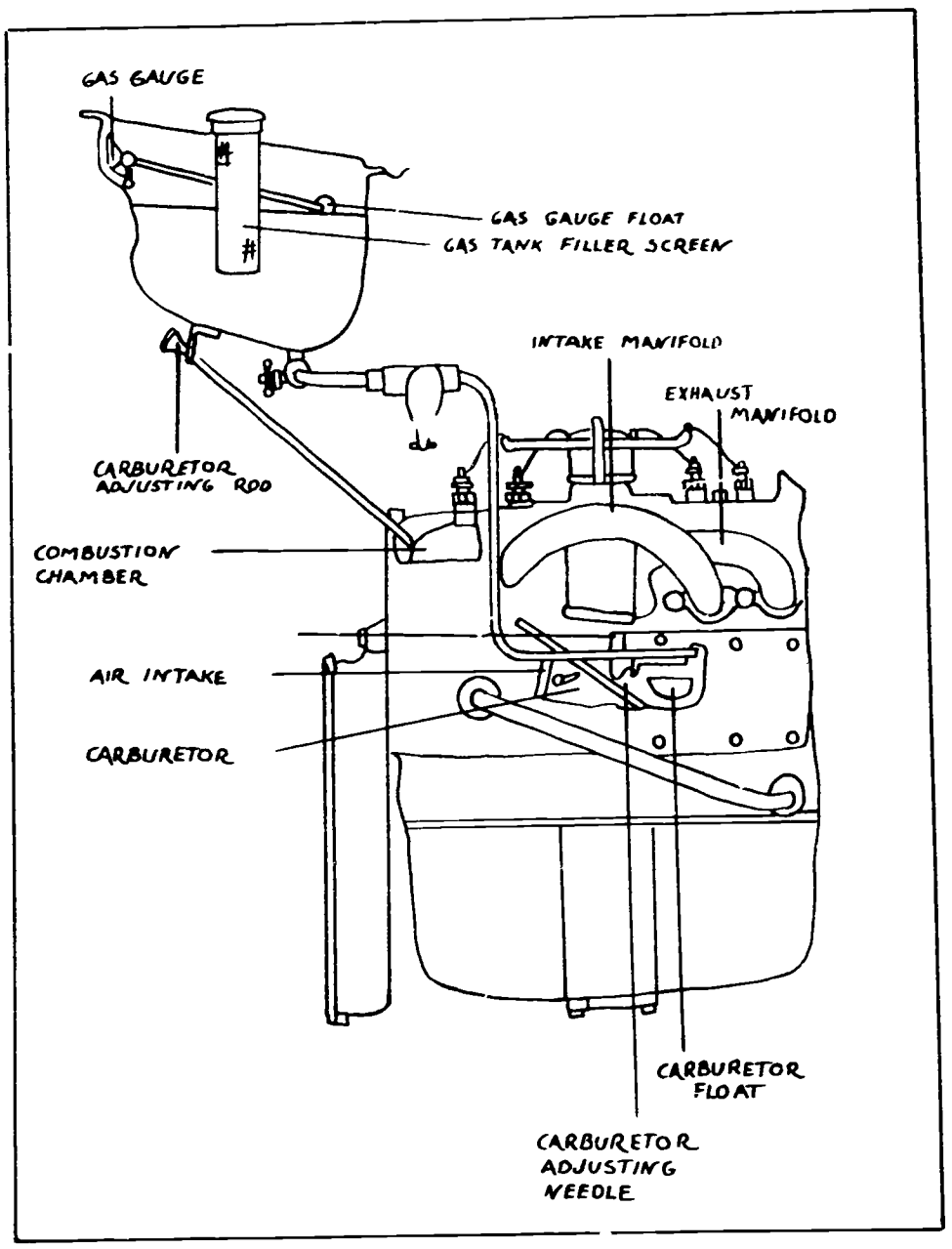
So you see, timing is important. A bad spark plug can sometimes make the explosion come too soon.

How does it do this? Well, explosion is fire, isn't it? Fire makes smoke and makes whatever is near it <u>black</u>. This black stuff is <u>carbon</u>. When a lot of it collects, it's like a piece of coal. When the explosions start, that makes the carbon like a piece of hot coal. When the valve opens to let the air and gas mixture in, it will explode before the piston pushes the air up to make the pressure.

The carbon also collects on top of a valve. And that, too, can cause the same kind of early explosion.

The timer is part of the <u>distributor</u>.





FUEL SYSTEM

All engines need fuel to make them run. Most cars use gas. The gas is stored in the gas tank.

A pump called the fuel pump forces the gas out of the tank, through a tube called a fuel line. The fuel line is connected to the carburetor. The gas goes through the fuel line into the carburetor. There the gasoline is mixed with air.

The job of the fuel system is to give the engine cylinders a combustible mixture. Combustible means that it can be burned. We already know that means air and gas.

The simplest fuel system is the gravity feed system. Gravity means going down. When you throw a ball up in the air, it must come back down. Gravity makes the ball come down. In the gravity feed system the gas tank must be higher than the carburetor. Can you guess why? It is because when a car climbs a hill, the carburetor is in front of the car, the gas tank is in the back. The carburetor is higher than the tank. Gravity makes things go down, not up.

The fuel would not be able to get to the carburetor this way. With the gas tank higher than the carburetor, the gas will go down to the carburetor.

Some popular types of carburetors in 1900 were the Kingston, Schebler Model E, and the Breeze. The difference between them was in the type of valve which controls the mixture of gas and air which is sent to the cylinders. A valve is a moving piece of metal which acts like a faucet or spigot.

In the Kingston carbur tor, the valve is a needle valve. It is located on top of the cylinder. It screws down to control the size of the opening of the hole. From this hole the air and gas mixture is sent into the cylinder. If the hole is large, the mixture is rich. By rich we mean there is more gas mixed with the air than usual. If the hole is smaller, less gas and more air go through the valve. Less gas makes a lean mixture.

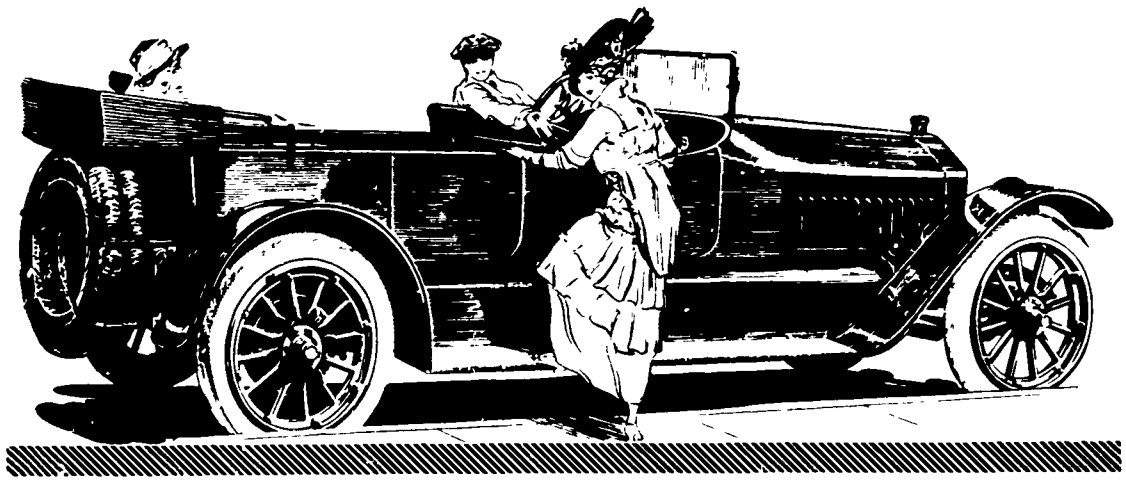
In early 1900, the Schebler carburetor had its needle valve in the <u>bottom</u> part of the carburetor. The valve was made of leather. The leather valve was held closed by a spring. By pushing on the spring, the valve made the hole small. By letting the spring loose, the hole would get bigger.

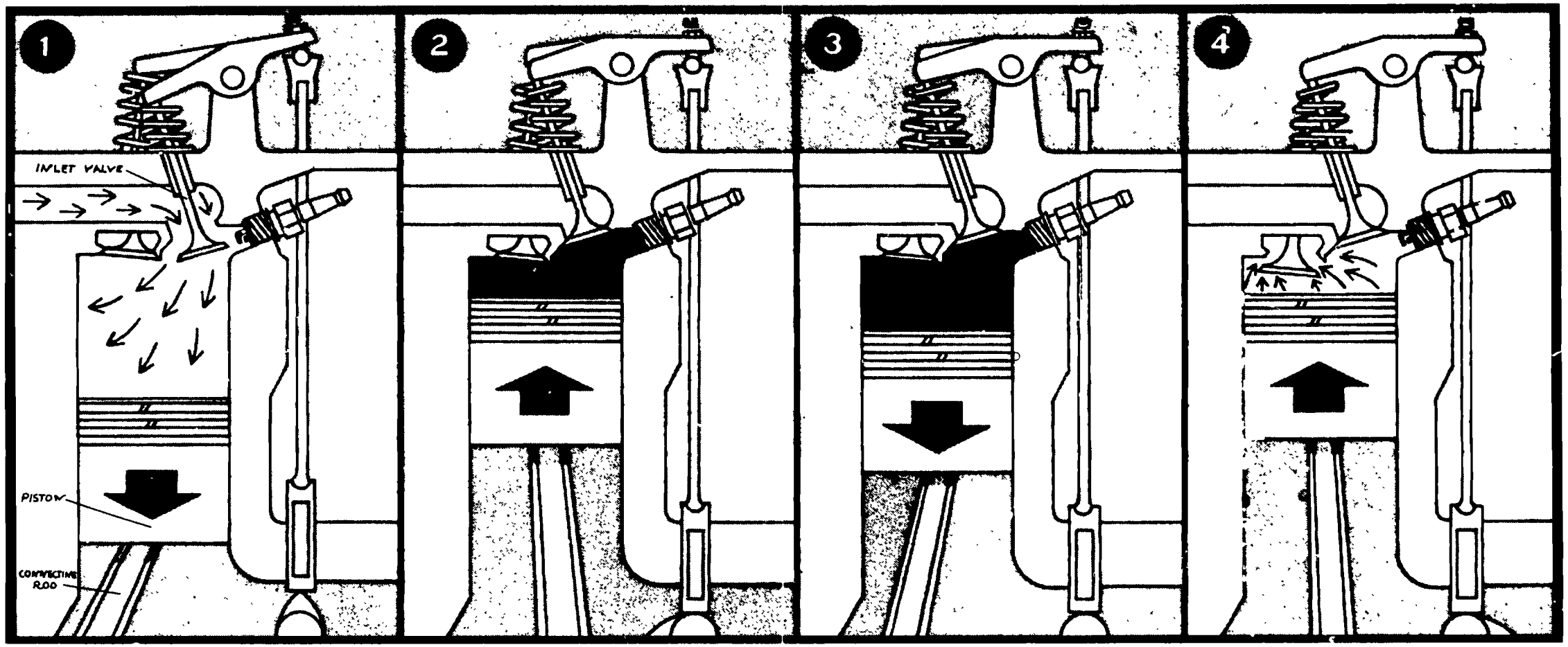
The Breeze carburetor had <u>two</u> valves:

1) A <u>needle</u> valve for the <u>gas</u> flow
2) A <u>spring</u> valve for the <u>air</u> flow

Another model of the Breeze carburetor had a metal ball which controlled the flow of gas.

When the gas leaves the carburetor, it goes into the cylinders.





HOW GAS IS CONVERTED TO POWER

1. A combustible air-fuel mixture from the carburetor is forced into the cylinder.

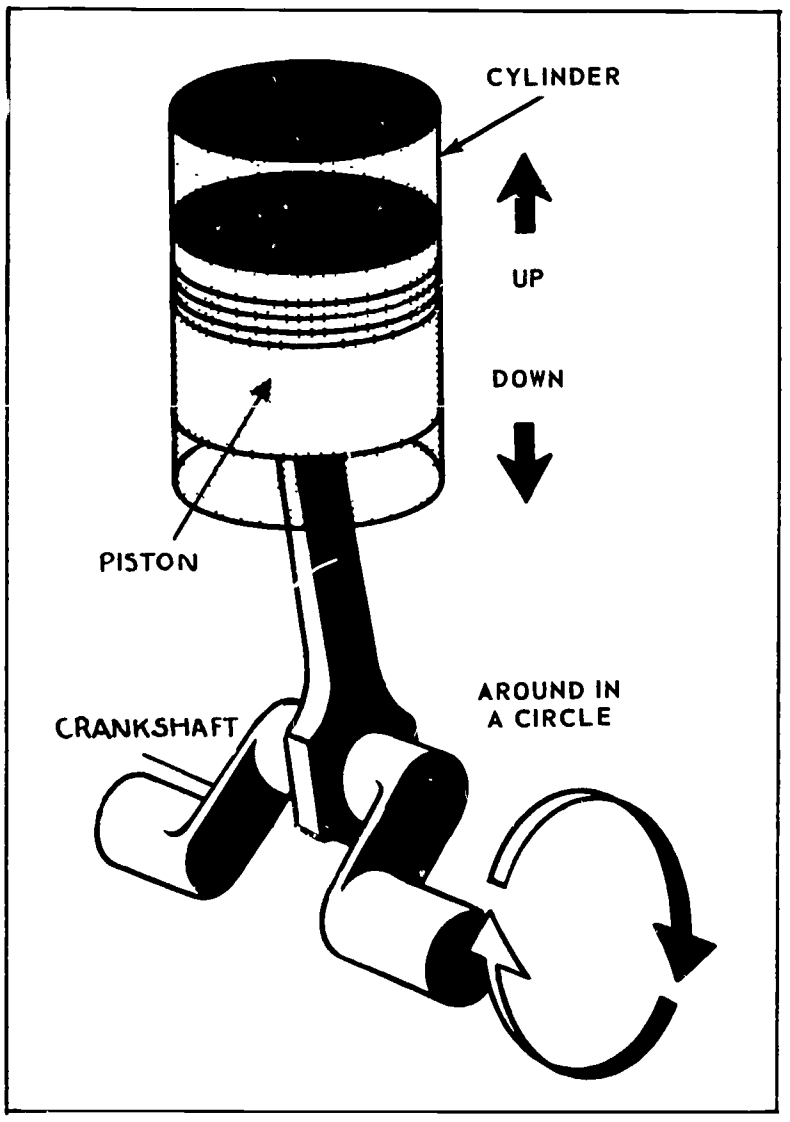
2. This air-fuel mixture is compressed by the upward stroke of the piston. Near the end of the stroke, ignition occurs when a spark leaps between the spark plug electrodes.

3. The air-fuel mixture explodes, furnishing the energy which pushes down the piston. The piston turns the crankshaft and flywheel, making the power which goes to the wheels.

4. On the exhaust stroke, the used combustion gases are forced by the piston out of the cylinder through the open exhaust valve.

PISTONS

Pistons move up and down in the cylinders of the engine. To get a good picture in your mind of how it looks, imagine two water glasses which fit into each other. The inside water glass is smaller than the outside one. But the inside glass fits into the outside one just loose enough so it can move up and down; but it's tight enough so that it slides on the inside walls of the outside glass. That's so no air will be able to escape between the two



walls. The outside glass is the cylinder; the inside glass is the piston. Of course, in cars the pistons and cylinders are usually made of steel.

The force of the explosion on the pistons is used to drive the car much as your weight drives a bicycle. Your weight forces one pedal of the bicycle down at a time. When your foot reaches the bottom, you shift your weight to the other foot driving that pedal down. You alternate your weight between the two pedals.

A four-cylinder car uses four pedals instead of two. These pedals are really part of the crankshaft. The connection between a piston and a crankshaft is called a connecting rod. On six-cylinder cars there are six pistons and six connecting rods. On an eight-cylinder engine there are eight of each, and so on.

In a four-cylinder automobile, each explosion happens at a different time. For instance, while cylinder number one goes to stroke one, cylinder two is exploding, cylinder three is opening its exhaust valve, and cylinder four is closing its exhaust valve.

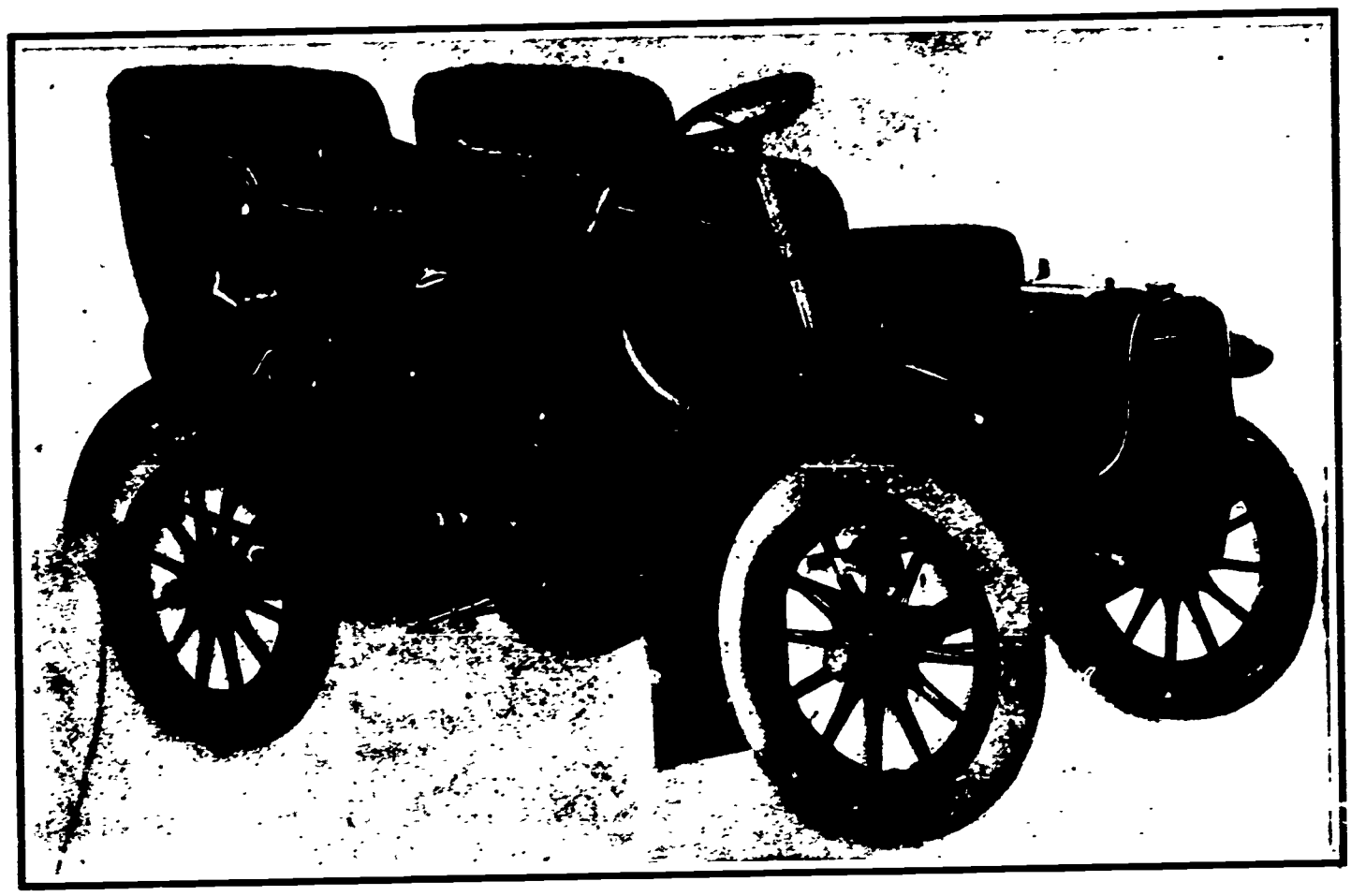
As the piston moves down the cylinder, the inlet valve opens. When the inlet valve opens, the gas and air mixture goes into the cylinder.

When the piston goes up, the inlet valve closes. The piston pushes the air and gas together. This makes pressure. The pressure is called compression.

The spark plug sticking into the cylinder lights the gas and air mixture, which explodes. This pushes the piston down again. When the piston has gone all the way down, the exhaust valve opens.

When the piston goes up again, the pressure pushes the burned gases out of the cylinders and the exhaust valve closes.

Each time the piston goes up, or down, it is called a stroke. Since the piston goes up twice and goes down twice before the same thing happens again, we have a four-(4) stroke cycle.



1906 CADILLAC

This is an 8-horsepower, single cylinder Cadillac touring car. It was known for its simplicity and service. It was so constructed that any of the parts could be easily and cheaply repaired.

It got 20 and sometimes as much as 40 miles to a gallon of gasoline.

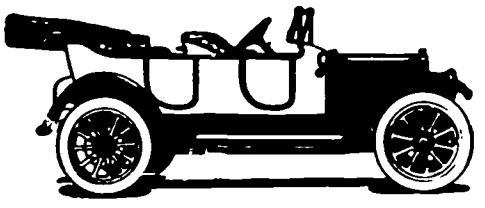
The 1912 Cadillacs were very popular. Fifteen thousand of them were produced that year. The pictures on page 79 show the variety of styles.

As you will notice, the seven-passenger limousine sold for a little more than three thousand dollars. Do you know how much a Cadillac costs today? Can you buy a new one for $1975.00 today?

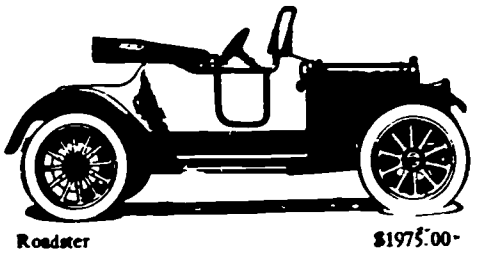
Notice, too, that four of the six models were convertibles. They were very stylish in 1912.

There were no trunks on these cars, but if you'll look for the <u>running board</u>, near the back wheels you'll see the tool box.

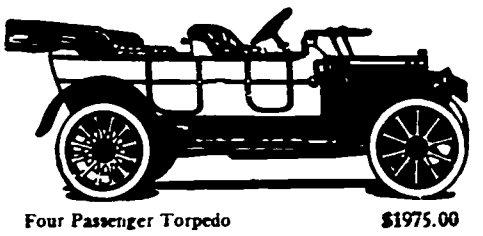
Six models of the 1912 Cadillac



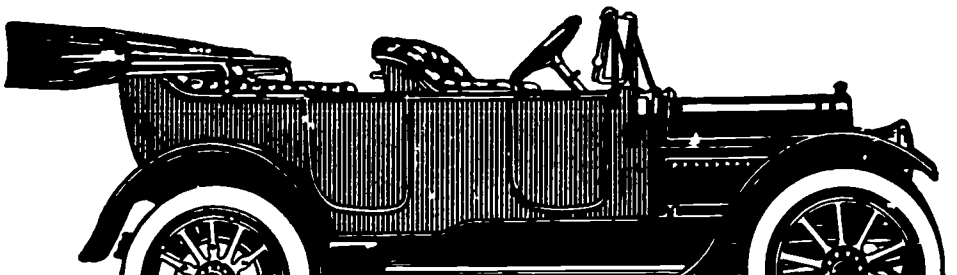
Four Passenger Phaeton $1975.00



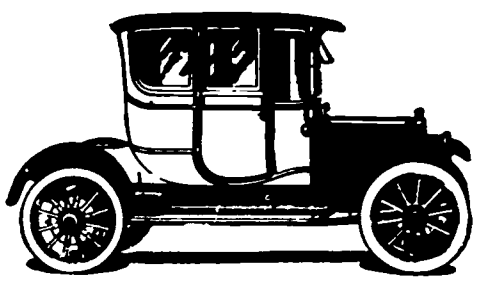
Roadster $1975.00



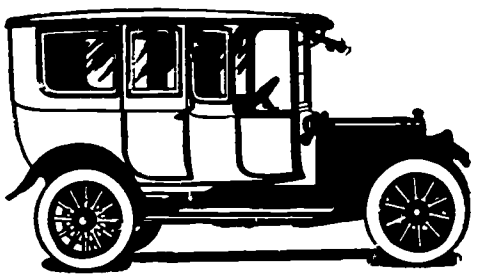
Four Passenger Torpedo $1975.00



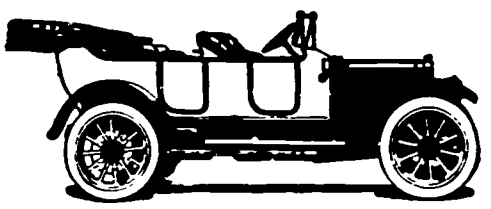
Five Passenger Touring Car $1975.00



Four Passenger Coupe $2500.00



Seven Passenger Limousine $3250.00



Six Passenger Car $2075.00

THE CLUTCH

There are two kinds of clutches:

1) The <u>cone-type</u> clutch (shaped like a cone)

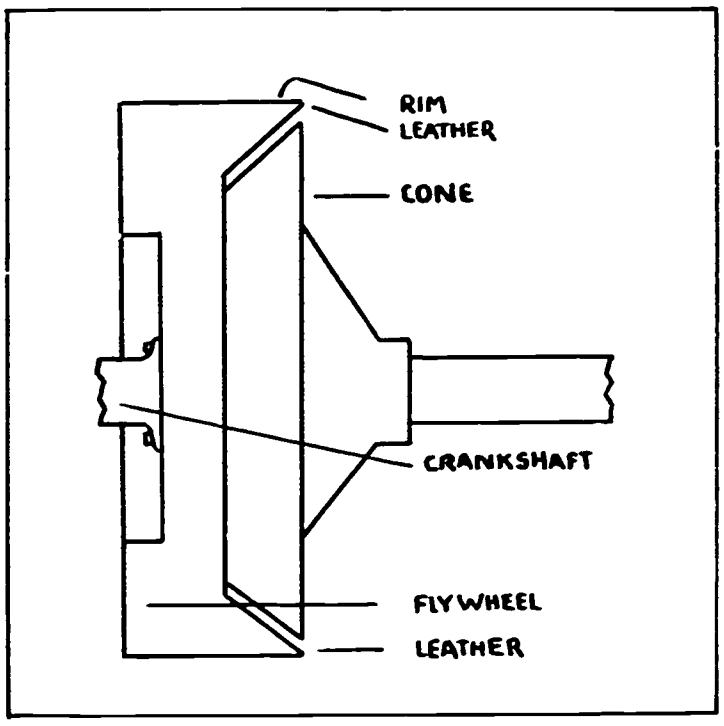
2) The <u>plate and disc</u> clutch

The cone-type clutch is a very good clutch.

It comes in two parts:

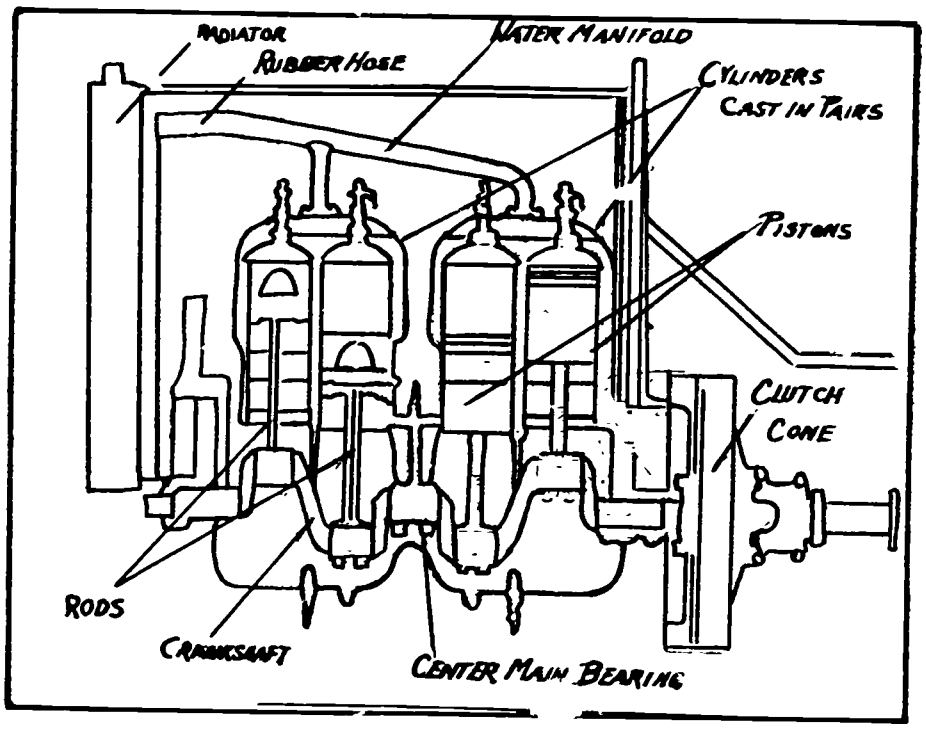
A) The flywheel rim--outside part

B) The cone-shape saucer--inside part



The cone-shape saucer (B) is covered with leather. Leather is used because a <u>friction</u> surface is needed to hold the flywheel rim and the cone tightly pressed together. Because of friction, whatever touches it won't slip off. The power from the driveshaft (the driveshaft that is connected to the axle and turns the wheels) goes through the leather.

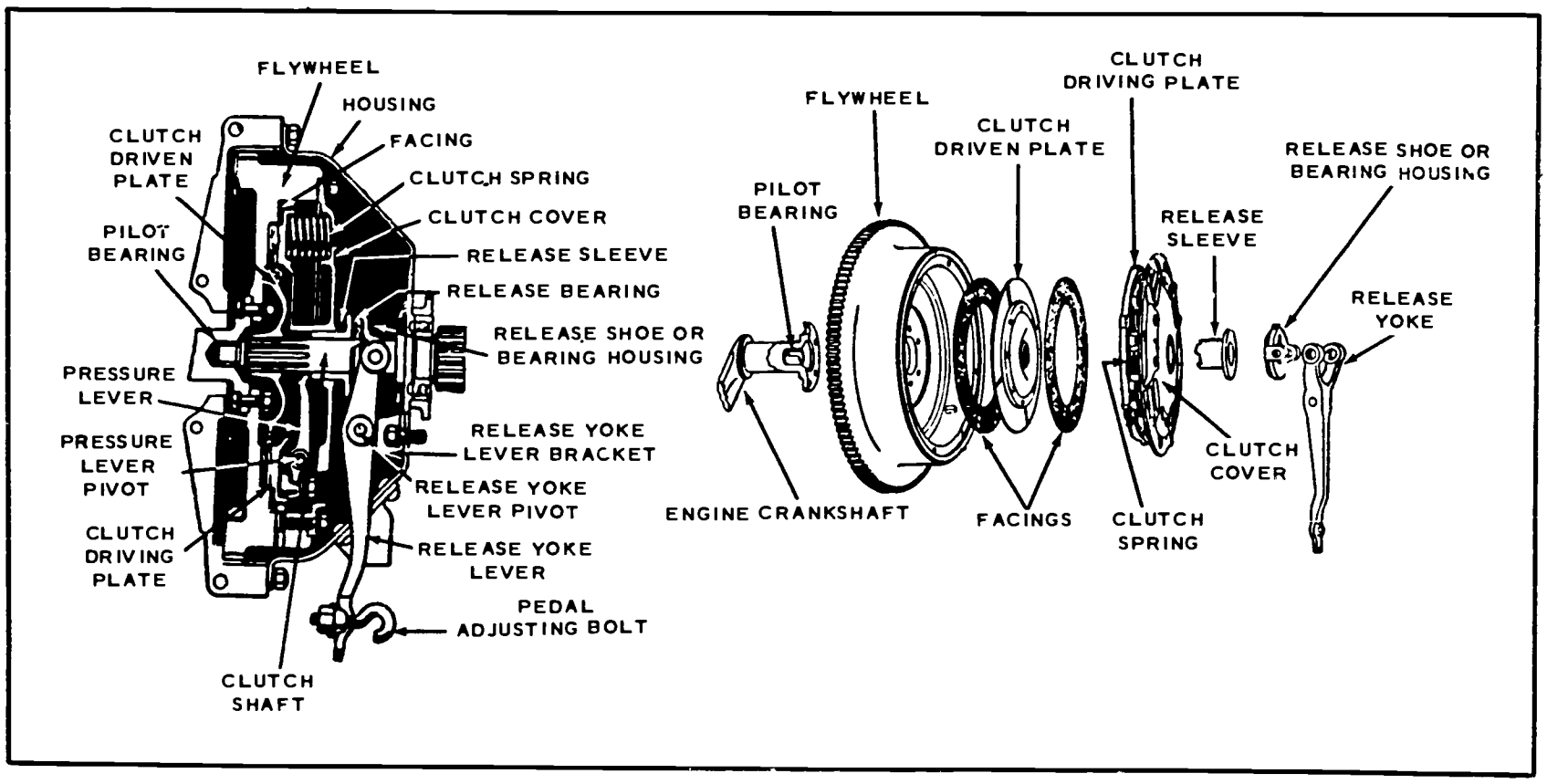
Once you press down on the clutch, you separate the cone and flywheel. The motor runs but the car doesn't move because the cone and flywheel aren't touching. Once you let up on the clutch, the cone fits into the flywheel and because of the friction, it holds the gears in place, and the car moves again.

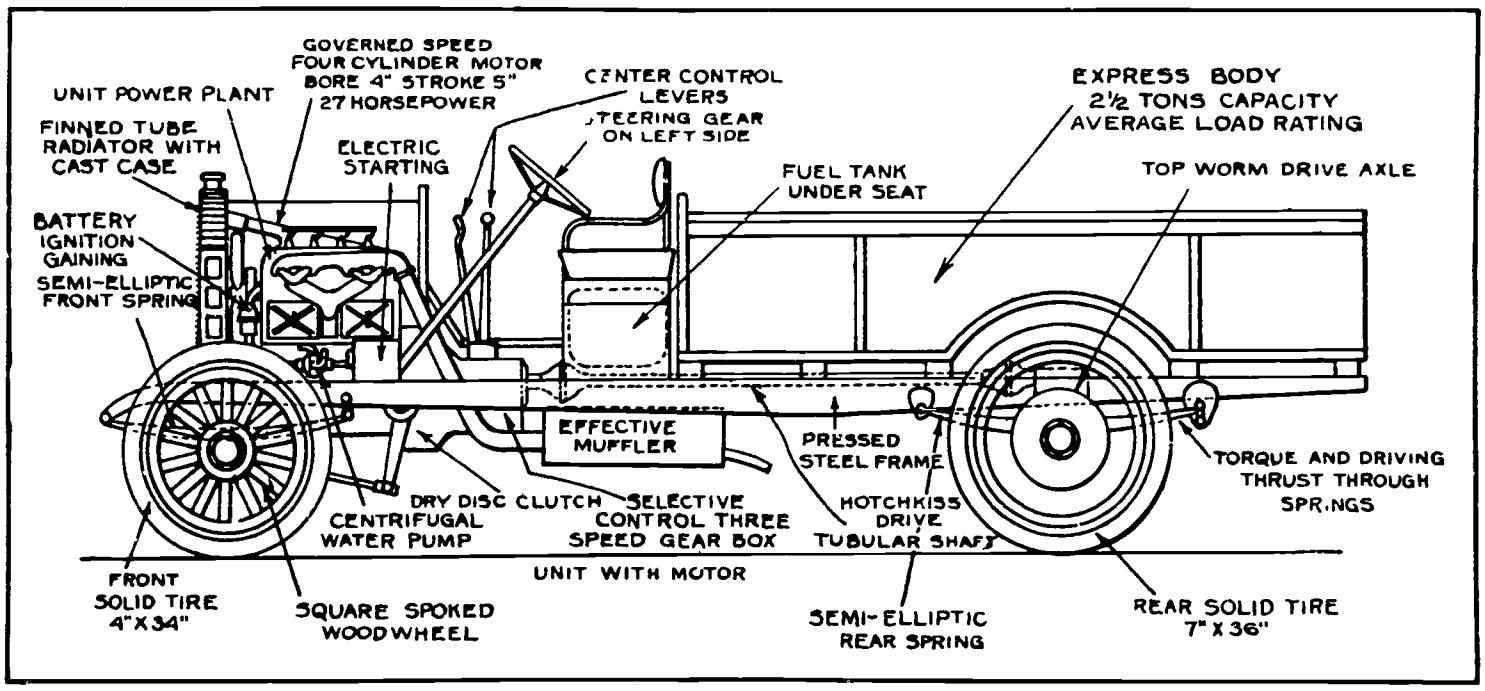


The second type of clutch is called the plate and disc clutch. In this type, instead of the leather cone which was pressed against the flywheel, we have a disc which has wedges, or grooves. The plate fits itself into the grooves by pressure pushed against the plate by springs.

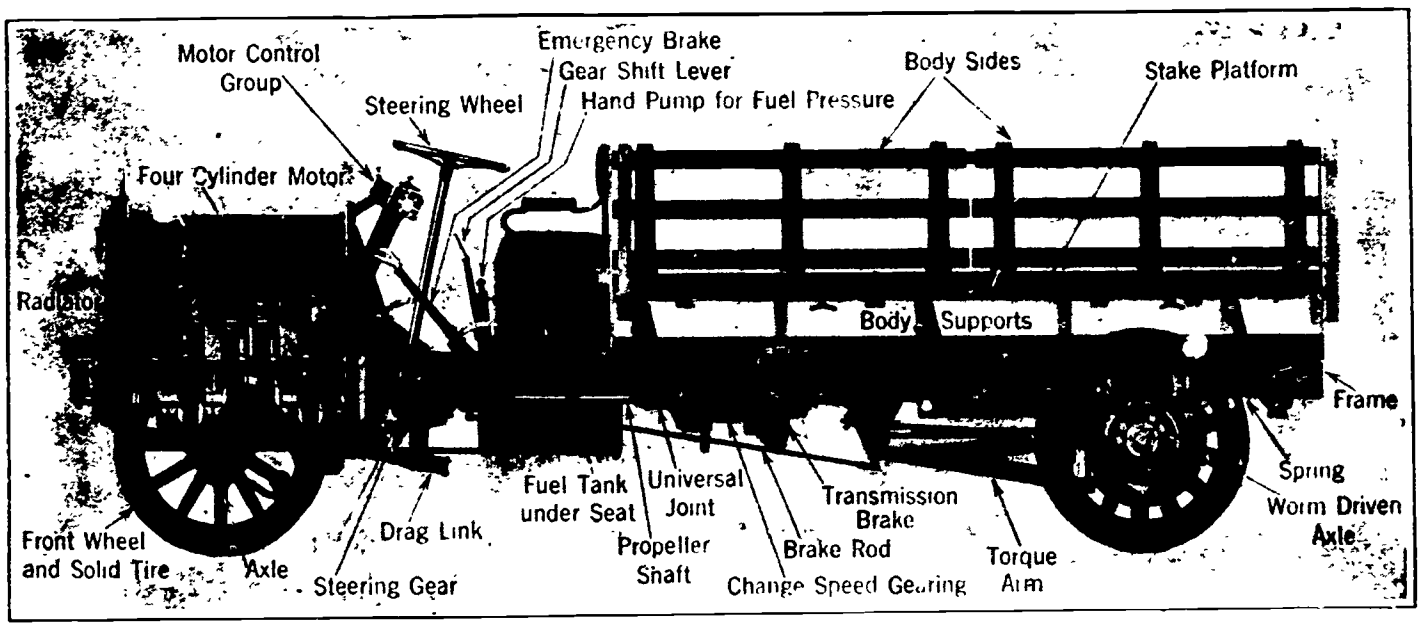
When the driver wants to change gears, he pushes in the clutch pedal. That causes the spring to come loose which separates the disc from the pressure plate. Because of this, the driveshaft is separated from the crankshaft.

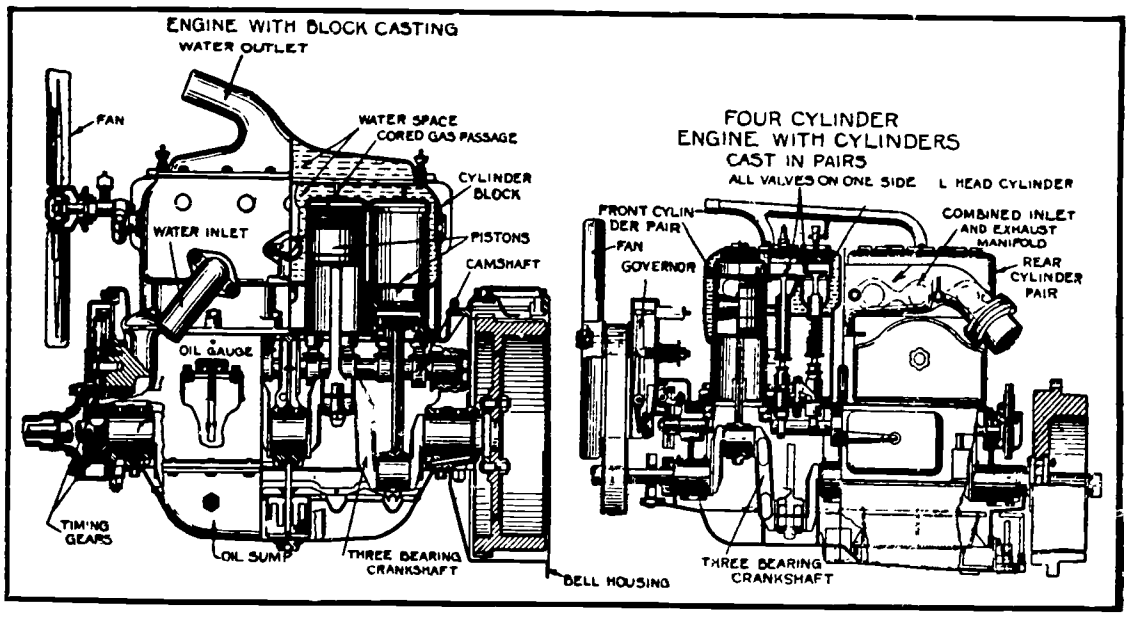
The car is now out of gear and won't move. When the driver shifts the gear and lets the clutch up, the car is in gear again and moves in whichever gear he has selected.



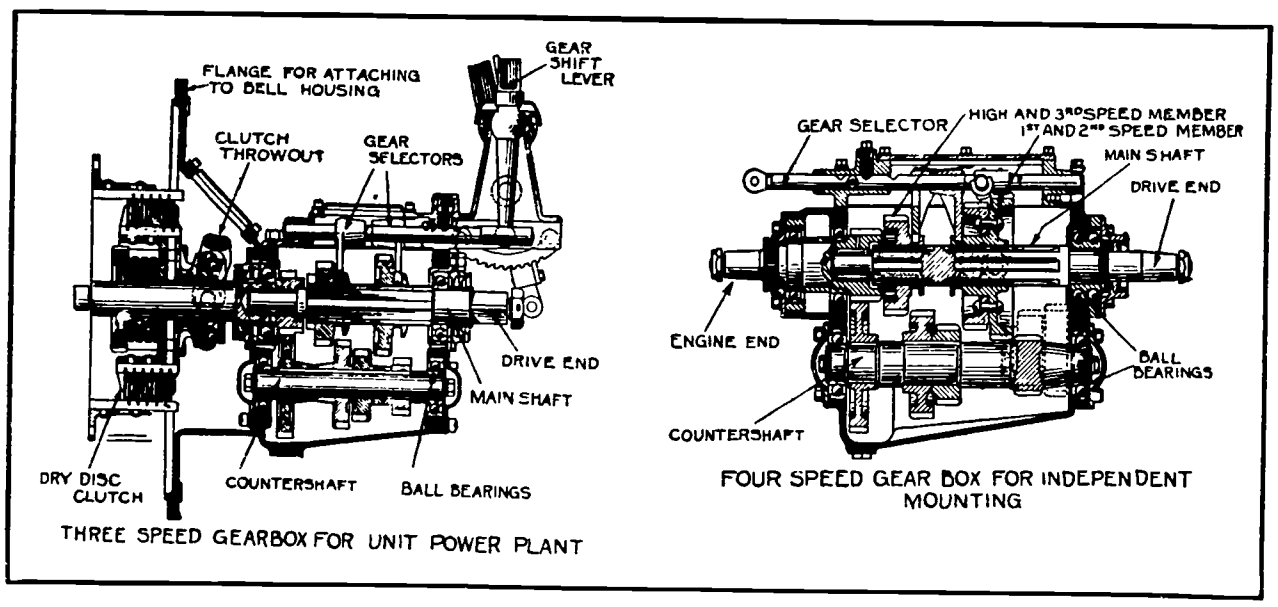


Views of 1917 Motor Truck





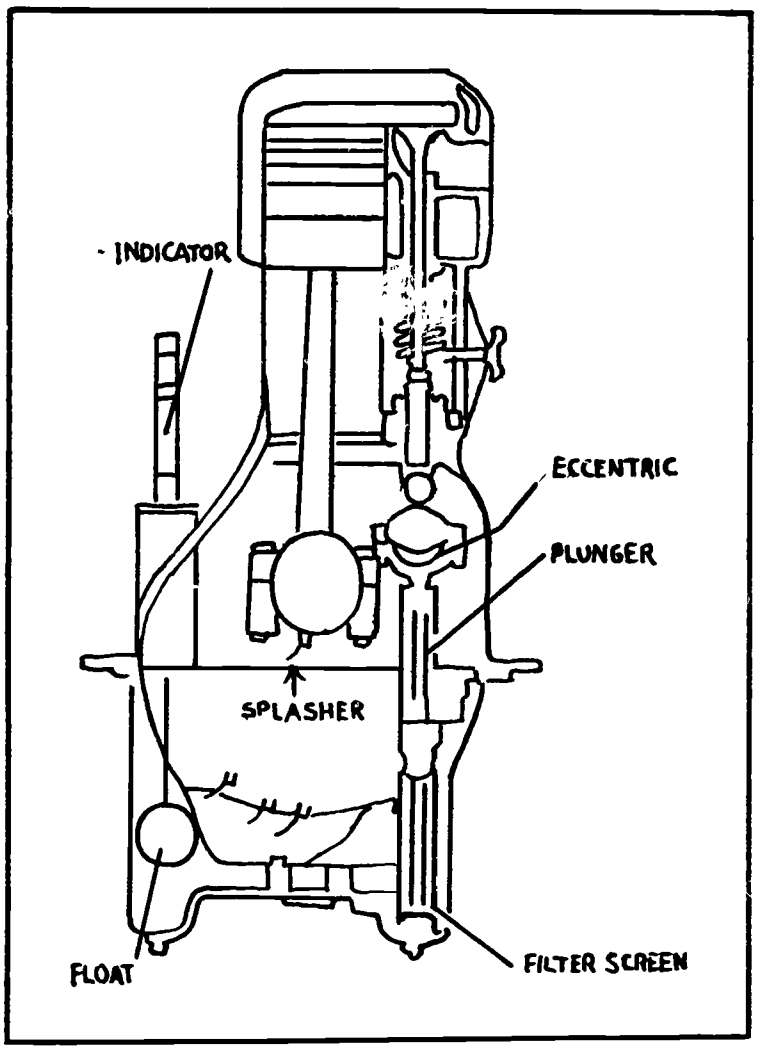
Two types of engines used in the 1917 trucks



Two speed changing gears used in the 1917 trucks

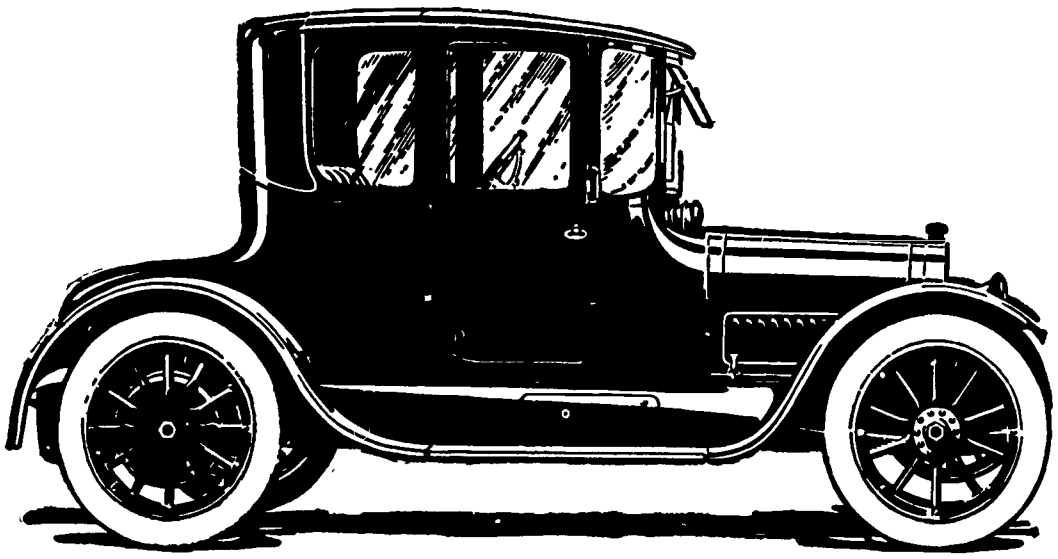
LUBRICATION SYSTEM

The Overland automobile used a constant-level oiling system. This means that at any speed and any road condition, the oil level remained the same. The oil is pumped through a fine mesh screen. The oil oozes through little openings on the bearings. The oil pan directly under these bearings catches the oil and so is always full. In this way, the bearings are always supplied with oil. This is why it is called a constant-level oiling system.



Another system worked this way: The lower end of each connecting rod had an oil dip which scooped oil directly to the bearings and piston. Think of a bicycle going through deep water. As the pedal goes through the water, it picks up some of the water. When the pedal gets to the top, the water drips off.

The cleaning of the oil screen is very important in this type of lubrication system. If the screen becomes dirty, the oil will contain dirt. This dirt would then ruin the engine parts.



LANDAULET COUPE
(Three Passenger)
$2500 F. O. B. Detroit

In 1900, the Pierce-Arrow used a lubrication system which was very different. In this system, oil is drawn from an oil container at the bottom of the crankcase to a reservoir at the top of the cylinders. The oil is pumped to a reservoir through large oil tubes coming from the container. Both the oil reservoir and the crankcase are slanted at a twenty-five degree angle. This lets the car go uphill or downhill without a loss in the oil supply.

Many cars, such as the Jeffrey or Abbott-Detroit, used two pumps. All of these cars had a float in their oil supply to show the oil level. When the float went down because of lack of oil, the gauge on the dashboard would show it. If the oil reservoir were full, the float would be very high. If the float were high, the gauge on the dashboard would show a reading of full.

COOLING SYSTEM

Hopping, skipping, running, jumping, and walking are all movements of your body. When you run, you get heated up because of the movement. You need to cool off. One way to cool off is simply to stop running. What would happen if your body kept all the heat in and could not cool off? Well, for one thing, you would burn out. Too much heat is bad for any body or mechanism.

A moving car makes heat just as a moving body does. The car, too, must cool itself or the great amount of heat would damage it. If a moving body stops, it will cool off. If a moving car stops, it will cool off, too. But if a car stopped every time it got hot, it would take a whole day to go five miles! Is there a way to be able to move and still be cooled off? Yes, the body does it by perspiration. We sometimes call it sweat. An automobile does it by its cooling system. Let's see how it works.

In the cylinders, air and gas mixtures are exploded by a spark from the spark plug. There are many explosions going on at the same time in many cylinders. These explosions make a lot of heat. This is one way a car heats up. Water surrounds these cylinders in a water-jacket.

Because of the explosions going on in the cylinders, the water around them heats up. Hot water is lighter than cool water. Since the hot water is lighter, it rises to the top of the cylinders. The cool water stays at the bottom. The hot water now goes through the top of the radiator. The radiator cools the hot water.

Now that the water is cool, it goes through a tube called a manifold, which is connected to the bottom of the water-jacket. The cool water goes around the cylinders until it is again heated by the explosions in the cylinders. The water rises again and the whole process is started once more.

Did you notice how much the Model T is like the Model A? Both of them are also similar to many of the other old cars. All of the old cars are a lot like cars of today.

The mechanical ideas started by the early motor companies have influenced all the cars which came later. Even modern cars follow the same basic ideas.

We hope you enjoyed this book and have learned from it.

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It is hoped that this booklet will be useful to teachers to stimulate interest in reading and in related mechanical subject matter areas.

This booklet is part of the curriculum and materials for teaching basic vocational talents being prepared under Contract No. OE-5-85-023 with the United States Office of Education.

Grateful appreciation is hereby expressed to Mr. Henry E. Edmunds, Director of the Archives (Henry Ford Museum and Greenfield Village), for the photograph of the Model A Ford on page 33 and for Model A printed materials through the Educational Affairs Department of the Ford Motor Company; and to the publishers for permission to use materials from the 1900-1918 issues of the Scientific American.

Comments and suggestions will be appreciated. Address all correspondence to:

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