A BOY'S TEXT BOOK ON Gas Engines

by

FAY LEONE FAUROTE.

A BOY'S TEXT BOOK ON GAS ENGINES

¶ A Book for Boys Describing and Explaining in Simple Language the Automobile Gas Engine.

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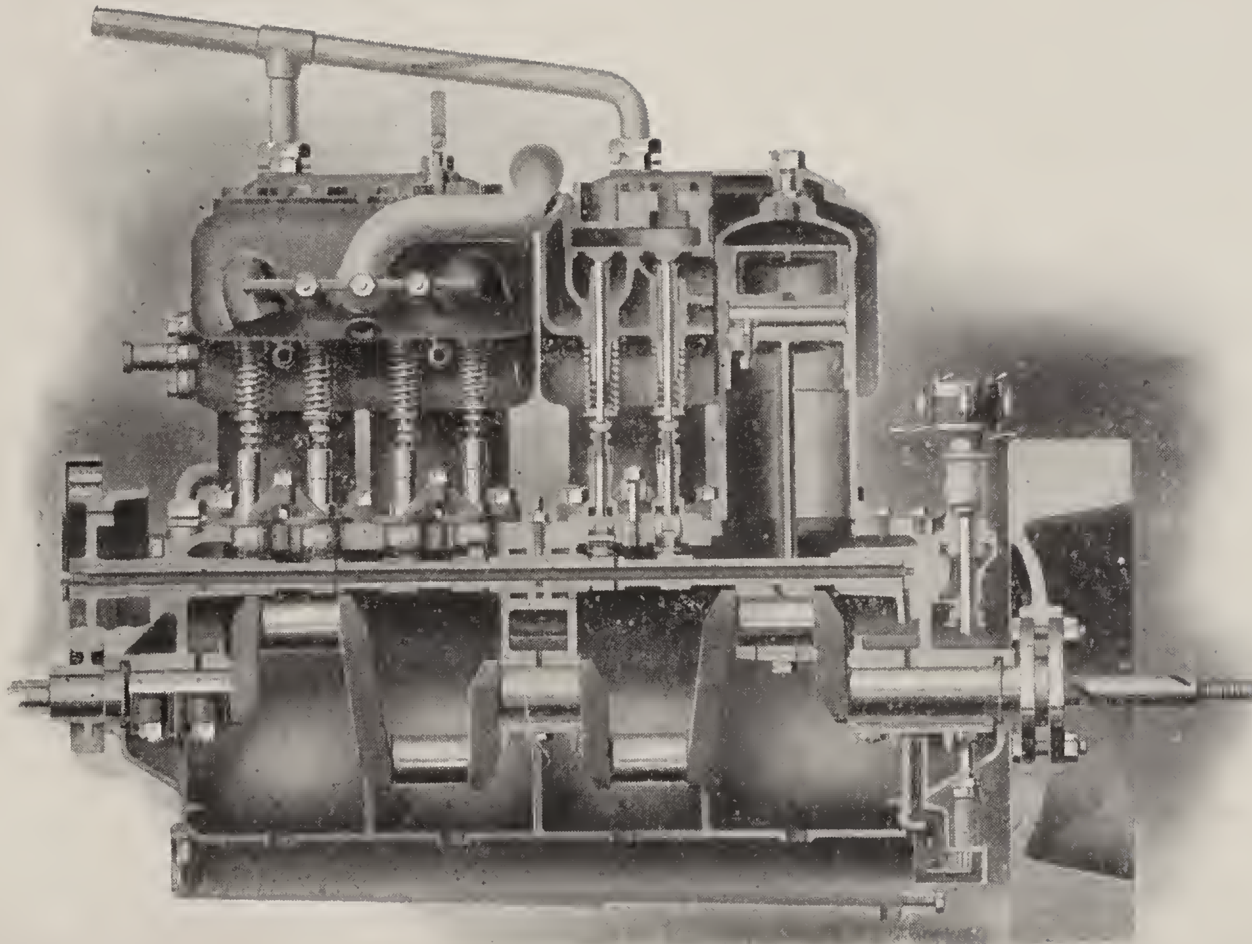
Published by the Author
LANSING, MICHIGAN, U. S. A.

PREFACE

Knowing that the motor car is fast becoming the modern form of transportation, both in the social and commercial world, and feeling that the principles of the mechanism which constitutes its propelling power are as yet somewhat of a mystery to the average individual and to "Young America" in particular, the author feels that some of the simple explanations offered in the following pages of this book will be welcomed and appreciated. While they do not cover the entire subject, it is hoped that they may tend to shed some light, and in a way make understandable the construction and operation of the automobile gas engine.

FAY L FAUROTE.

November 25, 1907.



A Four-cylinder Motor, so sectioned that it shows interior of cylinder, valves, piston, crank shaft and connecting rods.

A BOY'S TEXT BOOK

ON GAS ENGINES

INTRODUCTION

Boys, when I was a small boy, I remember how much I was interested in everything which was mechanical. The engineer was my hero; the solving of the mysteries of an engine and the learning how to drive one, was my ambition.

I remember well how I tried to read the dry, technical description of motors, steam engines and such things. I remember, too, how hard it was to understand those books; how the various technical terms used to bother me, until at last, in despair, I would throw the books aside. It seemed as if the men who wrote them never realized that boys existed,—that boys wanted to know about such things.

At other times how glad I was when I found a good-hearted engineer who seemed to know and understand my feelings and my desire to learn. How easy it was to comprehend his explanations, because he used homely, everyday things to illustrate his meaning. He made you forget there was anything complicated about machinery. He simply took up one part at a time, and when he had finished with it, everything was as plain as the nose on your face.

Boys, then and there I decided that if I ever did understand some of these seeming mysteries of engineering, I would write a book that boys could understand. I would write it so that they couldn't help it, it would be so plain; there would be no secrets; they should know all about it, and what is more, should be able to reason it all out for themselves.

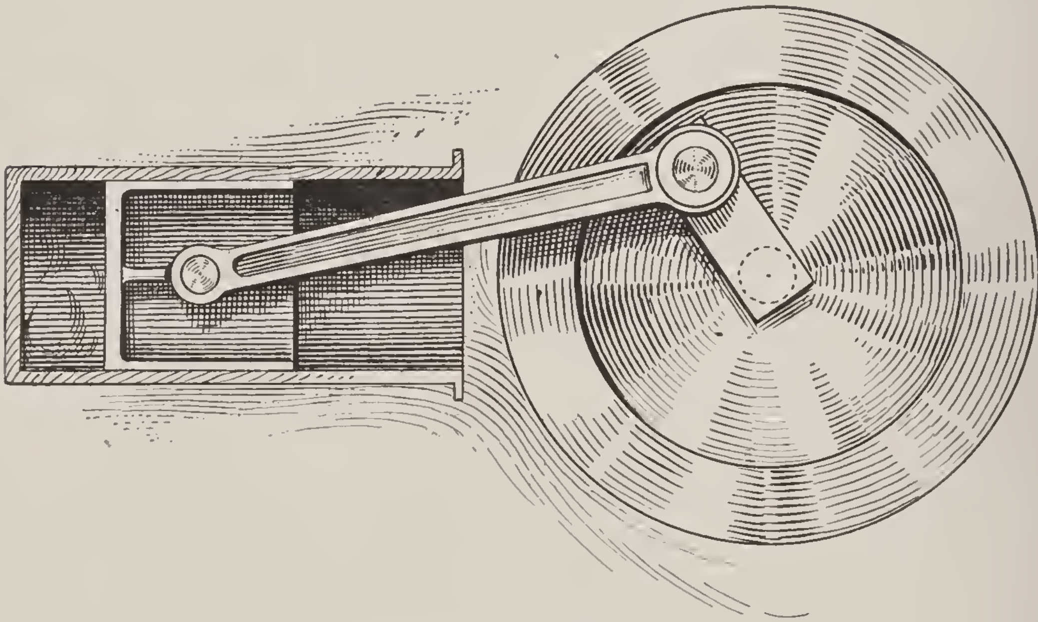


Fig. 1—The Essential Parts of a Gas Engine.

Let me tell you about each part separately. After we have gone over each part you will find that you will understand the action of the motor and other parts of the car well enough so that you will unconsciously reason it all out for yourselves. Some of the descriptions and explanations may at first seem unsatisfactory, but I think with a little thought and study you will be able to master them in a short time. I want your confidence, boys, and then I know we will get along all right together.

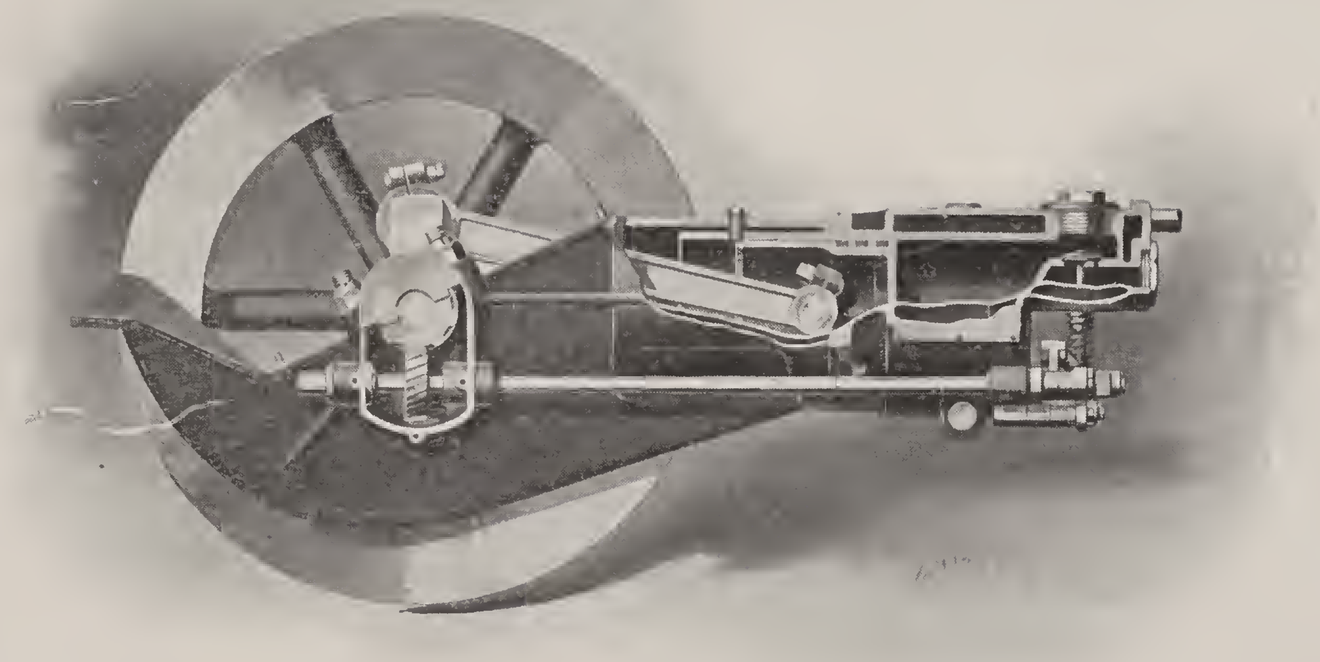


Fig. 2—A Single-cylinder Horizontal Engine. Note location of valves in this type.

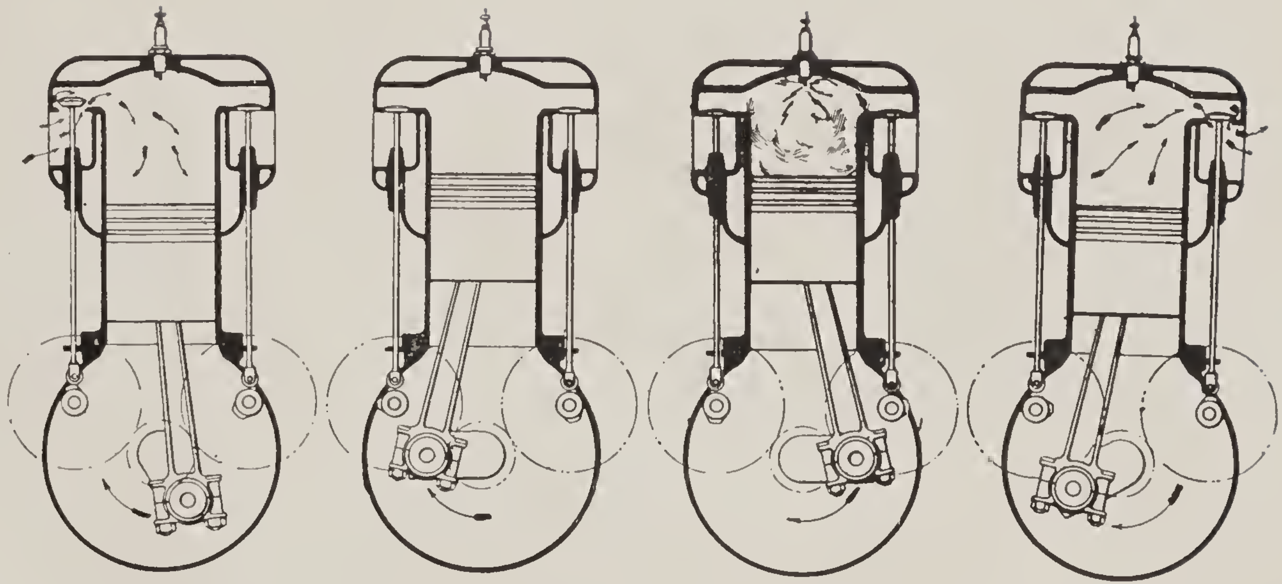


Fig. 3 - Four views of a section of a Vertical Cylinder, showing position of valves, pistons and cams for the four different strokes.

THE FOUR-STROKE CYCLE.

This subject looks like a bugbear, doesn't it. Well, it is one of the first things of which we shall have to dispose, and so we'll tackle it right away. We will start backwards, and take the word *cycle* first. If you will look in the dictionary you will find that this word means "a circle or orbit; an interval of time in which a succession of events is completed, and then returns in the same order."

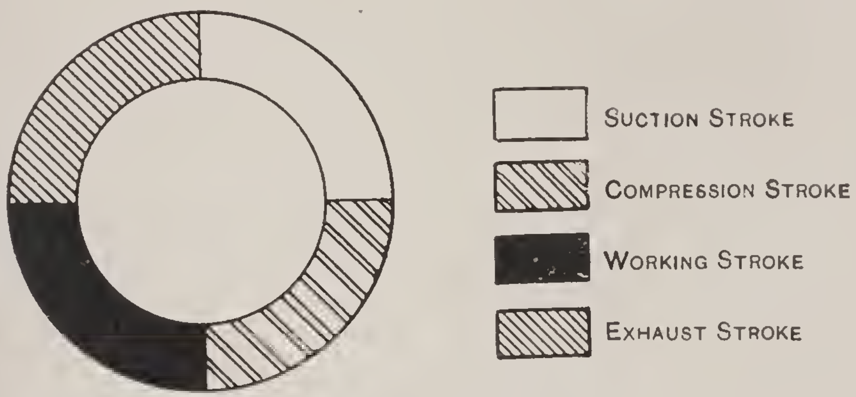


Fig. 4—A Four-cycle Diagram, showing sequence of strokes in this type of motor.

This does not mean very much to you, does it? Well, let us go into it a little farther. Supposing you were running relay races around a block; you would run down on one side, across on another, back on the other side, and then back to the starting point, wouldn't you? You would have completed a cycle then because you have taken a "certain time in which a succession of events (streets) has been completed" and you are back again at the start ready to "return in the same order." There is not anything complicated about that, is

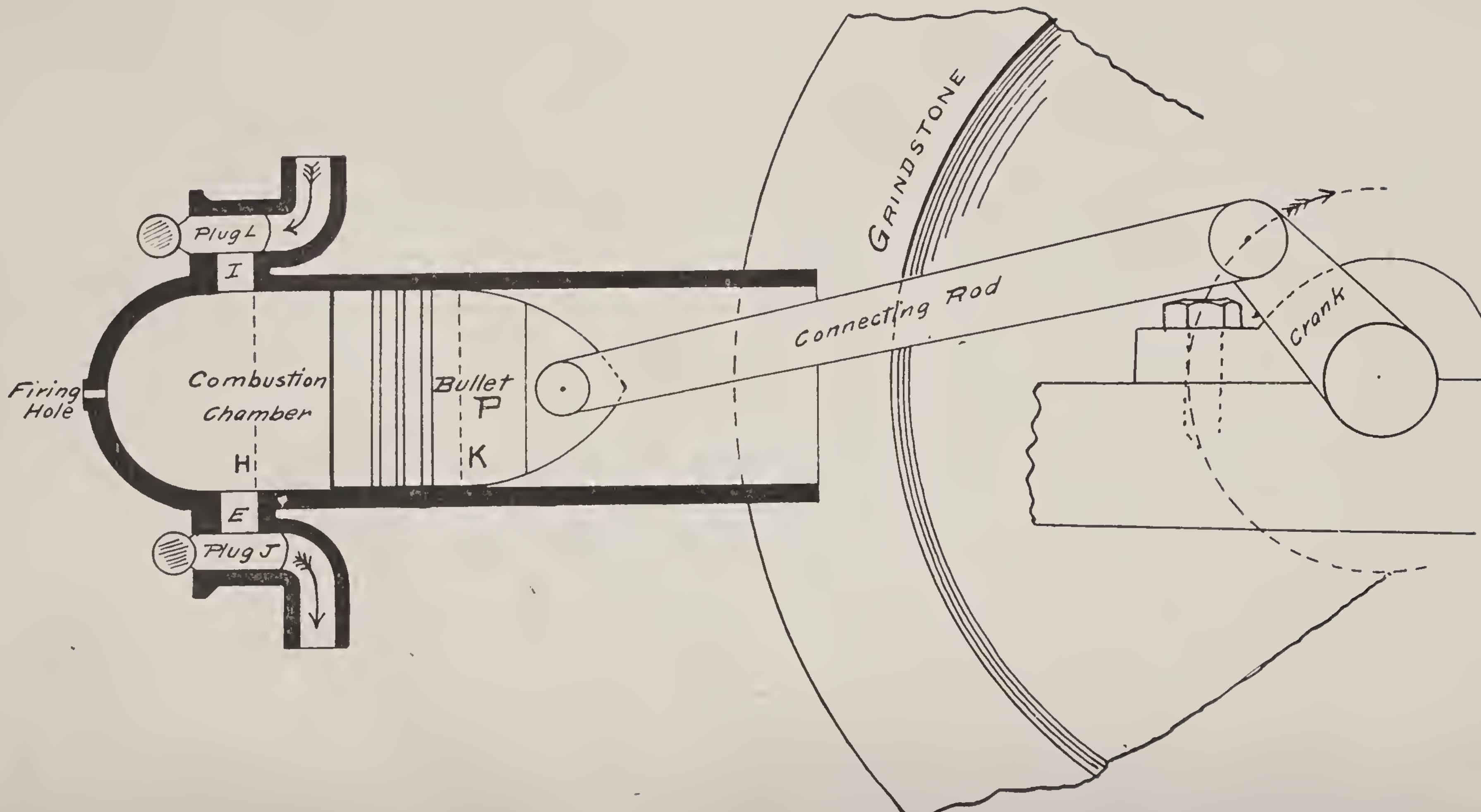


Fig. 5—Drawing showing comparison between gas engine and a cannon connected with a grindstone.

there? In other words just change the *four-stroke cycle* to a *four-street circle,* and this will help you to keep in mind the meaning of this term. Do you remember last Fourth of July when you had your cannon out, how many things you had to do to fire it, or in other words to complete the *cycle* of operations. You did four things, didn't you?

No. 1. You put in the powder.

No. 2. You rammed it in with a ramrod.

No. 3. You fired it by touching a match to it.

No. 4. You cleaned it out.

You had gone around your four-sided circle, and were back again, at the start, ready to do the same things over again. You were running a gas engine then, only you did not realize it.

Let us assume for the sake of argument, that you had a bullet in your cannon, and that to this bullet was connected a rod which had its other end fastened to the crank of a grindstone. Then if the barrel of the cannon was long enough, and the rod which connected the bullet and crank was short, the bullet could not get out of the cannon barrel, could it? It would therefore have to go back and forth very much like the pedal on a grindstone does. Of course the rod and the crank would have to be very strong in order to keep the bullet in, but we will assume that they are, and that the bullet must travel back and forth inside the barrel. Now, if the bullet is going to stay in the barrel we must provide some way to load the cannon, and also to clean it out, therefore we will cut two holes in the end, one at I and one at E, and then instead of using powder suppose you use some explosive gas which will not leave so much soot behind it. You know how a squirt gun works—how you draw the water in by pulling out the plunger, and how you force the water out again by pushing it in again. Let us

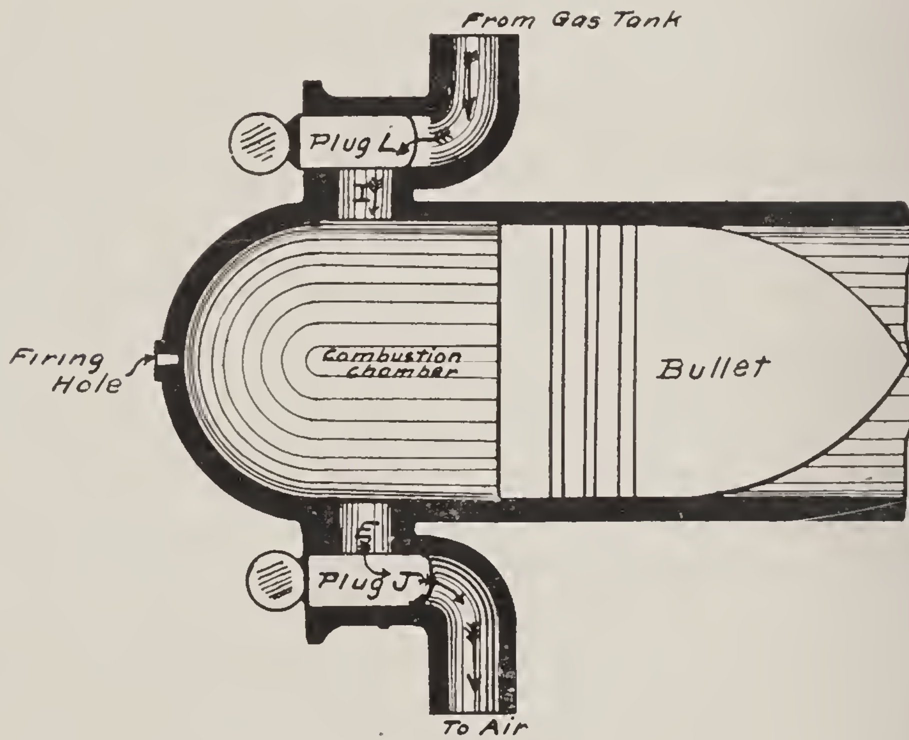


Fig. 6.

work the cannon the same way. Let us call the *farthest point* to which the bullet travels *going in* "H" and the *farthest point* to which it travels *going out* "K." Now let us assume that the bullet is at "H," and that it is just starting out in the direction of "K." If we open the hole "I" in the side of the cannon by taking out the plug "L," and put a hose, connected with our gas tank, in there, then the outward motion of the bullet

"P" will pull the cannon full of gas, won't it? Before the gas has a chance to escape we will put in the plug "L" again. Now we have the cylinder full of gas, but as the bullet is at the end of its stroke, and cannot go any further, we will have to push the gas together again and get the bullet into position "H." This will be a good thing for the gas, because it will crowd the particles of it closer together, and make it explode quicker, so we will do this. Of course, in order to keep the gas in there we have had to close up the touch-hole of the cannon, but now that we are ready to fire it, we will take this plug out, and touch a match to the gas. An explosion follows, and the bullet travels from the position "H" to the position "K." All this time the crank of the grindstone must have been turning because the bullet and the crank are fastened together, and therefore, instead of traveling through the air, the bullet has used up its energy in turning the grindstone. When you get a grindstone started it is rather hard to stop, isn't it? And if you didn't stop it, it would keep on turning around, wouldn't it? If this is true, we might as well let it clean the cannon. As the hole "I" is connected with the gas tank, we cannot let it force the burnt gas out there, can we? We will therefore pull out the plug "J" in the hole "E" just as the bullet reaches the point "K" so that in coming back it will force the burnt gases and smoke out through the hole "E." Now we are all ready to start over again; the cannon has been cleaned out, and the bullet still being fastened to the grindstone, which is turning, as a result of the explosion, would immediately begin starting out on another outward stroke. If we put in the plug "J" again and pull out the plug "L," the bullet or *piston* as we might call it now, will suck in another charge of gas. You can see that if you had two boys, one

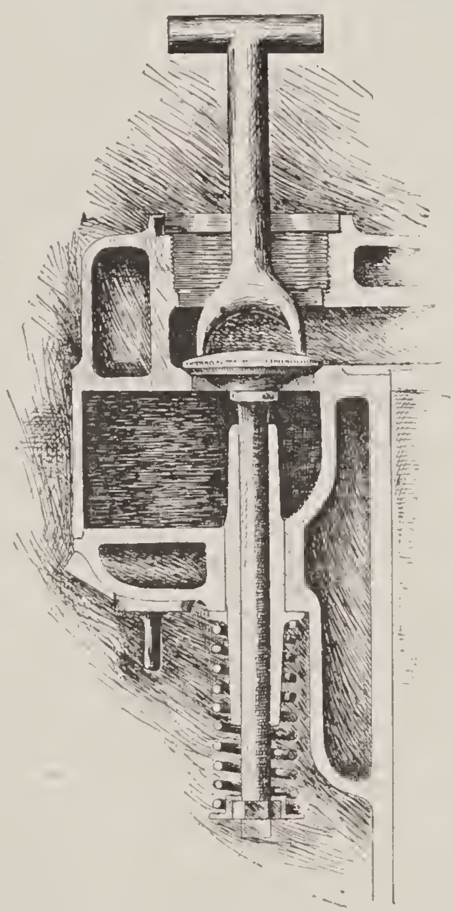


Fig. 7—Grinding a valve.

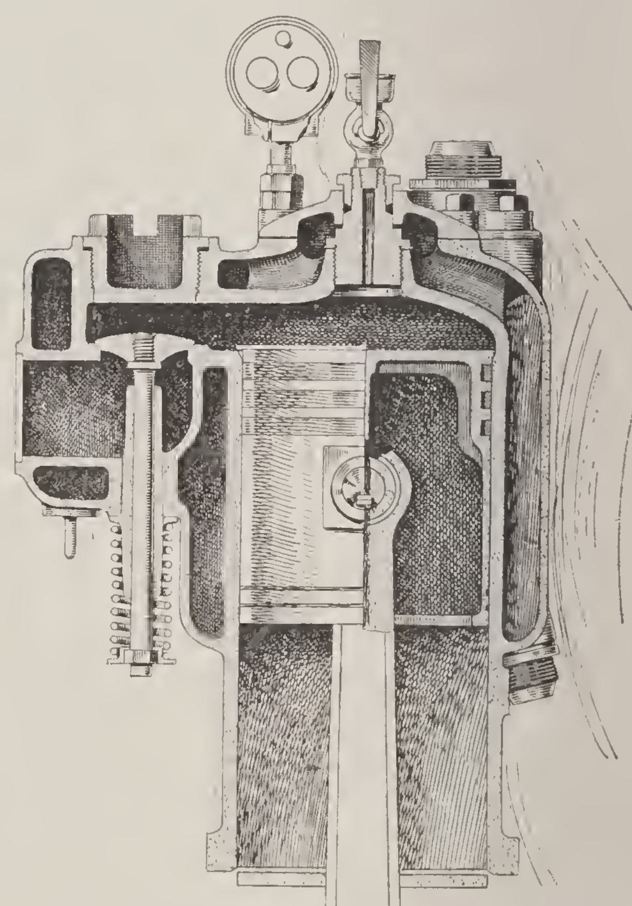


Fig. 8—A section of a Cylinder showing location of various parts—end view.

of them to pull out the plugs, and another to fire the charge you could keep the gun firing steadily, and run the grindstone. After you have done this for a while you will get tired of taking out the plugs and putting them in, and standing there with a match lit all the time, and you would wish there was some way to make the grindstone, which was running, do all this for you. This is exactly what happened to some of the old engineers, and so they set about trying to accomplish this result. They succeeded in rigging a piece of machinery that would open and close these holes automatically, and with the introduction of electricity they also devised a way whereby the charge could be ignited by an electric spark instead of a match. The plugs which cover the holes, they called *valves* and the plug which contained the electric wires, used for firing the gas, they called a *spark plug.*

Now let us see what we have learned in this chapter. We have found that it takes four strokes to explode one charge of gas

1. *Suction stroke,* during which the gas is *sucked* into the barrel of the cannon, or cylinder as it is called.

2. The *compression stroke,* during which the gas is *compressed* so that it will burn easier.

3. The *explosive stroke,* or *working stroke,* called so on account of the fact that the explosive force of the gas is used to *turn* the wheel.

4. The cleansing, or *exhaust* stroke, during which the burnt gas and smoke is *forced out* of the barrel.

For this reason, a gas engine which works on this principle is called a *Four-Stroke Cycle Engine.* It requires *four strokes* to *complete the entire operation* and *bring it back to the beginning* ready to start over again.

THE CYLINDER

So far we have confined ourselves to the parts of a cannon, but now that we are going to take up the study of the motor in its details let us call them by their regular names. The *barrel* of the cannon we will call a *cylinder*. In an actual motor a cylinder is made out of cast iron, carefully bored out inside, so that the hole is per-

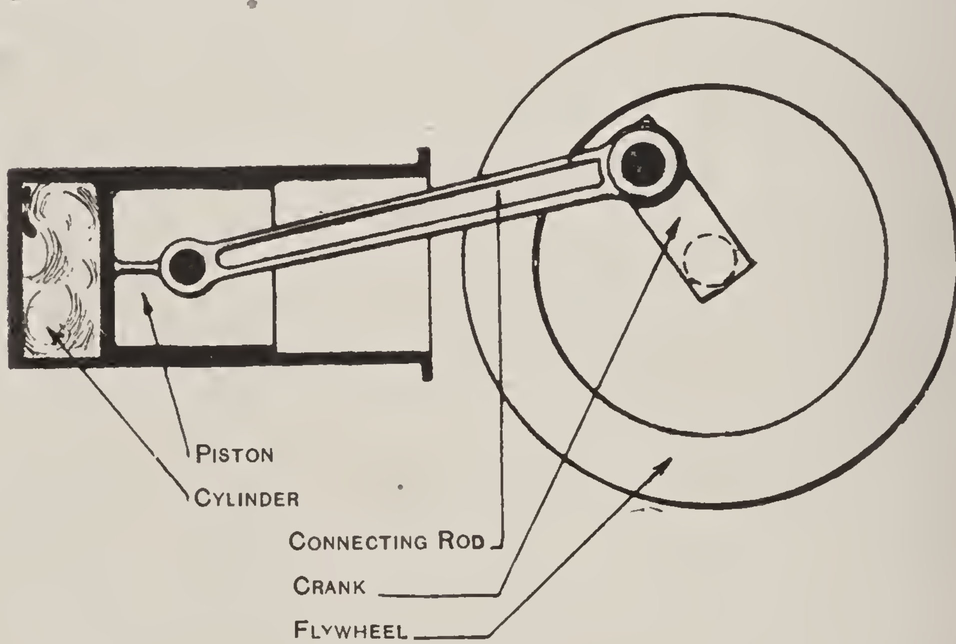


Fig. 9.

fectly round, and the sides of the wall as smooth as possible. You will realize that this is necessary as we want to reduce, as much as possible, any rubbing or friction, as it is called, between the piston and cylinder walls. Next we must provide some means of cooling these walls, as you know that the continuous firing would soon make them very hot. This is done by surrounding the cylinder with what is known as a *water jacket* through which water can be circulated, thereby carrying off the heat, and keeping the iron from getting red hot. We must also cut two holes in the side of the cylinder to make places for the valves and a place for the spark plug.

A cylinder is generally mounted on its side in a one cylinder engine, and is set up on end when it is desired to use more than one. Therefore, in a one cylinder motor you will notice that the pis-

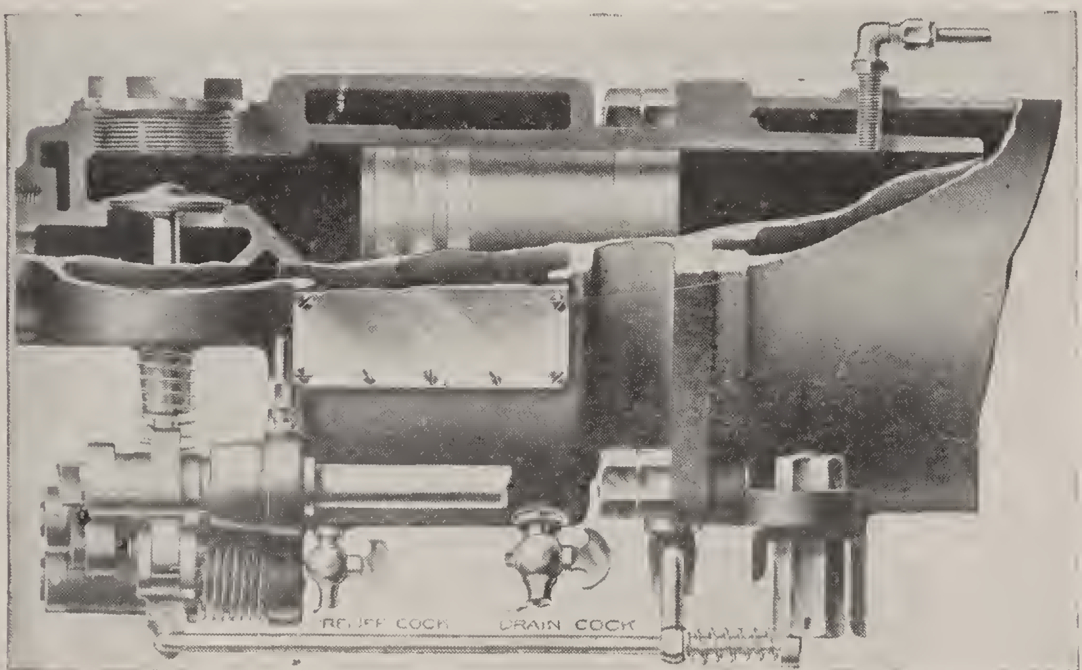
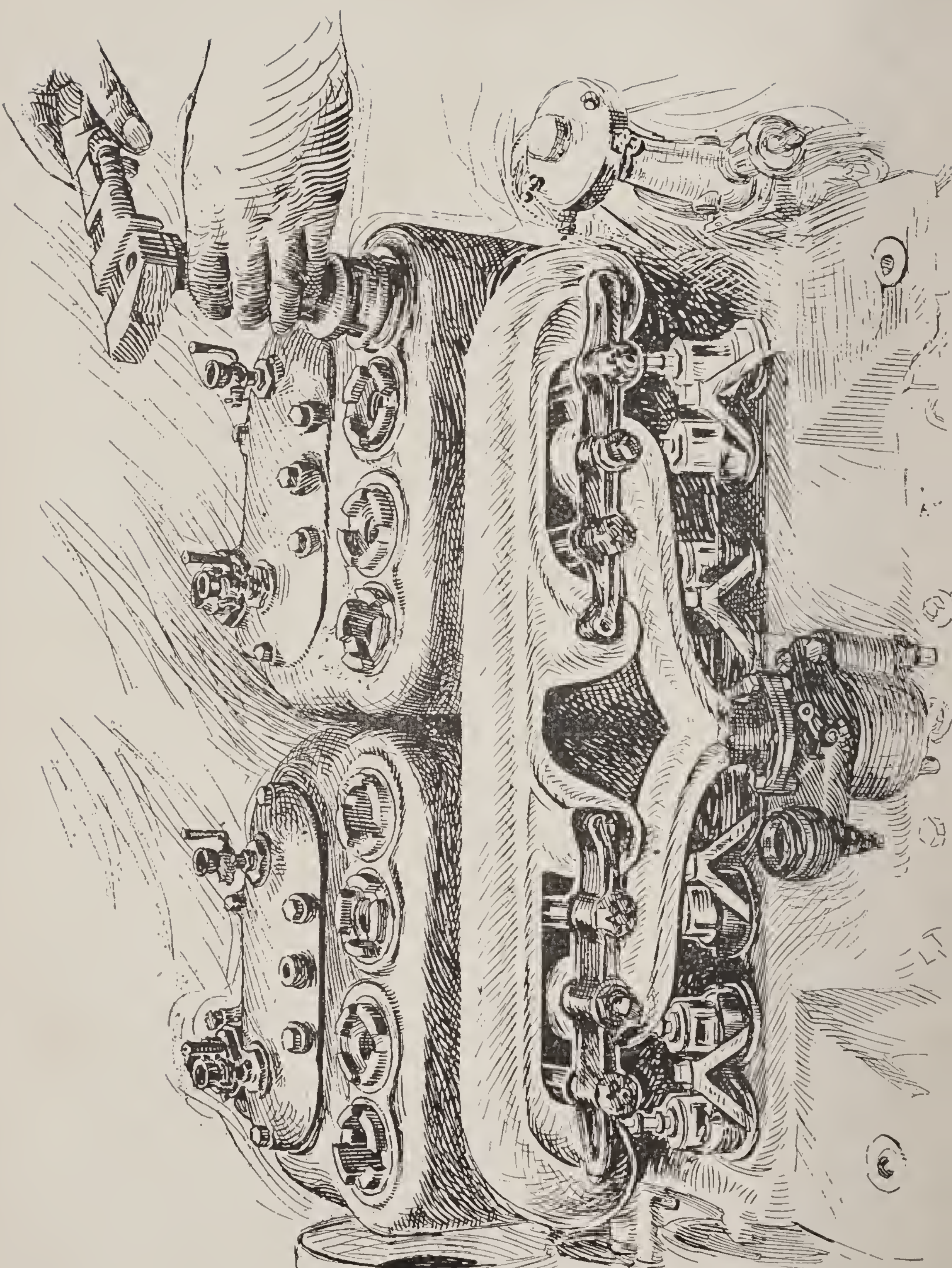


Fig. 10—End view of Horizontal One-cylinder Motor, showing piston, valves and valve mechanism.

ton moves back and forth, whereas in a two-cylinder, four-cylinder or six-cylinder type, the pistons move up and down. As far as the action of the parts is concerned they work in exactly the same way, only that the valve mechanism has to be changed somewhat.

The cylinder is bolted to a framework called the crank case which furnishes a solid foundation upon which it can rest.



VALVES

You will remember that in first discussing the *drawing in* and *cleaning out* of the gas that two holes had to be cut in the sides of the cylinder wall. One of these through which the *fresh gas* might be *sucked in,* and the other through which the *burnt gas* might be *expelled.* Also remember that we kept these holes plugged except when it was necessary to have them open to perform their work.

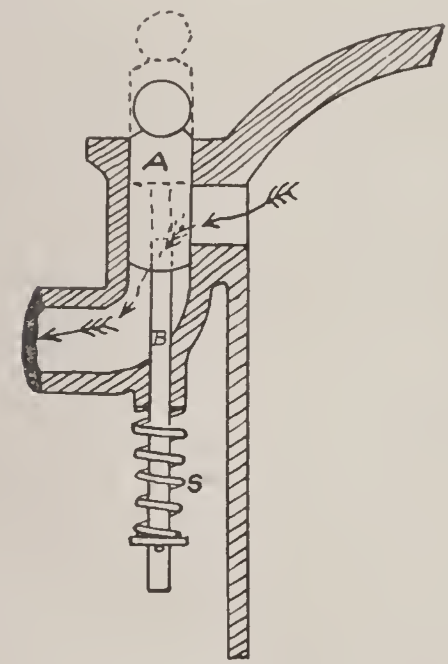


Fig. 11—The evolution of a Valve.

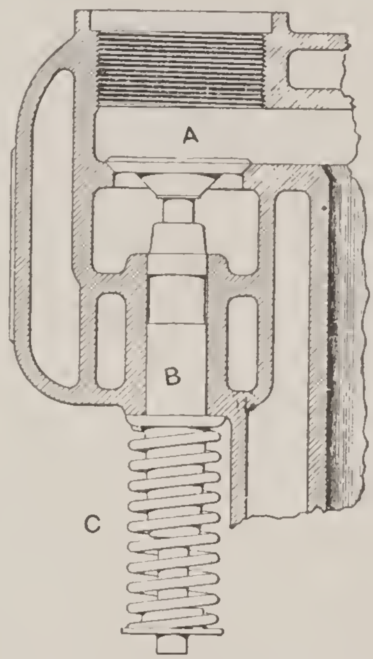


Fig. 12—A regular Valve.

Now let us take a section of a *valve* and see how it is made up. You will notice first the little plug "A" which covers the hole in the cylinder; it is tapered very much like a glass stopper in a bottle for the reason that in this form it is easier to fit it to the opening; it can be *"ground in"* in the same way that a glass stopper can, in order to make an air-tight fit. "B" is a rod known as the *valve stem,* and is simply a round piece of steel fastened to the valve plug "A." "S" is a *valve spring* which holds the valve down into the cylinder wall, or *valve-seat*, as it is called. In order to open these valves you can see that all that is necessary for you to do is to *push up* on the *valve stem* "B." This will raise the valve "A" away from its seat into the position shown by the dotted lines, leaving a space all around through which the gas may enter or leave. In

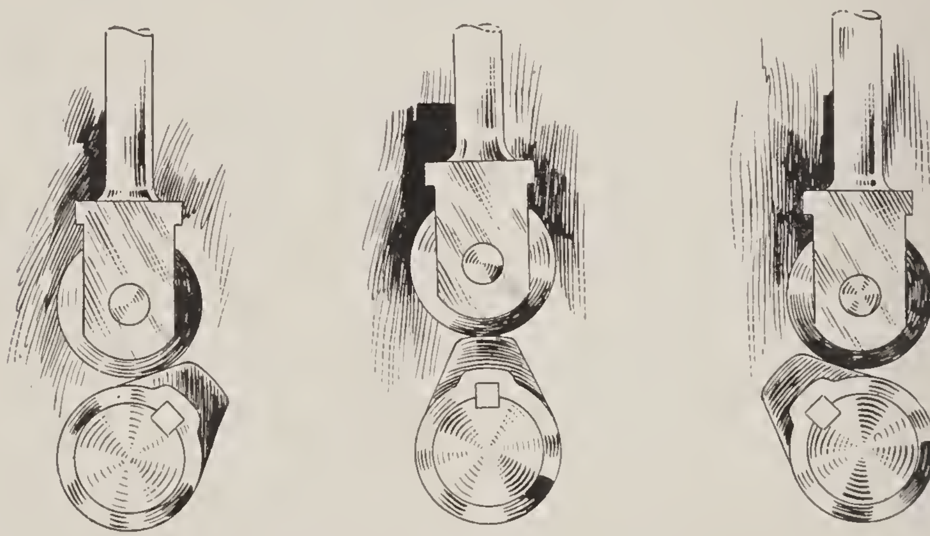


Fig. 13—Three positions of a Valve Cam.

an actual motor, however, little irregular pieces of steel, cut out in general shape shown in Fig. 14 perform the operation of *raising* the valve. Fig. 13 shows three positions of one of these revolving pieces of steel, technically called *cams,* first, in the act of just starting to raise the valve; second, its position when the valve is entirely open; third, its position when the valve has just closed. If both valves are operated by these cams you can see that if they are set at the proper position they can be opened at different times and entirely independent of each other. If you will look at Fig. 3 you will see a complete motor, the *inlet valve* on the left side, and the *exhaust valve* on the right side. This figure will also show you the little cams in their various positions at different points of the four strokes. Sometimes the two valves, instead of being on *opposite* sides of the cylinder, are placed on the *same* side, and *both cams* are put on the *same shaft,* which, by the way, is called a *cam-shaft.*

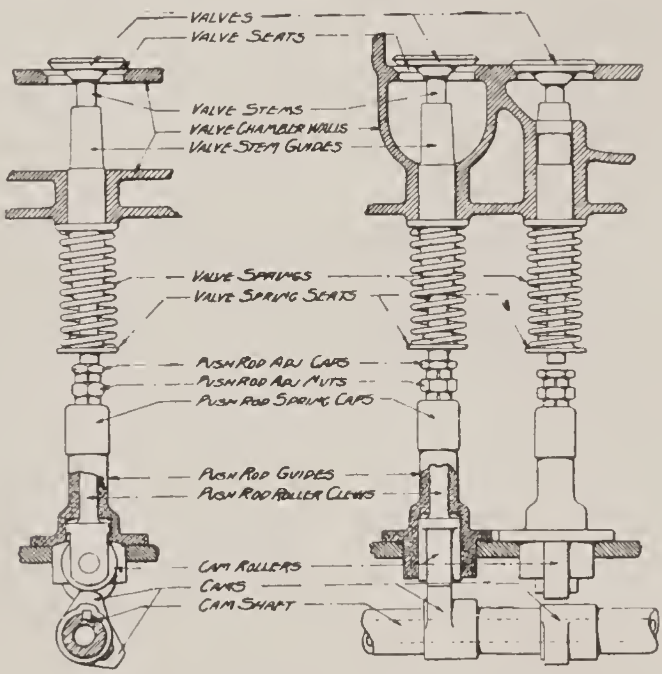


Fig. 14 – Names of Valve Parts.

Fig. 14 shows two such valves, the left hand one opening, and the right hand one closed. The extreme left hand view shows the way they would look if viewed from the end. It also gives you the names of all the parts.

Fig. 7 shows how the valves are "*ground in.*" The way you do it is to take the valve out, and coat it with very fine emery dust and oil, and then put it back in place leaving off the spring, fit a wrench to it on top as shown in the picture and twirl it around as you would a glass stopper in a bottle until it is perfectly air-tight, after which the valve should be removed and both it and the valve seat carefully wiped off so that none of the emery will get into the cylinder or other working parts of the engine and cause them to be cut.

There are several different ways of making valves and several places to put them so that you must not always expect to find them in the same place. Their action is the same, however, no matter where they are situated or how they are operated, and I think with a little examination and study you will always be able to find them and understand how they work in any engine.

THE PISTON

The *piston* forms, as you will recall, the *bullet* in the cannon, which instead of leaving the barrel, was made to travel back and forth inside of the cylinder under the action of the explosive gas. Owing to the fact that a solid piece of iron would be very heavy and would get very warm, the real piston used in a motor is made *hollow* so that it is merely a shell. Instead of fastening the rod

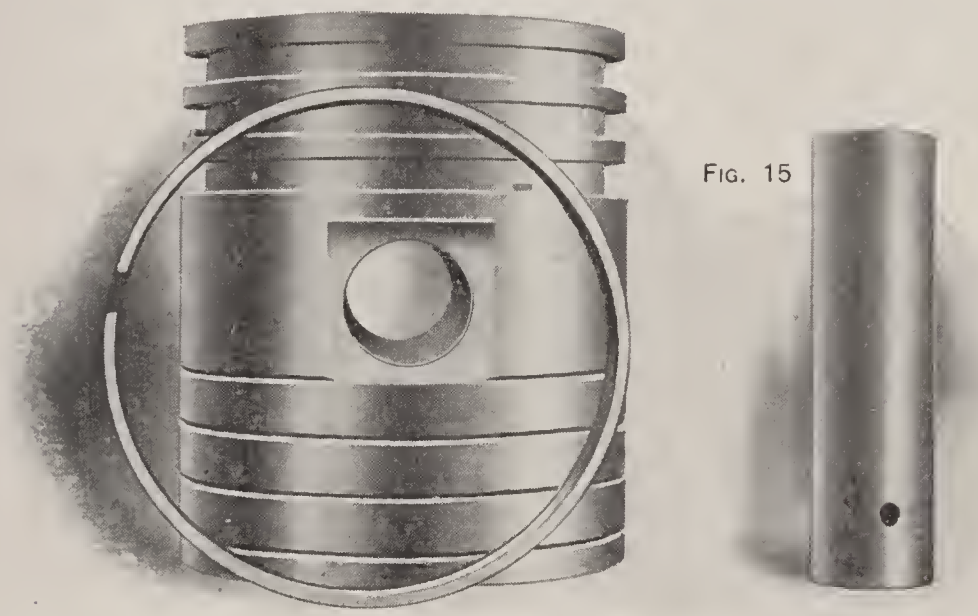


FIG. 15

Fig. 15—A Piston, Piston Ring, and Piston Pin

to the end of it, a small rod, called the *piston pin* is in the center of it, and to this the connecting rod is connected. Fig. 16 shows a section of the piston. You will notice that the piston pin is kept from sliding sideways by a bolt that is screwed into it.

Owing to the fact that both the cylinder walls and piston get hot, and that iron expands and contracts according to its temperature, it is not possible to make a piston alone which would remain air-tight all the time. Engineers, therefore, found it necessary to put *rings,* which were cut at some point in their circumference, on the outside of the piston itself. These *piston rings,* due to the fact that they are cut, can accommodate themselves to the varying diameters of the cylinder, and can therefore keep an air-tight fit, even when

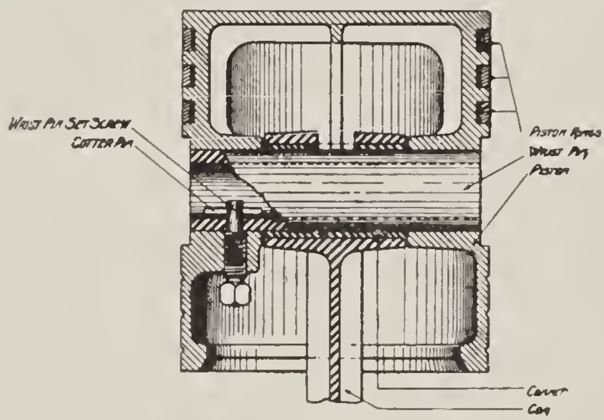


Fig. 16—A section of a Piston, showing location of piston pin and end of connecting rods

the piston is moving back and forth all the time. Most of you, no doubt, know that the plunger in a pump is made air-tight by one or a set of leather washers, which, owing to their pliable structure, can expand or contract so as to always fit air-tightly the pipe in the pump. Piston rings work in precisely the same manner, and are always kept lubricated so that they will work smoothly, thus doing away with any friction which might result.

THE CRANK SHAFT

Most of you are familiar with a crank as applied to a grindstone. A crank in a motor is practically the same shape except that it is supported on two bearings instead of one and is therefore made in the form shown in Fig. 17. The crank shafts for two and four-cylinder motors are only a combination of two or four of these single cranks. Crank shafts are made up of steel, carefully forged, and then turned and ground down to

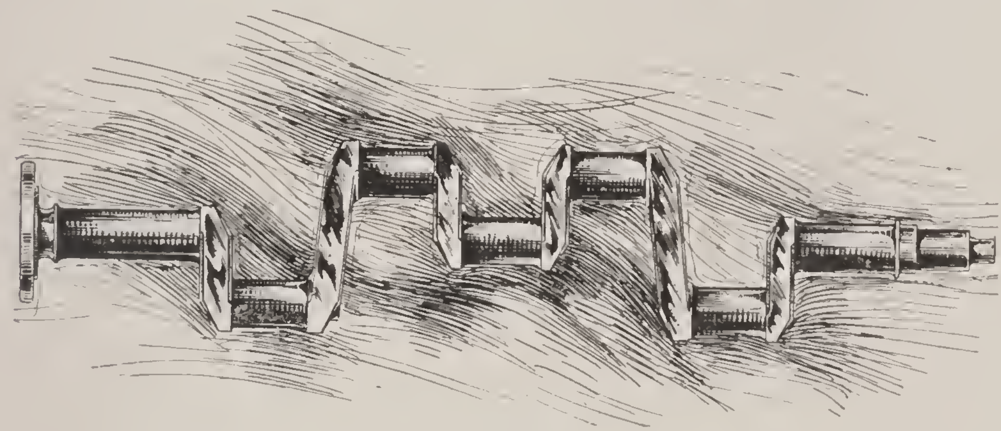


Fig. 17—A Four-cylinder Crank Shaft.

proper size to fit the bearings for which they are intended. They are hardened and every precaution taken to keep them from wearing. They form one of the most important parts of the motor because they *change* the *back and forth motion* of the piston into the *rotary motion* of the fly wheel. The *fly wheel* in our former illustration was represented by the *grindstone* itself. In the real motor the fly wheel is made of cast iron, and after being carefully balanced so that it turns evenly, it is securely bolted to the crank shaft, so that they practically form one piece.

THE CONNECTING ROD

The *connecting rod,* as you can guess from its name, forms the *connecting link* between the piston and crank shaft, *transferring* the *energy* of the explosive gas, acting behind the piston, to the crank shaft and fly wheel, from which it can be transmitted to the driving wheels of the automo-

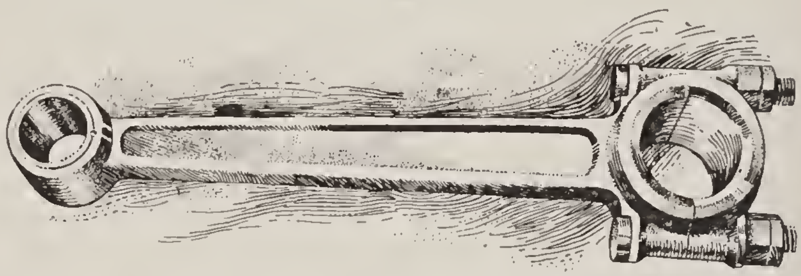


Fig. 18—A typical Connecting Rod.

bile. It is made up in some such form as shown in Fig. 18 and is made of steel or bronze. It has a bearing at each end, the smaller one fitting

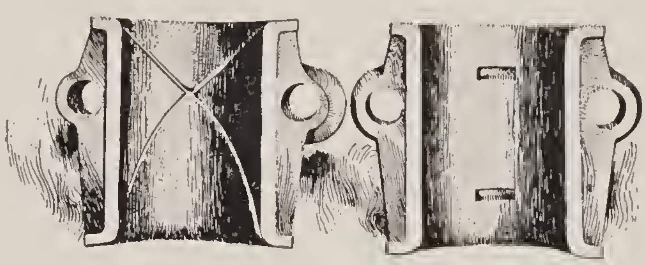


Fig. 19—The two halves of the Connecting Rod Bearing.

around the piston pin, the larger one surrounding a portion of the crank shaft called the *crank pin.* Both of these bearings are lubricated by oil which splashes up from the bottom of the crank case when the engine is running. You will notice that one of the bearings is cut in two and bolted together so that you can take it off from the crank shaft, should you wish to examine it.

THE CRANK CASE

The crank case of a motor serves as a foundation for the engine, furnishes a support for the main bearings in which the crank shaft revolves and encloses the working parts in such a way as to provide for their lubrication and protect them from the dust and other substances which might

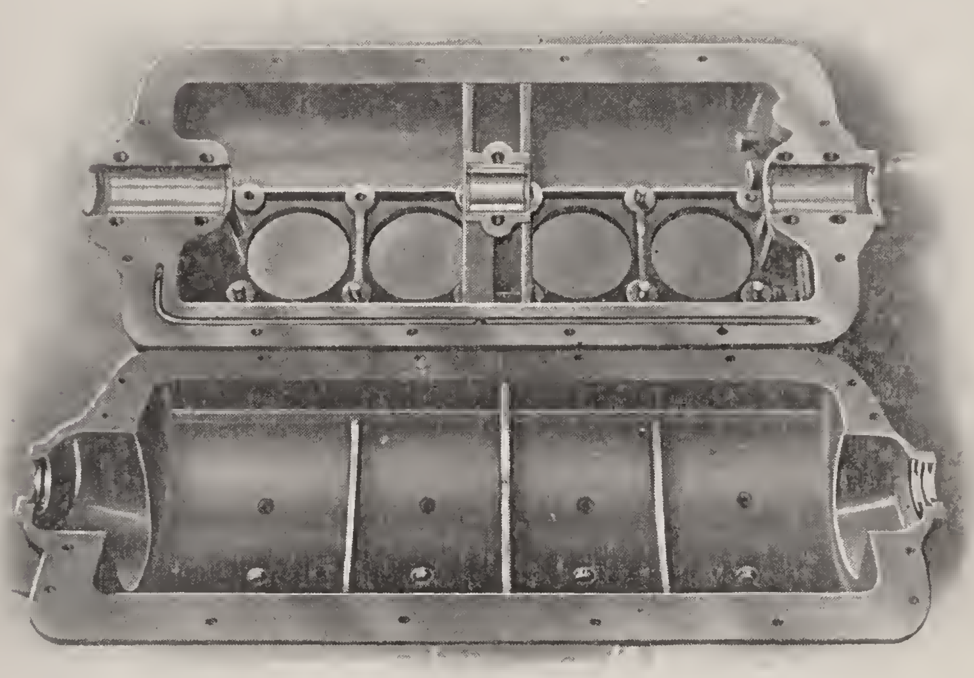


Fig. 20—The two halves of a Four-cylinder Crank Case.

materially hinder the proper performance of their functions. To a certain extent the crank case might be compared to the framework of the grindstone, although the latter does not answer as many purposes as the real crank case of the motor does.

The case itself is made of iron or aluminum, and is so put together that, although practically air-tight, there is still a means provided for getting inside of it for examination of the working parts or an adjustment of the bearings.

THE CARBURETOR

The *carburetor* or *mixing chamber,* as it is sometimes called, is a device used for obtaining an *explosive mixture* of gasoline and air. It consists, as shown by the accompanying drawing, of two principal parts, an air pipe and gasoline pipe, the latter running through the wall and discharging into the center of the former. In order to

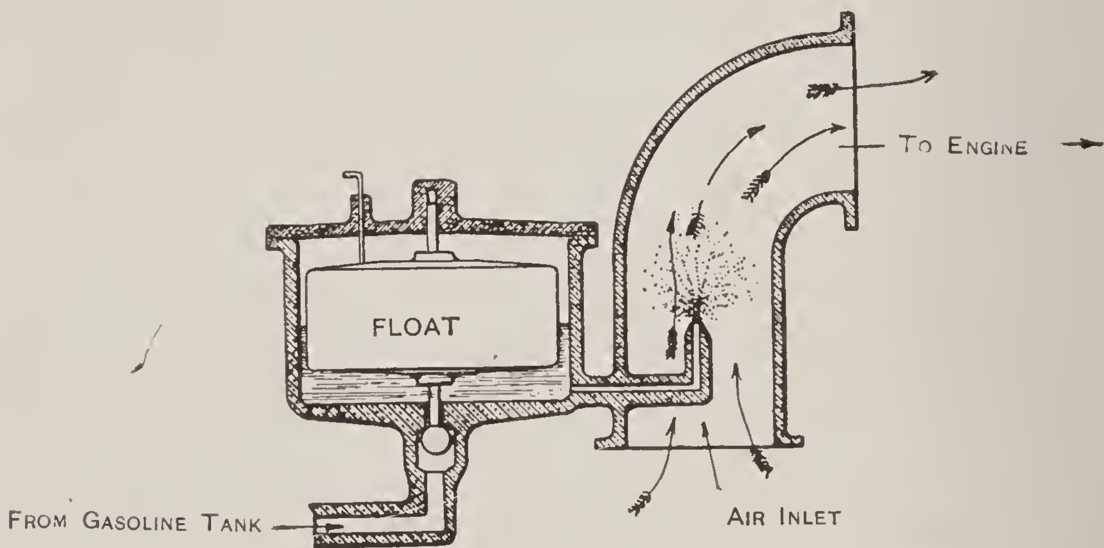


Fig. 21—Simple drawing of a Carburetor.

make sure that the amount of gasoline flowing out of the gasoline jet shall be just the right amount at all times it is necessary to provide a little gasoline tank, which forms a part of the carburetor casting itself, which is known as a *float chamber,* so that the amount of gasoline in the main tank will not affect the amount discharged at the nozzle. You can see why this is necessary if you think of a water tank or a dam. If the water was almost up to the top of the dam and you should bore a hole through the wall somewhere near the bottom, the water would flow out faster than if the water was low. By putting this little gasoline tank in the carburetor itself and keeping a certain height of gasoline in this smaller reservoir, which always automatically shuts off the supply at the right time, you can make the pressure, and therefore the flow of the liquid, always the same. The illustration will show this plainly. For instance, when the gasoline gets low the little float will gradually drop down until the ball on the end of the float stem will open the valve in the gasoline pipe. The gasoline will then flow in from the tank until the proper amount has filled the float chamber and caused the float to bob up to its former position, carrying the ball, which closes the gasoline off, up with it. By this means the requisite amount of gasoline is always kept in the float chamber.

The amount of air entering the mixing chamber is controlled by changing the size of the hole through which the air enters and the quantity of gasoline admitted is regulated by means of a needle valve in the gasoline pipe.

Although many carburetors, in fact most of them, do not look like this drawing, yet their action is the same, and by careful study you will find that the same principles enter into their construction. Fig 22 shows an actual sectional drawing of a carburetor used on a four-cylinder motor. In this particular carburetor, however, the float chamber and float surround the mixing chamber, and the float valve, instead of being directly under the float, is at the right hand side and is operated by means of a lever. The needle valve, which is the little round rod having a "T" handle, running up through the center of the mixing chamber, controls the amount of gasoline flowing from the gasoline chamber to the nozzle. The air comes up through the bottom and around the gasoline

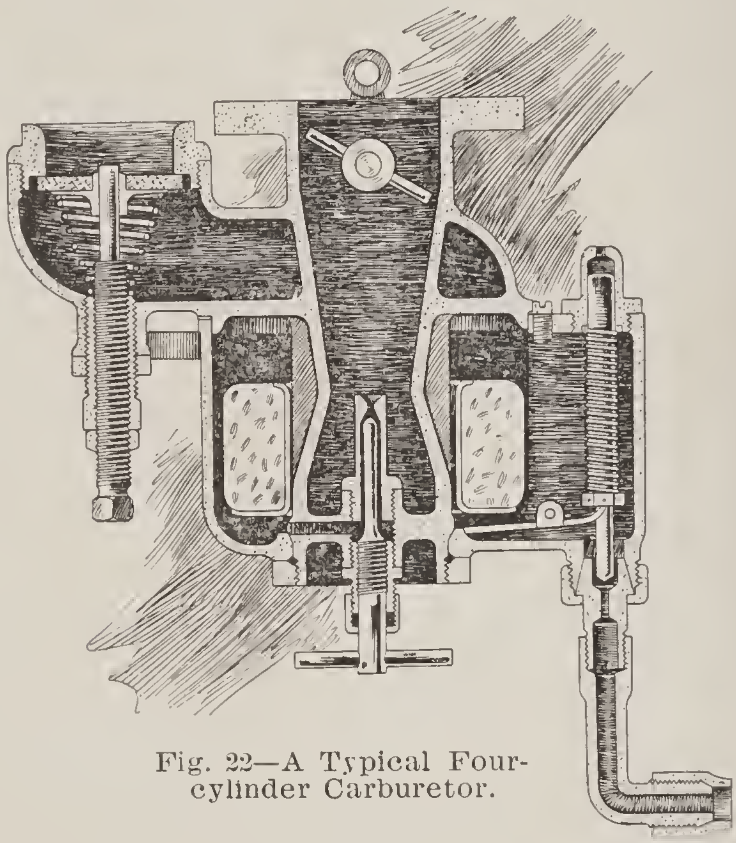


Fig. 22—A Typical Four-cylinder Carburetor.

jet. At the left you will notice a small valve which opens downward, which you do not find on the other carburetor. It is known as an auxiliary air valve and allows a certain amount of air to be added to the mixture, a small quantity of which is sometimes needed to keep the mixture just right. The throttle valve, which looks like a damper in a stovepipe and which controls the amount of gasoline vapor going in to the engine, will be seen in the upper pipe.

THE IGNITION SYSTEM

The *ignition* system is the name applied to the batteries, coils, commutator and spark plug which, acting as a whole, produce an *electric spark hot enough* and at the *right time* to *fire* the charge in the cylinder. There are three ways in which an electric current may be obtained which have been found to be of practical use in automobile construction. First, by a dry battery; second, by a storage battery; and third, by magneto or dynamo. You can look up the construction of these things in any good book on electricity, so that I will not explain them further here. As the object of the whole system is to produce a sufficiently hot spark to fire the mixture at the right time, it is sometimes necessary to raise the pressure of the electric current. When either a dry battery or storage battery or a certain type of magneto is used, it is necessary to put it through what is known as an *induction coil* in order to *raise* the *pressure* so it will be high enough to *jump across* the two points in the cylinder.

An induction coil consists merely of a bundle of soft wires around which is wound two separate coils of wire. The first, known as the *primary* winding, is of coarse wire, and the second, known as the *secondary* winding, is of fine wire. When the current flowing through the primary coil is rapidly made and broken, another current of very high voltage is created in the secondary circuit.

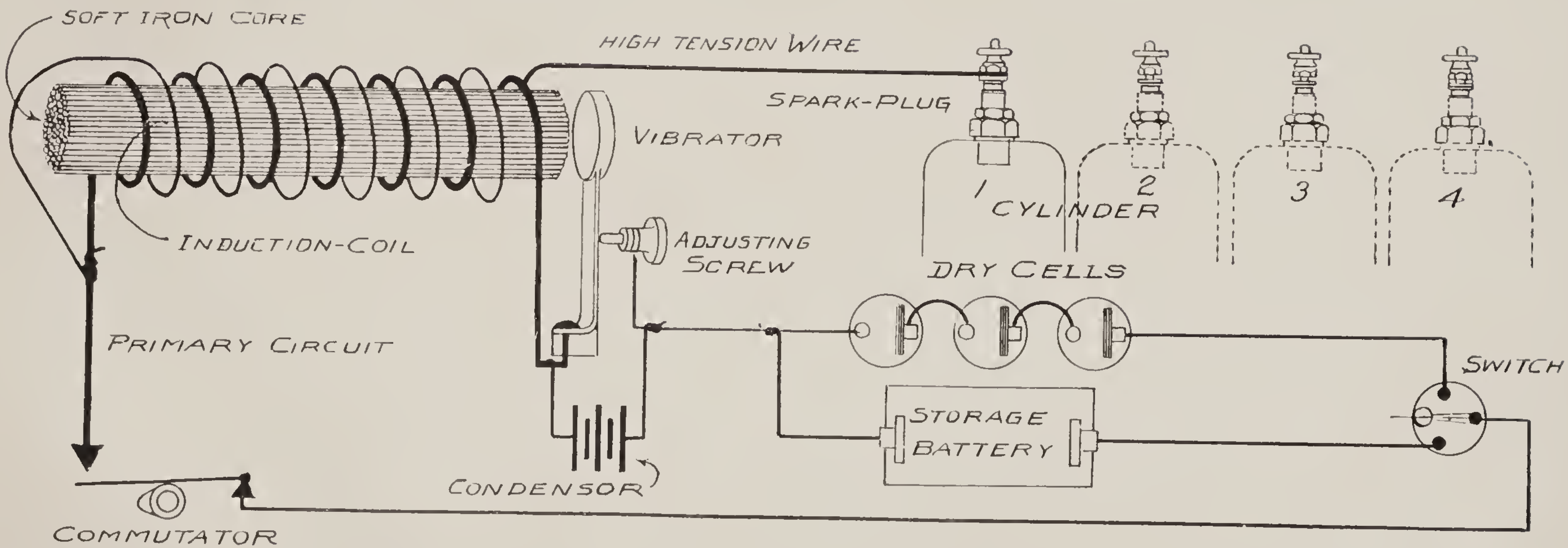


Fig. 23—Wiring Diagram, showing electric circuit for one cylinder. The sketch is only diagrammatic—not a reproduction of any actual wiring system.

When the current starts to flow through the primary winding, the bundle of wires immediately becomes a magnet and attracts the vibrator. As soon as this occurs, however, the flow of the current is interrupted and the vibrator resumes its former position and the action is repeated. Thus you can see that the coil automatically makes and breaks its own circuit. The rapidity with which this is done may be changed at will by adjusting the vibrator screw.

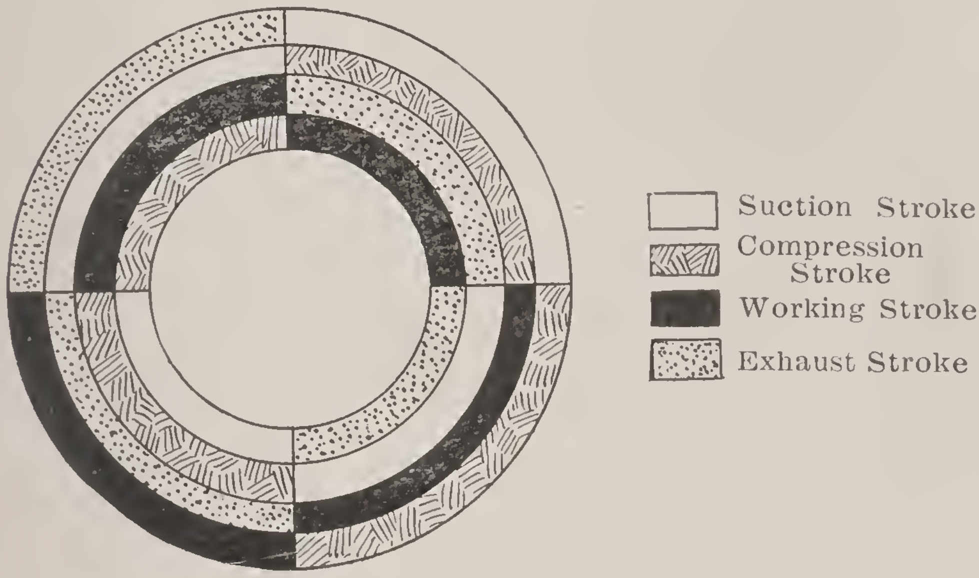


Fig. 24—The Four-cylinder, Four-cycle Diagram, showing the order in which the various cylinders do their work.

Having thus obtained an electric current of sufficient strength to fire the mixture it is necessary to supply a device which will *automatically* open and close the electric circuit at the *proper* time. Such a device is called a *commutator* and consists of two parts; one a *rotating* part, actuated by the engine, which makes a metallic contact with one or more points on a stationary part, the points being so located that contact occurs at the proper time for igniting the charge in any particular cylinder.

In the *four-cylinder* wiring diagram (Fig. 25) in various parts of an ignition system may be easily seen. The electric current is furnished either by

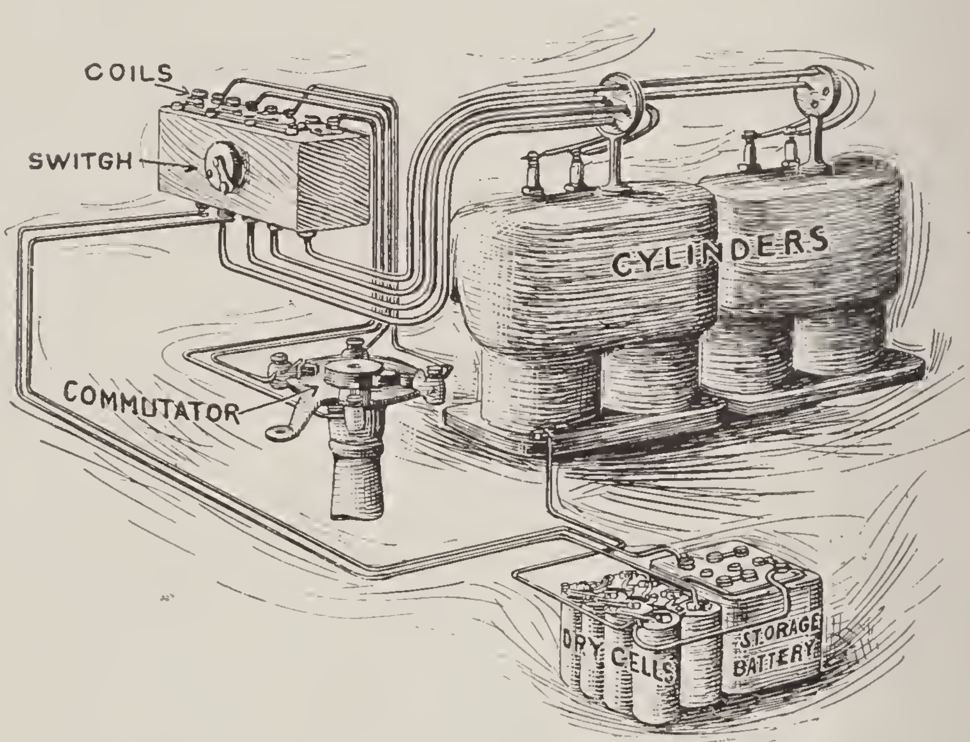


Fig. 25—Four-cylinder Wiring Diagram.

a set of dry cells or by a storage battery. *Four* individual coils and a *four point* commutator are used. The commutator is driven by means of bevel gears from the engine itself. A single switch controls the whole circuit, it being provided with two points, making it possible for either battery to be used at will.

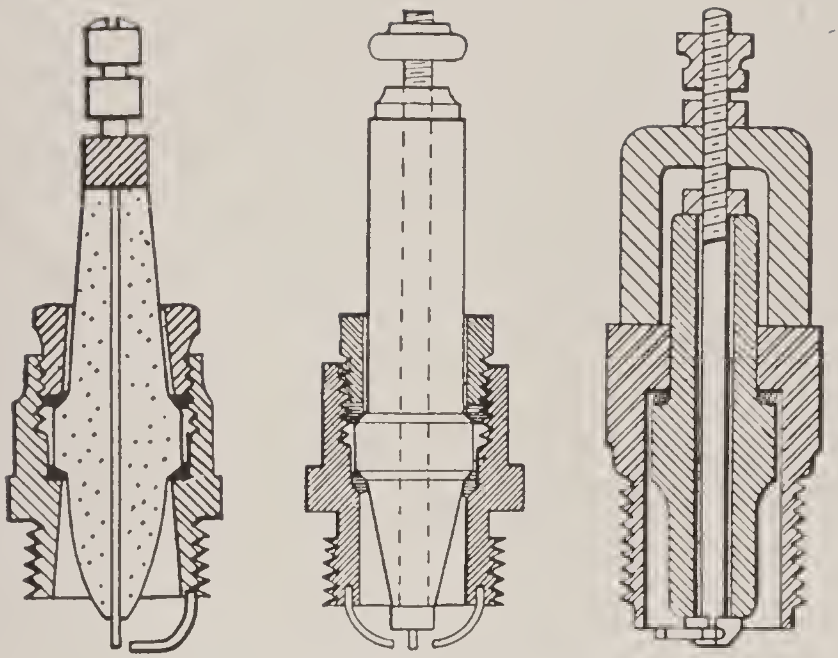


Fig. 26—Types of Spark Plugs.

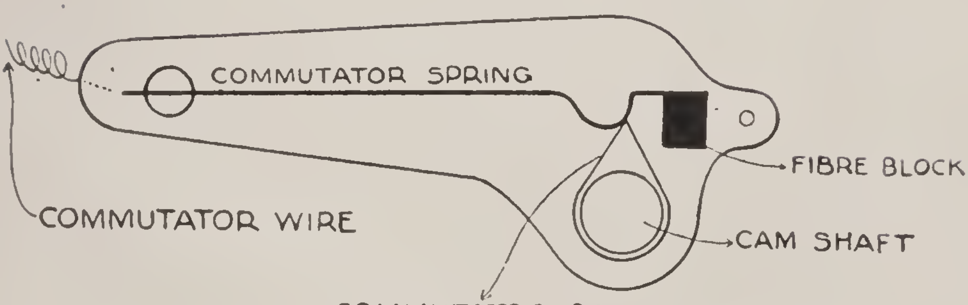


Fig. 27—A Single Cylinder Commutator. Diagrammatic sketch.

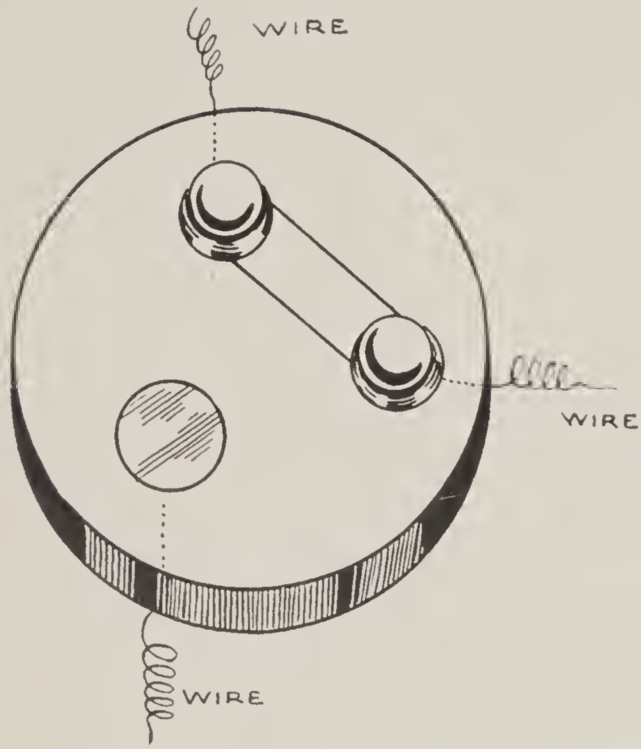


Fig. 28 – A Two-point Switch.

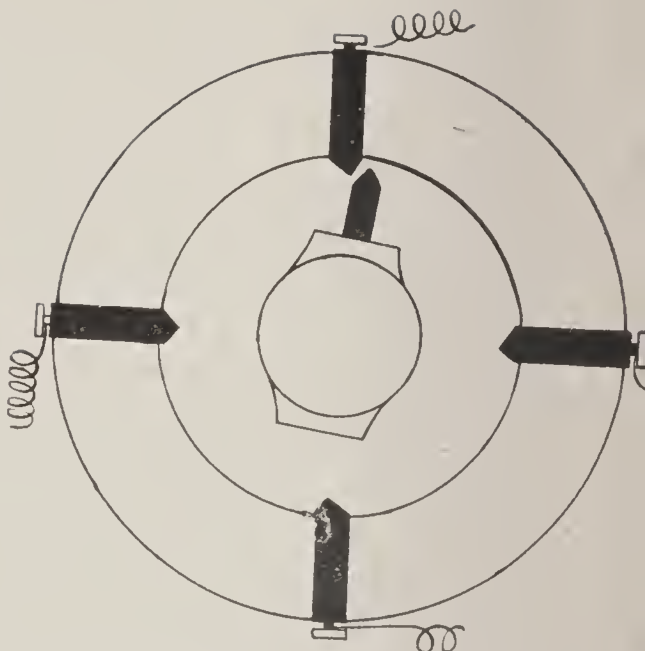


Fig. 29—A Four-cylinder Commutator.

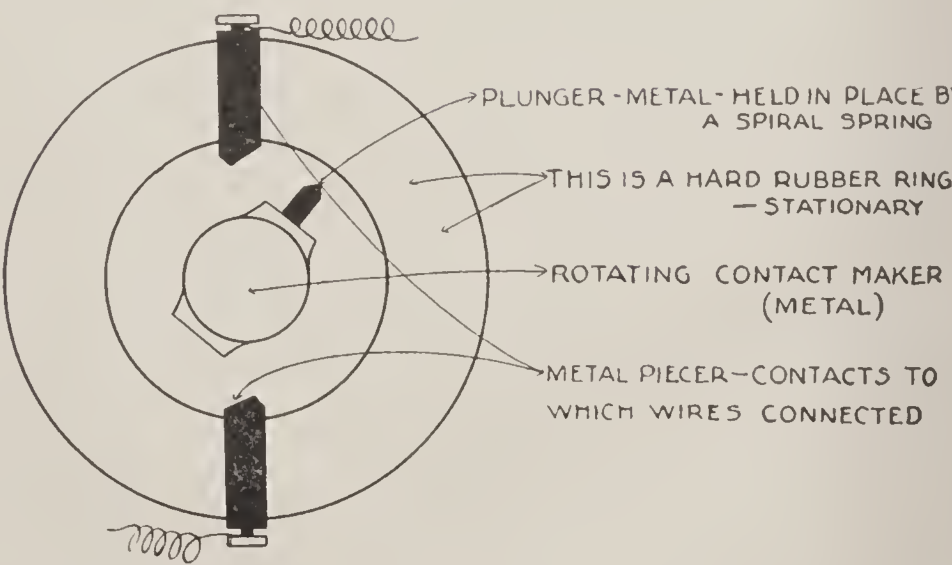


Fig. 30—A Two-cylinder Commutator.

THE COOLING SYSTEM

In order to prevent the walls of the cylinder from becoming red hot, it is necessary to cool them by some means, and this is done by surrounding the cylinder with a *water jacket* through which

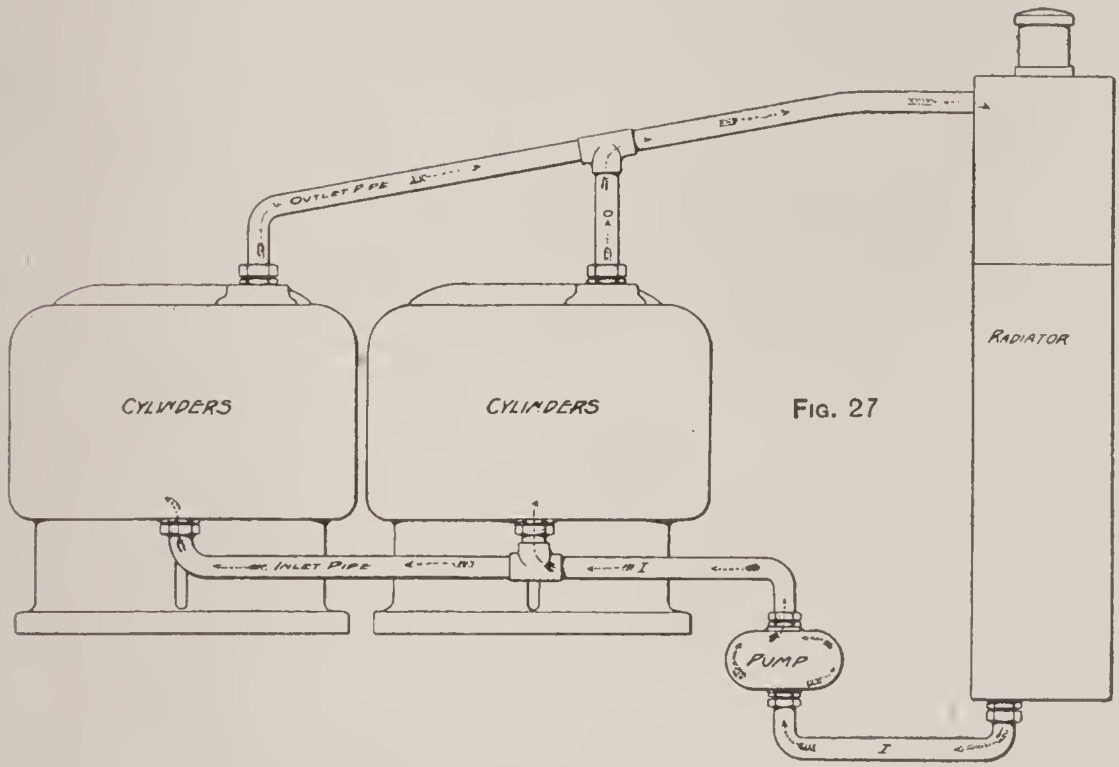


Fig. 31—A Diagram showing piping and direction of circulation in a One-cylinder Water-cooled Motor.

the cooling water is circulated. In order to prevent the water from boiling and evaporating, thus making the constant addition of water necessary. a *radiator* is introduced into the system. This radiator is made up of very thin tubes which give up their heat rapidly, thereby keeping the temperature of the water below the boiling point. A fan is also used sometimes to draw the air through between the tubes, thereby making the process of cooling take place more rapidly. The system is so arranged that the water is drawn from the lower part of the radiator where the water is coldest by means of a pump and forced up through the water jackets and back into the radiator again. Several different styles of pumps are used, but a

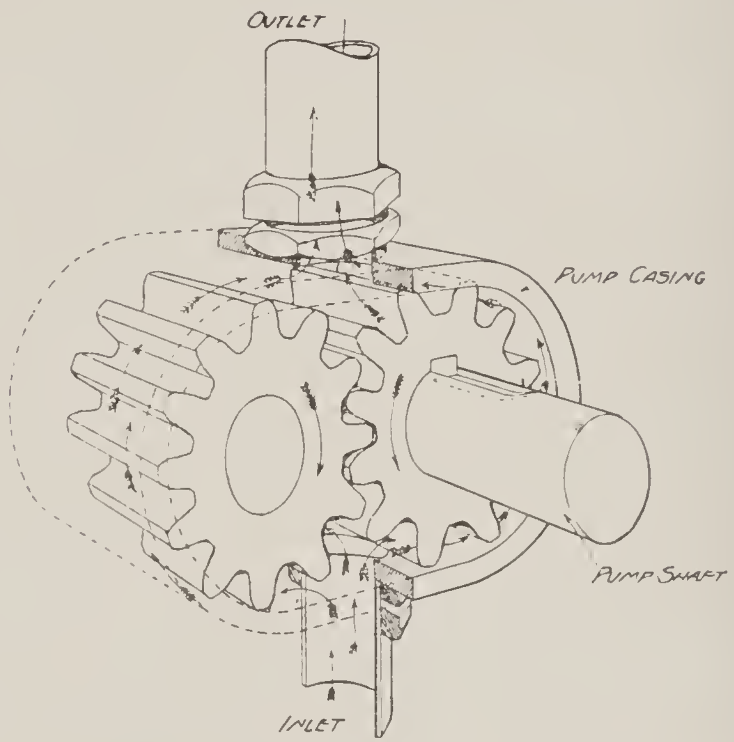


Fig. 32—A Gear Water Pump.

very common one is the *gear pump* shown in Fig. 32. As you will see by the drawing, it consists of two gears en mesh with each other which revolve in the direction indicated by the arrow. The water entering through the inlet pipe is drawn around the outside and forced out through the outlet at the top.

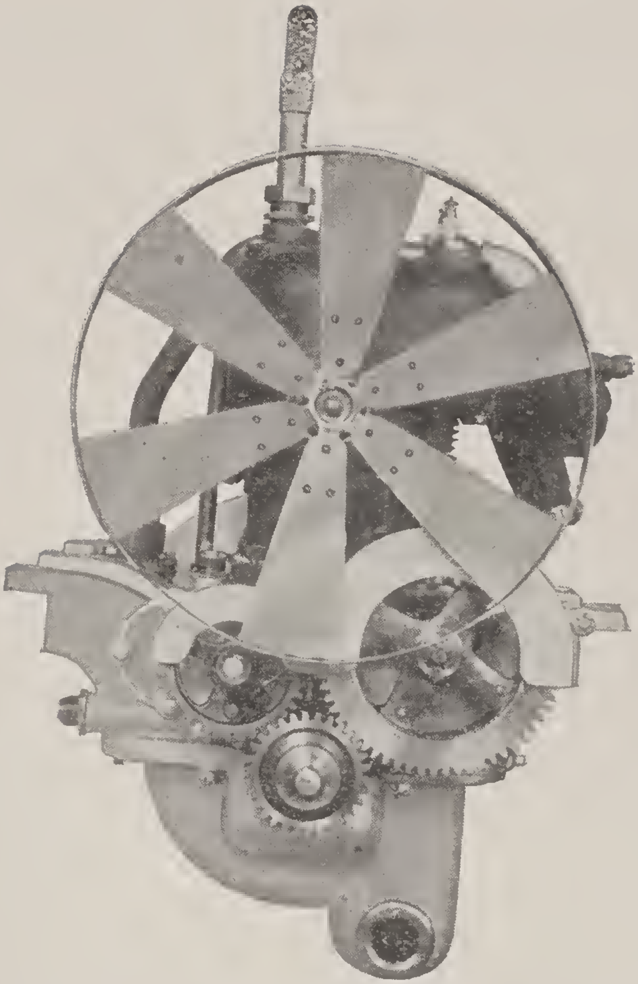


Fig. 33—Front End of Motor, showing radiator fan and cam shaft gears.

Fig. 34—A typical Radiator.

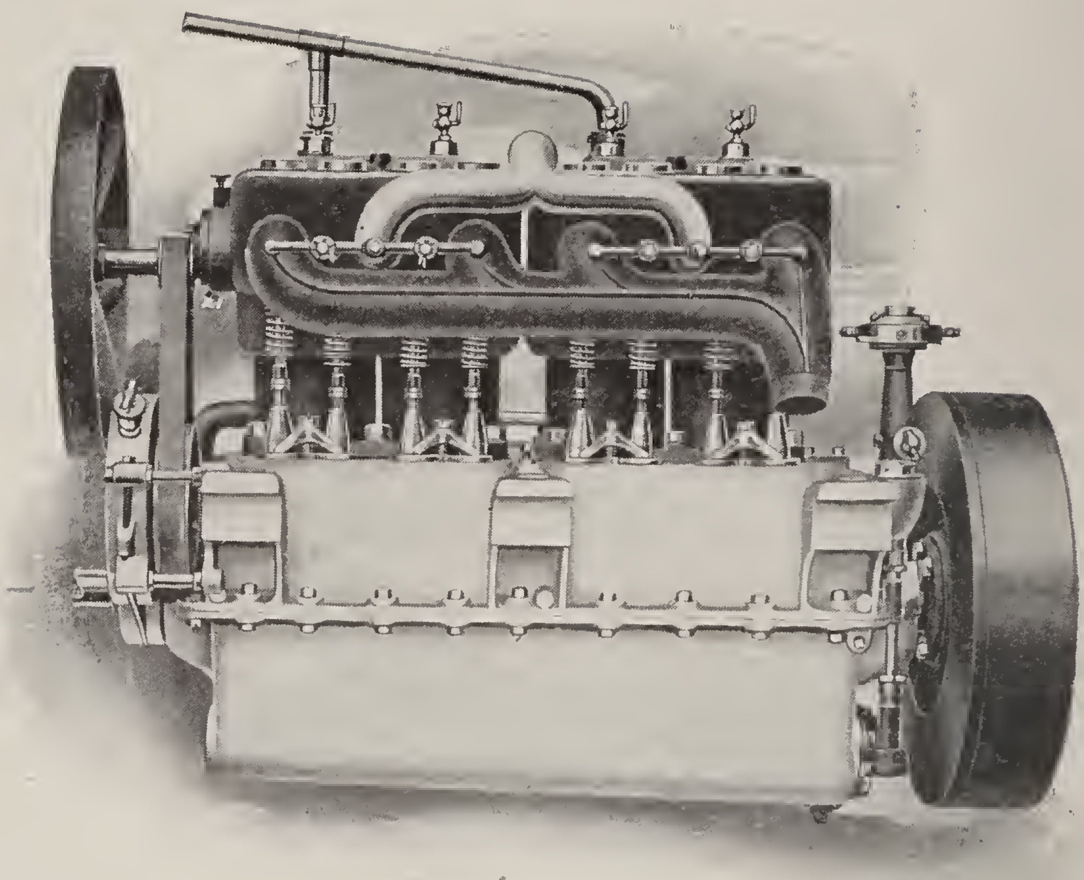


Fig. 35 - Valve side of a Four-cylinder Motor.

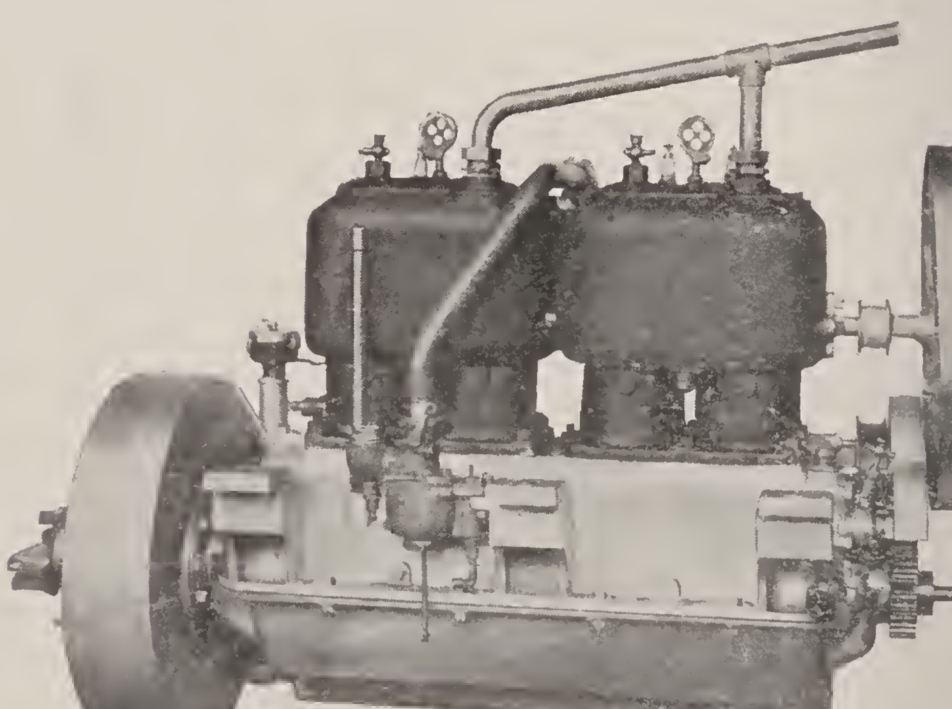


Fig. 36—Opposite side of same Motor showing Carburetor and Inlet Pipe.

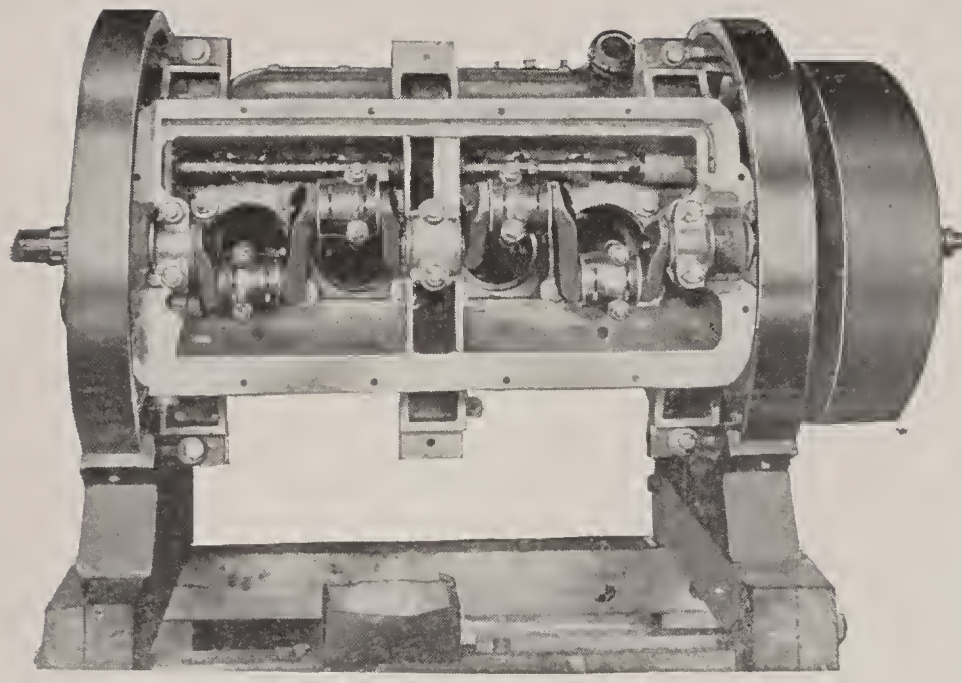


Fig. 37—Bottom view of same Motor with oil pan removed showing Crank Shaft, and Connecting Rods.

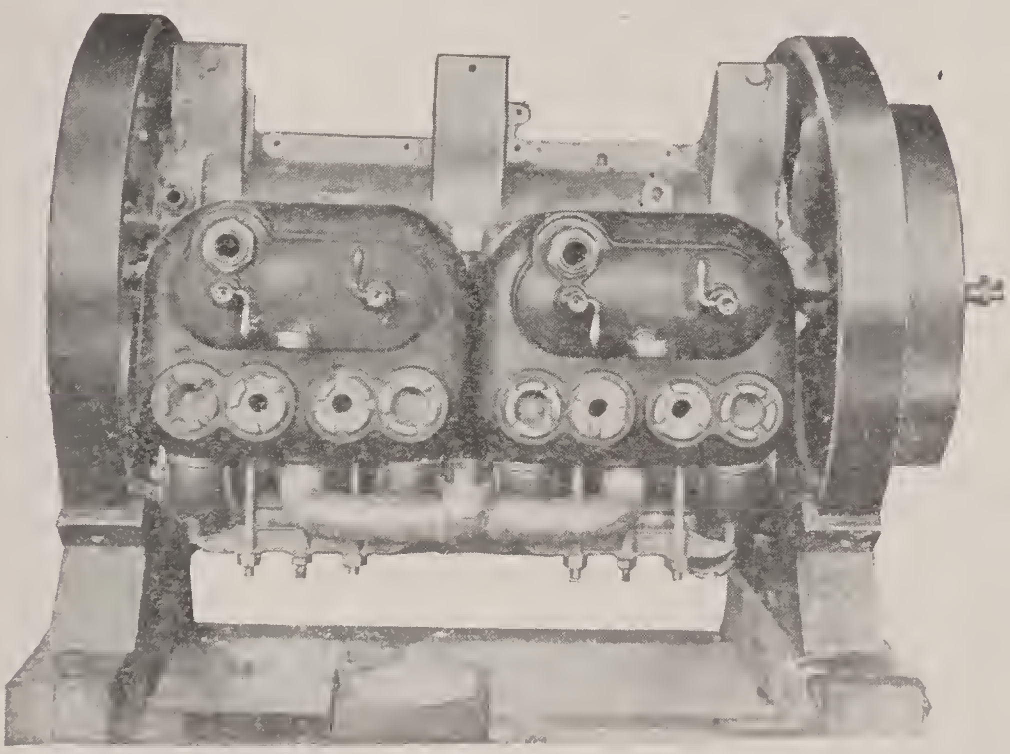


Fig. 38—Top view of same Motor showing Valve Caps and Holes for Spark Plugs.

NOTE—Both views show motor mounted in ring frames used for assembling in factory.

THE TWO-CYCLE MOTOR.

Although the four-stroke cycle type of motor is used by most of the automobile manufacturers, yet

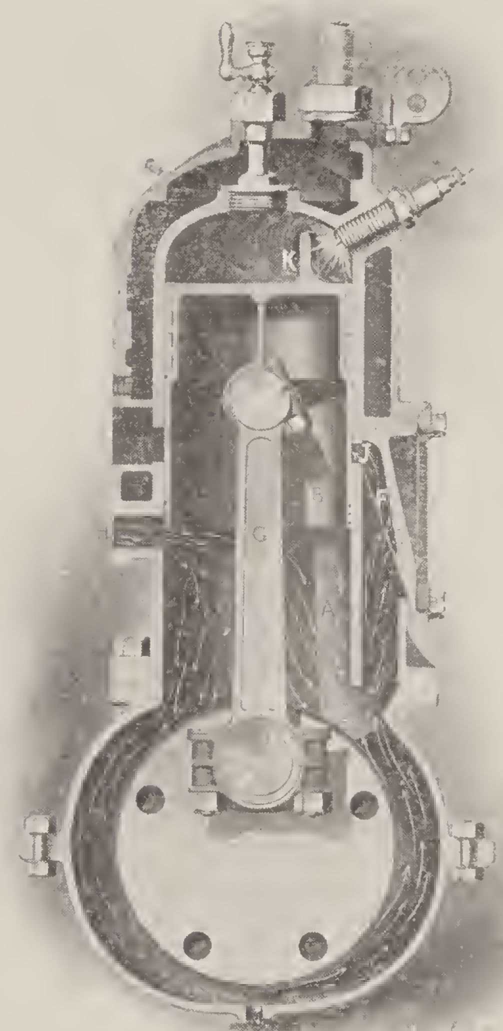


Fig. 39.

there is another type which has given such good results that it is destined to become one of the important forms to be used in gas engine vehicle manufacture. It therefore merits a brief description. It has the advantage of being very simple in construction and operation, and for this reason it has become very popular among the marine engine builders, although with a few exceptions it has not as yet been accepted by motor car engineers. It is called a Two-stroke Cycle Motor, so named because it combines in *two strokes* the series of changes ordinarily accomplished in *four* in the four-stroke cycle type. Its operation may be seen by referring to the accompanying diagrams. It is first assumed that the engine is being turned over by hand in the direction indicated by the arrow. You will note that as the piston moves up it will uncover a port (H), allowing the gasoline vapor from the mixing chamber to enter the crank case. As soon as the piston moves down again, a port (J) will be opened, allowing the mixture which has just been compressed to rush through a "by-pass" (F), into the "combustion chamber," or upper part of the cylinder. Now, as the piston moves up again on the next stroke, this charge is compressed still more, then as the piston reaches its uppermost position the charge is ignited and the engine begins to work under its own power. The gases continue to act on the piston until nearly the end of the stroke is reached, when you will notice, by referring to the drawing, the exhaust port (G) is passed. At this point the burned gases rush out into the air. You will also notice that in order to aid the discharge and fill the cylinder again, as the piston travels a little farther down, the inlet port will be again uncovered, and the next charge, which has meanwhile been taken into the crank case and compressed, will enter the cylinder, forcing the exhaust gases out. In order to prevent the vapor which has

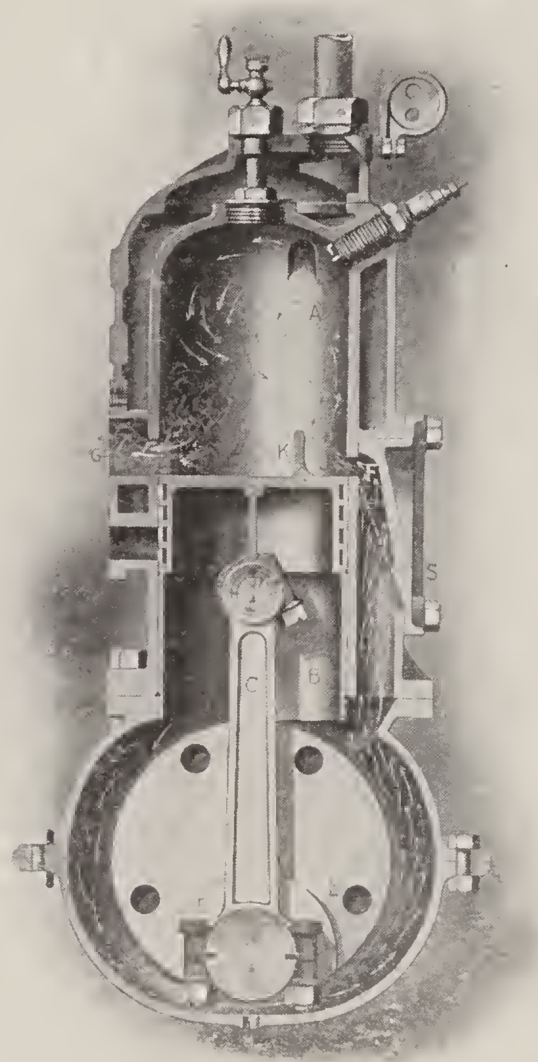


Fig. 40.

just entered the cylinder from traveling straight across and out through the exhaust port, thus wasting a portion of the fuel, a "baffle plate" (K) is cast on top of the piston which deflects the gases toward the top of the combustion chamber, producing a sort of whirling action which tends to scavenge the cylinder most thoroughly. In order to prevent the burning gases from traveling back into the crank case and igniting the gas there, thus producing a "back explosion," a wire gauze (S) is placed in the *"by-pass."* You will note that this type of motor has no valves, no cams and no cam shaft, in fact, its simplicity is such that it practically cannot get out of adjustment. It therefore is a form of gas engine which as soon as engineers are able to educate the public to its pecularities bids fair to become as popular and practical as the four-stroke cycle.

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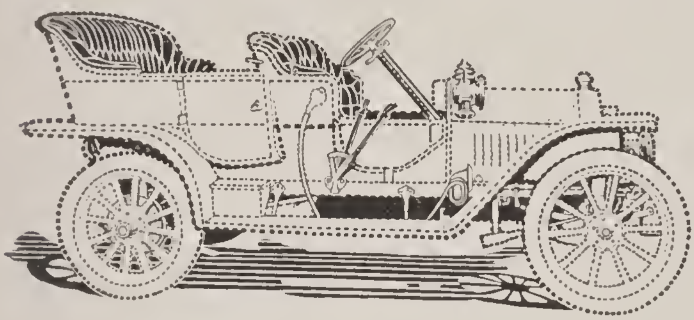

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