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IH-C-GAS ENG

The

McCORMICK-DEERING

GAS ENGINE HANDBOOK

A brief, illustrated treatise on the principles of operation of the internal combustion engine, together with a description of the McCormick-Deering engine and instructions for its care and repair.

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Why a Gas Engine

Pumping water and many other jobs require only power—no brain work—an engine would do them quicker, better, and cheaper, permitting the farmer to apply himself to the jobs which pay highest returns—those requiring brain work. Time spent at power-producing jobs is worth less than two cents per hour.

A farmer exchanges the product of his labor for the products of workers in other industries. The more efficiently he utilizes his labor, therefore, the more advantageous to him will such exchange be.

Putting it another way: returns from farming are on a "piece work" basis—it is not how hard a farmer works, but how much he actually produces, which determines his income; the greater the quantity of his product, and the lower the cost of that product, the greater is his net income, or profit.

The work of the farmer or his hired hands may be divided into three classes—the production of energy, the direction of energy (whether of his own muscles, of animals, or of a mechanical power plant), and brain work.

Strangely enough, the hardest physical work performed by a farmer usually pays him the lowest returns, for he is then competing against animals and engines in the production of power, while the brain work, which requires the least effort on his part, yields highest returns, the same as in any other business.

The less time spent on power-producing jobs, and the more time spent directing a large amount of power, whether of large teams or a yet more powerful tractor, or in studying ways and means of improving the business, other things being equal, the greater will be the returns from the farm.

A man pumping water, turning a grindstone, or doing similar tasks, is acting merely as a power plant; such work requires no exercise of brain power—an engine will do it just as well and often better, and at a fraction of the cost.

No farmer can make money doing these jobs by hand. Nor can he afford to pay a hired man from 25c to 50c per hour to do work which an engine could do faster and for 2c or 3c per hour.

What Makes a Gas Engine Run

THE principles of operation of an internal-combustion engine, or, as it is more commonly called, a "gas" engine, are simple, and anyone of ordinary intelligence can readily understand them if they will spend a few minutes studying them.

Furthermore, so universally are gas engines used in our everyday lives, that it behooves everyone, women as well as men, to understand thoroughly the fundamental principles of their operation. Such knowledge will frequently save a lot of time and expense, as well as annoyance, when an engine fails to run because of some minor difficulty which can be quickly located and remedied by anyone at all familiar with the functions of the various parts of an engine.

This book has been prepared entirely for the purpose of making it easy for the novice to acquire the necessary information. The illustrations, together with the text, will enable anyone to learn just how a gas engine operates, if they will devote to it a few minutes of careful study.

Internal-combustion engines and steam engines (sometimes called "external combustion engines") both derive their power from heat usually generated by burning fuel. In the steam engine, coal or other fuel is burned under a closed boiler containing water. Part of the heat from the combustion is absorbed by this water, whereupon it begins to change into a vapor—steam. As more and more heat is absorbed, the quantity of steam generated increases, thus creating pressure in the boiler.

This steam, under the pressure thus created, is then allowed to pass through a pipe into a cylinder containing a movable piston, and the steam, in its effort to expand, pushes this piston, which is connected to a crank by a connecting rod, and in this manner the steam is made to turn the crank just as a man turns the crank on a grindstone.

In the steam engine, as just explained, the fuel is burned entirely outside the engine.

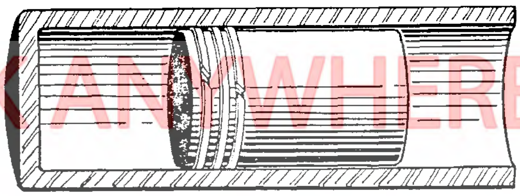
In the internal-combustion engine, fuel and air under compression are burned within a closed cylinder, and the heat generated by burning fuel is applied directly against a piston, the piston being connected to a crank by means of the connecting rod, just as in the steam engine. It is the fact that the fuel actually burns within the cylinder itself which gives this type of engine the name "internal-combustion."

Why Called "Gas" Engine

The commoner term, "gas engine," undoubtedly comes partly from the fact that the earliest internal-combustion engines used ordinary illuminating or natural gas as a fuel. However, the term is entirely correct when applied to so-called gasoline, kerosene, or other "oil" engines, for such fuels are always converted into a gas before they are burned.

True, we supply fuel to the engine in the form of a liquid, but neither gasoline nor kerosene (nor, for that matter, the lighter oils such as naphtha, benzine, or ether) will burn in liquid form—they must be vaporized and mixed with air before they will ignite. The pure vapor will not burn.

If you pour a little gasoline into a saucer, strike a match and hold it above the liquid, a flame will appear above the gasoline if it is of good quality. If you observe closely, you will notice that this



Illust. No. 2. Cylinder with piston and piston rings.

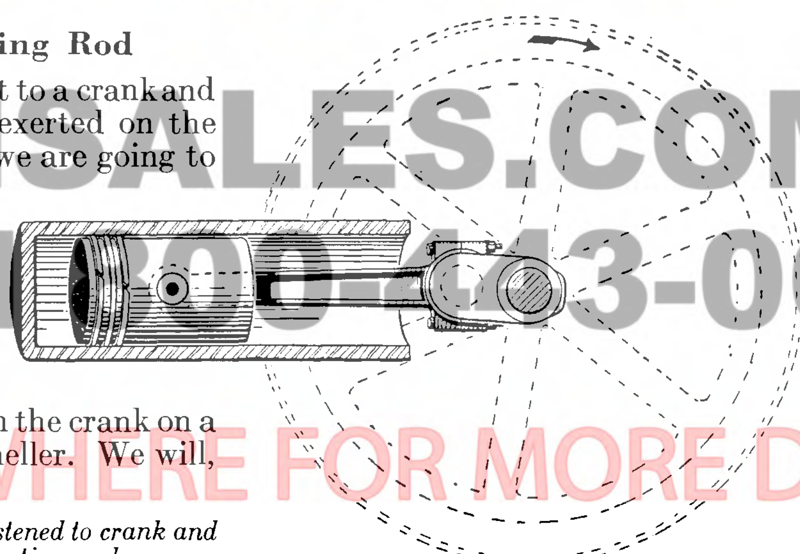
grooves are placed cast iron rings. These fit the grooves closely and at the same time press outward against the cylinder walls with sufficient pressure to prevent gases from passing between the rings and the cylinder walls, yet not hard enough to scrape off a film of oil from the surfaces of the rings and cylinder walls. These rings are usually cut from iron castings having a slightly larger diameter than the piston. A short section is cut from one side of the rings and they are then compressed until they are the same diameter as the inside of the cylinder and, while held in that position, are ground so that their outer surface forms a perfect circle. While we usually think of cast iron as being brittle, it has an appreciable amount of elasticity and cast iron piston rings made as described will continue to press outward against the cylinder walls for thousands of hours of service.

The Connecting Rod

In order to transmit to a crank and flywheel the power exerted on the piston by the gases we are going to burn in the cylinder, we must connect the piston in some manner to the crank for we want to make the piston turn this crank just as you turn the crank on a grindstone or corn sheller. We will, therefore, connect the piston to the crank by means of a steel rod, known as a connecting rod. To fasten it to the piston, we will bore two holes through opposite walls of the piston about midway of its length and put a pin through this hole and also through a hole in the end of the connecting rod. This makes a sort of hinged connection of the connecting rod with the piston. The pin which fastens a connecting rod to a piston is called a "piston pin" or "wrist pin," because of the wrist-like motion of the joint.

The Crankshaft and Flywheel

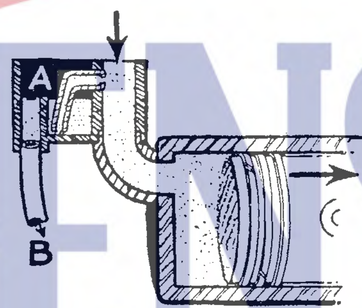
The other end of the connecting rod we will fasten to a crank fastened to a flywheel. For this we will use a closely fitting bearing, generally known as the "connecting-rod bearing." Occasionally it is termed the "crank-pin bearing," since the part of the crankshaft which turns within the bushing at this end of the connecting rod is called the "crank-pin," because of the fact that in the earliest gas engines, which had only one cylinder and one flywheel, the connecting rod was often fastened to a "pin" in the flywheel or crank-arm.



Illust. No. 3. Piston fastened to crank and flywheel by connecting rod.

If you blow such a spray two or three inches above the top of a hot stove, the tiny drops will evaporate before they touch the stove. In fact, the spray will hardly be visible, so quickly will these drops evaporate when exposed to hot air.

Some of the earliest carburetors for gas engines depended upon the evaporation of the fuel in a comparatively large bowl by having a current of air pass over it. This would work fairly well with some of the earlier fuels which were much more volatile (more easily evaporated) than those of today. However, it was very uncertain, for changes in the temperature of the air would make a difference in the amount of fuel which would be evaporated.



Illust. No. 5. Simple fuel mixer or carburetor. Fuel is maintained at constant level in fuel chamber "A" by overflow pipe "B." Air enters at point indicated by arrow; fuel is sucked from fuel chamber through elbow-shaped tube.

A little later other carburetors made use of the same principle used in drying clothes. That is, a wick was kept wet with the fuel so as to expose a large surface of the liquid fuel to the air being drawn through the carburetor. Neither of these types of carburetors, however, would evaporate fuel rapidly enough for high speed engines, although they worked fairly well with some of the very early engines which ran at low speeds.

Practically all carburetors on the market today use the same principle as is employed in atomizers or liquid sprayers. That is, a stream of rapidly moving air passes over a small nozzle through which a tiny stream of the fuel is drawn by suction. This stream of fuel is broken up into a very fine mist by the current of air and is quickly evaporated, particularly if the air is heated, as it frequently is, by means of a "stove" around the exhaust pipe through which air must pass in order to reach the carburetor. Or, the intake manifold may be heated by the hot exhaust gases of the engine, either by making the intake manifold part of the same casting used for the exhaust manifold, or in some other manner.

In Illustration No. 5 is shown a cross-section of a simple carburetor of the atomizer type. It consists simply of a bowl in which a constant level of fuel is maintained either by pumping in more than is used by the engine and allowing the excess to overflow and return to the tank, or by a float which cuts off the supply of fuel whenever the supply in the bowl reaches a certain level and allows more to enter as fast as it is needed.

It is easy to see that when the piston is pulled in the direction of the arrow, air will now be sucked into the cylinder and pass over the small nozzle. The suction will also draw fuel from the bowl "A" into the intake pipe, where it will be converted into a fine spray and carried into the cylinder with the air which enters.

In the ordinary atomizer or spraying outfit, the hole through which the liquid passes is of a fixed size and no means is provided for regulating the amount which will be drawn out by the blast of air. Some carburetors work on this and fuel vapor to fill the space in the cylinder which it formerly occupied, it has completed the first "cycle" of a four-cycle engine. This is the "suction stroke."

The Intake Valve

As the flywheel keeps on turning, the crank, on its next half revolution, will, of course, push the piston back into the cylinder. If the intake pipe were left open, as shown in Illust. No. 7, the piston would simply blow the charge, which it had just sucked in, back through the intake pipe.

To prevent this, what is known as a valve is used. In most engines this is simply a round piece of metal which forms a sort of cap to fit over the opening from the intake pipe into the cylinder. To this cap of metal is attached a short rod or "stem" which extends to the outside of the cylinder through a small hole which it fits closely. This type of valve, as shown in Illustration No. 8, is known as a "poppet" valve. In order that such valves may seal the opening so perfectly that even air under pressure cannot get past them, the face of the valve and the seat against which it rests when closed are first machined very accurately and then the valve is "ground in" with fine emery powder or some other abrasive until both surfaces are so highly polished that they will fit so closely together that neither liquid nor gas can escape between the surfaces.

Poppet valves are held closed by means of a spring outside the engine, acting through the valve stem by means of a pin placed through a hole in the outer end of the stem; a horseshoe washer fitted into a notch at the end of the valve stem; or sometimes a split washer fitted into a notch and held in place by a "cup" washer which fits around it, thus holding the head firmly upon its seat.

In many cases, the intake valve is opened by a mechanical device usually operated by a cam. When the valve is placed as shown in Illustration No. 8 the engine is known as a "valve-in-head" engine. In this type, if the valve is to be opened by positive mechanical action, it requires a rocker arm actuated by a push rod usually driven by a cam, as mentioned. In some cases, the intake valve opens automatically from the suction created by the piston as it starts on its first cycle or suction stroke. In this case, only a light spring is used to hold the valve shut.

With the intake valve in place, as shown in Illustration No. 8, as the piston moves back after it makes its suction stroke, the air and fuel vapor which has been drawn in cannot escape from the cylinder and so is compressed as the piston is pushed backward by the crank as the flywheel keeps turning.

The Compression Stroke

When the piston is back to the same point at which it started on its first stroke, it has completed the second cycle of a four-cycle engine, having made what is commonly called the "compression" stroke. In other words, on the first two strokes or cycles the piston has sucked in a charge of fuel vapor mixed with air and compressed it. While the return of the piston to its starting point is a perfectly natural sequence, because of the construction of the engine which causes the piston to move back and forth in the cylinder as the crankshaft revolves, the compression of the fuel on this stroke has a very important effect.

First, the compression of the fuel mixture on this stroke generates a certain amount of heat