# A POWER PRIMER : AN INTRODUCTION TO THE INTERNAL COMBUSTION ENGINE, AUTOMOBILE, AIRCRAFT, DIESEL

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GENERAL MOTORS CORPORATION

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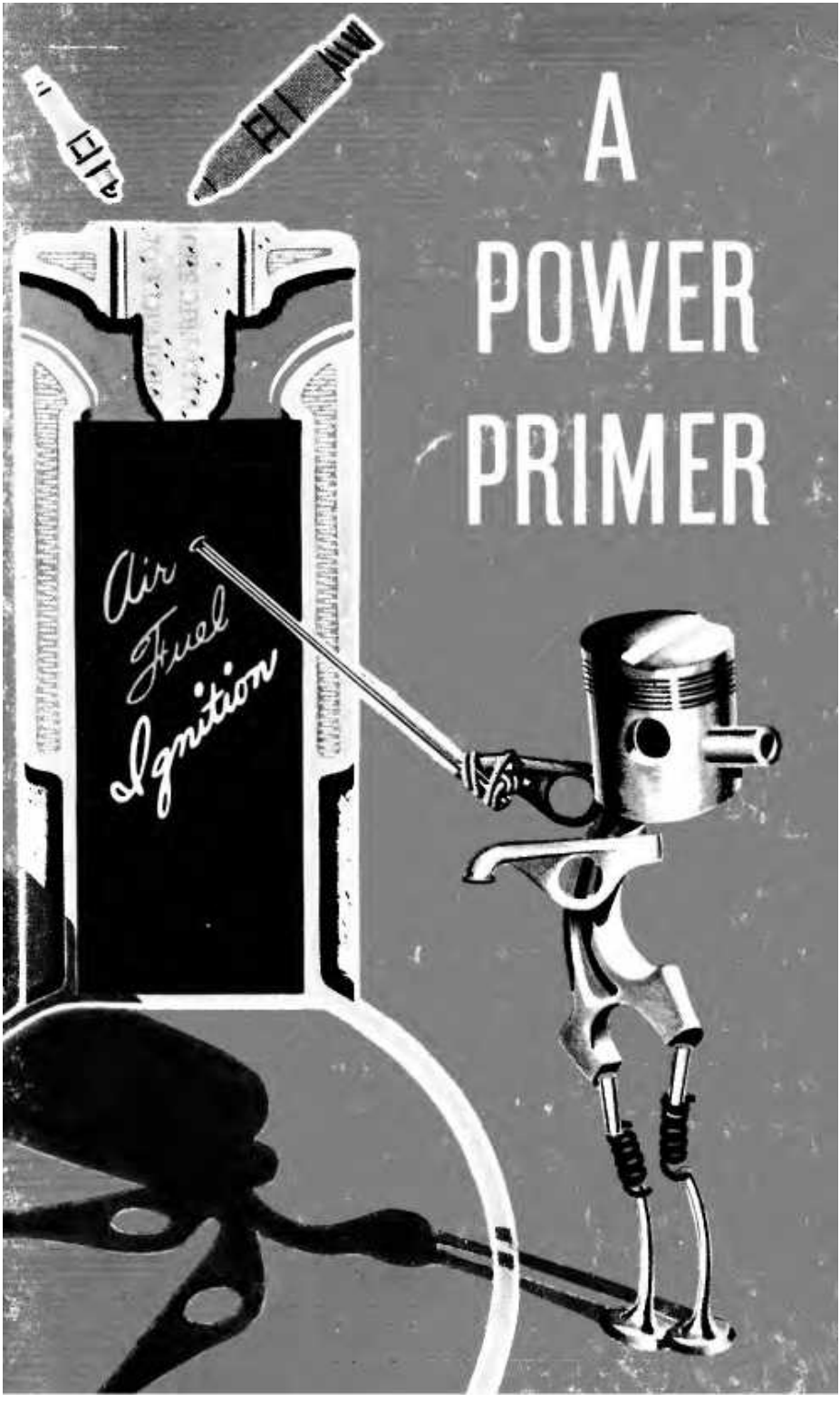
Trieste


A
POWER
PRIMER
Air
Fuel
Ignition


An Introduction to the Internal Combustion Engine

**AUTOMOBILE**

**AIRCRAFT**

**DIESEL**



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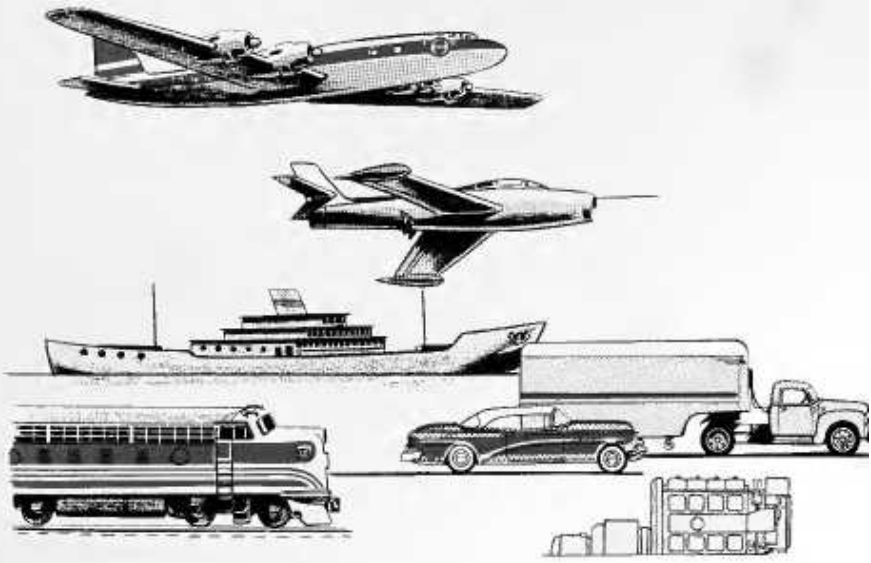
# Author's Note

This might be called a "sketch book of engines." Pictures have been substituted for words wherever possible, and the technical language has beer. held to a minimum. Our primary effort has been to explain technical facts in an interesting and non-technical manner. In doing this, it has been necessary to leave out many qualifying phrases—such as "other things remaining the same"—and to eliminate minor details in some cases in order to stress the major point. We do not believe this has resulted in any inaccuracies, but it may have left some openings for argument.

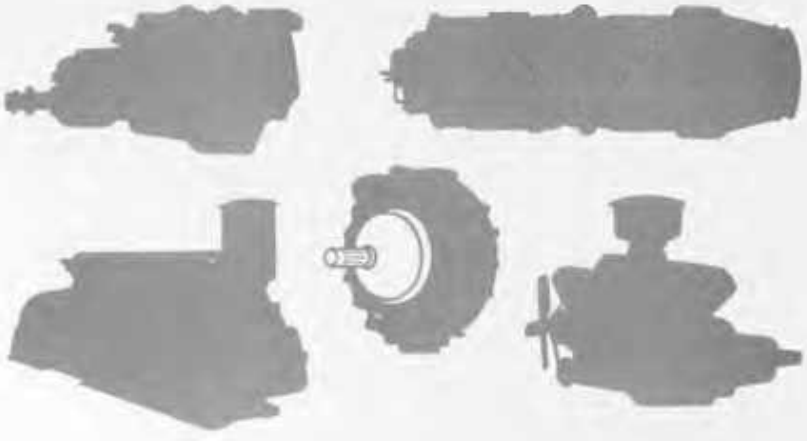
There are omissions. We are conscious of some ourselves, and no doubt many others will be discovered. All we can say is that this is a primer and internal combustion engines constitute a large subject. Our judgment may be questioned as to what has been put in and what has been left out, but we have tried to include that which would be most practical for the average person.



# WHAT is an Engine?

MOST people today have at least a nodding acquaintance with the internal combustion engine. To the great majority it is what makes an automobile go. But to others it may be the motive power for a tractor or truck, a cruiser or a tug-boat, a fighter plane or a transport. It may furnish power and light to an isolated farm, to a saw-mill in the woods, or to an entire city. For today the internal combustion engine has invaded all fields, from the bottom of the ocean to the limits of the heavens.

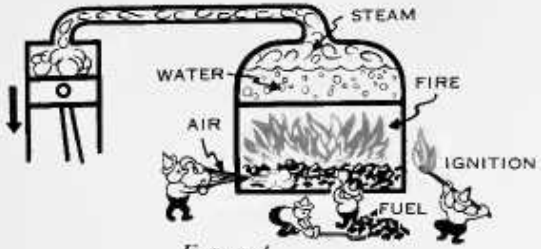
This great variety of names and types of engines can be very confusing—large and small engines, Diesel engines, automobile engines, jet engines, V-type engines, marine engines, radial engines, and so on. What we are trying to do in this booklet is to take away some of the mystery from these engines with different names. We are going to consider them all as internal combustion engines, and show that they are fundamentally the same. We will demonstrate that they all are based on three things—**AIR, FUEL** and **IGNITION.** We need those three things to make any internal combustion engine run. There are certain other features and principles common to every engine. We are going to point out the common features and then the principal differences in the various types of engines most generally used today.



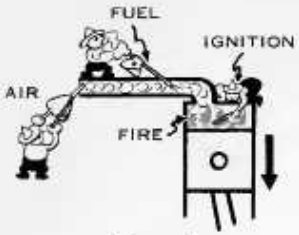
We have rather arbitrarily classified them in three groups—**automobile, aircraft,** and **Diesel.** We realize there are other important types, such as marine engines, stationary power plants, and so forth. But most of them are either one of the three types mentioned, with slight modifications, or are a combination of features from several classifications. So we feel this will cover the fundamentals of most internal combustion engines now in use even though some may not be mentioned by name.


## What is an INTERNAL COMBUSTION Engine?

What do we mean when we talk about internal combustion engines? "Internal combustion" is a rather cumbersome expression, but one thing can be said for it, it actually means what it says. "Internal" means "inside" or "enclosed." "Combustion" is "act of burning." Thus an internal combustion engine is one in which the fuel *burns inside,* that is, it burns inside the same




*External*



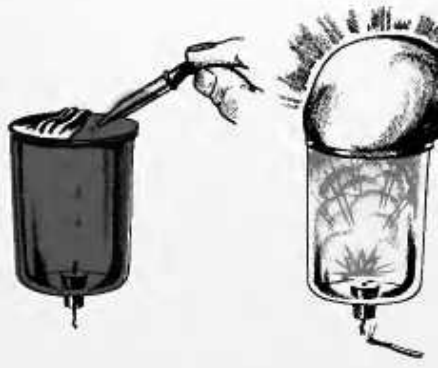

*Internal*

container which produces the power. In a steam engine the fuel can burn almost anywhere as long as it turns water into steam which can be led into the cylinder. That is "external combustion."

So an internal combustion engine is fundamentally a container into which we put air and fuel and start them burning.*

Let us try a crude but simple experiment to illustrate this. We take an open glass beaker, like a drinking glass, and into it pour a few drops of gasoline—just one or two. Cover the top with a rubber diaphragm—a balloon will do. In the bottom of the beaker is a hole plugged with a cork, and running through the cork is a fuse—an ordinary firecracker fuse. We light the fuse and wait to see what will happen. The instant the fuse burns up into the beaker, the mixture of gasoline and air will be ignited and will burn very rapidly. The heat will make it try to expand, to grow larger and occupy a greater space. This will push against the diaphragm, which will bulge upward above the top of the beaker. As we might say, the balloon will be blown up. The important point is that, due to the combustion, pressure will be exerted against the diaphragm.

Note: This should be considered a theoretical experiment. It is not something to be tried in the kitchen. It actually does work as described, but the quantities are rather critical. A few too many drops of gasoline may cause a dangerous explosion under some conditions.



*Inasmuch as the remainder of this booklet is concerned with only internal combustion engines, we will drop the longer term and use "engines" as meaning "internal combustion engines."

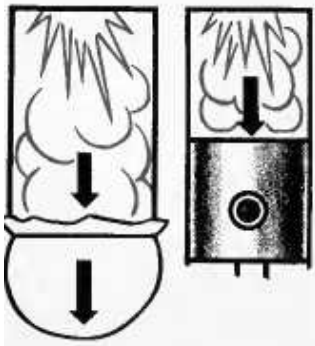
CYLINDER

PISTON

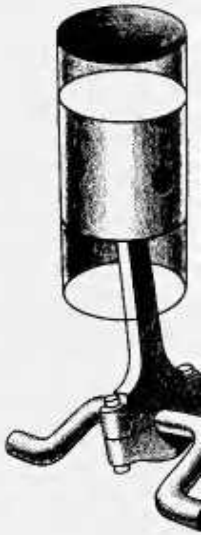
CONNECTING ROD

CRANKSHAFT

Now what do we have to do to make an engine out of this combustion? First, we will turn it upside down for convenience. The beaker is our **cylinder,** which is simply a hollow tube closed at one end. We will replace the diaphragm with a **piston.** This is a cylindrical object which slides in the tube, and as it fits closely against the wall it thus seals the other end of the cylinder.



Here we have the same arrangement that we had with the beaker. If combustion takes place in the cylinder, we will have expansion of the air and pressure will be exerted on the top of the piston. This will not bulge like the diaphragm, but will slide. So all we have to do now is connect that sliding piston up in some way to get useful work from it.



For this we need a **connecting rod** and a **crankshaft.** The connecting rod is a straight rod with one end fastened to a pin or pivot in the piston so the lower end can swing. The crankshaft is a shaft with its ends mounted in oiled bearings so it can revolve, and thus the offset portion in the middle, the **crank,** describes a circle as the shaft turns around. The lower end of the connecting rod is fastened to the crank, so it must follow the same circular path.

We have probably all ridden a bicycle at some time during our lives. The lower part of the leg of a bicycle rider is a connecting rod. The knee moves approximately up and down in a straight line. The foot follows the pedal, and therefore goes around in a circle.