The Rocket Engine

Several components had to work together for a liquid-propellant rocket system to work. The rocket motor itself consisted of two parts: a combustion chamber and an exhaust nozzle.

The combustion chamber was a metal tank where the fuel and oxidizer would combine and burn to produce hot gas that would shoot out through the exhaust nozzle to provide thrust for the rocket. The liquid fuel and the oxidizer had to be fed continuously into the combustion chamber to keep the fire burning. Through a series of experiments, Dr. Goddard found that forcing the gasoline and liquid oxygen into the chamber through a group of small spray nozzles was more effective than spraying each one through a single spray head.

With a very hot fire burning continuously in it, the combustion chamber could become so hot that a hole could burn through its wall or the entire wall could become so weak that the tank could explode. Goddard experimented with different materials that could withstand the heat, but he also developed a technique for constantly cooling the chamber. He built the combustion chamber with two walls, one inside the other. Gasoline from the separate fuel tank would be forced through the narrow opening between the two walls where it would absorb some of the heat from the inner wall. That would also preheat the gasoline so it would vaporize effectively when it was sprayed into the combustion chamber.

The fuel (gasoline) and the oxidizer (liquid oxygen) were contained in separate tanks outside of the combustion chamber. Sometimes, Goddard added a third tank containing liquid nitrogen. A heating element would vaporize the liquid nitrogen, which would be piped into the gasoline and oxygen tanks to force them into the combustion chamber. Other times, he used a system of pumps to force the gasoline and oxygen into the combustion chamber.

Combustion was only part of the operation of the rocket motor. Using the hot gas it produced in an effective way was also important for propelling the rocket. Rather than a simple opening at the bottom of the combustion chamber, a properly designed exhaust nozzle could concentrate the exhaust gas in a way that produced an even more powerful thrust. Forcing the exhaust gas to flow through a narrow throat increased the speed of the gas. Having that narrow throat open into a cone-shaped nozzle allowed the expanding gas to exert some of its force against the walls of the cone, which further increased the thrust.

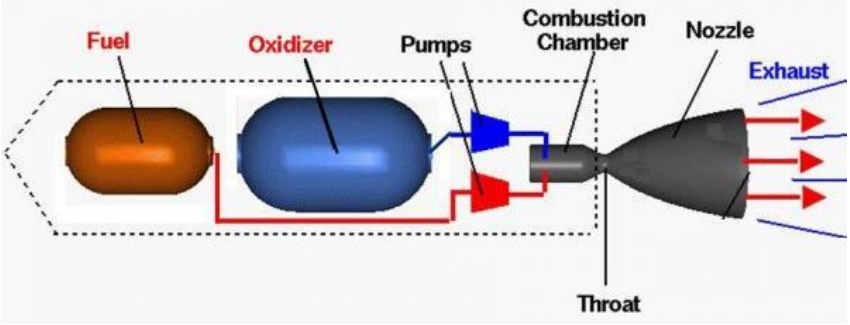

Illustration by NASA