water into steam which will become further heated after ignition. On account of the high specific heat of water, it requires a large quantity of heat to evaporize it or raise its temperature after it is vaporized. Since this heat must be absorbed from the heat of combustion of the charge it follows, necessarily, that the temperature of the mixture in the cylinder will be materially reduced. If very much water is introduced it may absorb so much of the heat generated during compression that the gases will not be hot enough to ignite readily. Especially will this be true if the charge is somewhat lean. This accounts for the fact that a leak of water from the jacket to the cylinder makes it difficult to start the engine.

Cooling, in the method just described cannot be carried out completely. Some writers declare that it is never conducive to good economy in any case because it reduces the temperatures and pressures in certain circumstances it may be advantageous to use. In kerosene engines and in many alcohol engines provisions is made to use a water spray and the result of such use is always a smoother running engine. A heavily loaded kerocene engine will poend heavily after it has run for some time unless a large amount of jacket water or spraying especially, becouse it is sufficiently cooled by the fresh charge of cold gas and air, althoegh it is customary to bring the water jacket as close around both valves as can be done conveniently.

The volume of the compression space is an important consideration in gas engine design and a kowledge of the part it performs is equally of value to the man who operates an engine. In steam engine practice it is a well recognized fact that the clearance space should be small in order to insure the best economy. What is true in this respect in the steam engine is equally true in the gas engine. The highest economy demands small compression volume. There is a practical limit beyond which high compression can not be carried, and this limit is different for every different knd of fuel used.

In a previous lesson the statement was made that there is an exact relation between heat and work. If work is done upon a gas by compressing it, it becomes heated, and if the gas afterwards expands and does work upon its piston its temperature falls. When the charge in a gas engine is compressed its temperature rises in proportion to the amount it is compressed. If compression is carried too high its temperature may reach the point at which it will ignite. The of water is used. It seems advantageous in some types of engines, both from an economical and mechanical point of view, to use a small amount of water in the cylinder, in addition to the regulation method of cooling by means of jacket water.

Water ignition is also practiced in some cases as respects the products of combustion, by introducing it into the exhaust pipe. The effect is to absorb the heat from the gases and allow them to escape at a lower pressure, thus acting to some extent as a muffler. This practice does not of course, affect the heat in the cylinder itself.

In very large engines the piston must be cooled as well as the cylinder becoese the heat in the central part of a large disc of iron, which exposes relatively a small surmace to the cool cylinder walls, can not part with its neat capacity rapidly enough to keep the central part of a safe working temperature. Cooling, in such cases is accomplished by circulating water under pressere within the hollew part of the piston, using either flexible connections of telescoping pipes to convey water.

It is also necessary to cool the exhaust valve by a water jacket owing to the high degree of heat of the exhaust gases. The admission valve does not need coolvapor if gasoline ignites at comparatvely low temperature, and it has been found by experience that if it is compressed much above eight-five pounds per square inch, pre-ignition will take place. Alcohol vapor on the other hand, is less volatile and needs a higher temperature in order to burn, consequently it wil stand a higher compression, and with higher compression it yields greater power for a given quantity of alcohol consumed. For this reason alcohol engines, designed primarily to use alcohol, have a smaller clearance volume than do gasoline engines. Engines designed to work under varying conditions and different fuels are usually given a clearance volume equal to from twenty to twenty-five per cent of the volume displaced by the piston. There are certain well-known laws which govern the pressure, volume and temperature of gases, which will presently be briefly alluded to. It should be understood in passing, that the three quantities, pressure, volume and temperature are inter-dependent, that is, when one changes, unless some means are taken to maintain one of them constant. The principal law connected with pressure and volume is known as "Boyle's Law." It may be stated thus: The pressure of a gas varies inversely as the volume