attack for the rotating blade with a subsequent increase in pressure rise. Of course, if the change in angle of attack or pressure rise is beyond some critical value, stall will occur. While the stall phenomenon of a series of rotating compressor blades differs from that of a single airfoil section in a free airstream, the cause and effect are essentially the same.

If an excessive pressure rise is required through the compressor, stall may occur with the attendant breakdown of stable, steady flow through the compressor. As stall occurs, the pressure rise drops and the compressor does not furnish discharge at a pressure equal to the combustion chamber pressure. As a result, a flow reversal or backfire takes place. If the stall is transient and intermittent, the indication will be the intermittent "bang" as backfire and flow reversal take place. If the stall develops and becomes steady, strong vibration and a loud (and possibly expensive) roar develops from the continuous flow reversal. The increase in compressor power required tends to reduce RPM and the reduced airflow and increased fuel flow cause rapid, immediate rise in exhaust gas temperature. The possibility of damage is immediate with the steady stall and recovery must be accomplished quickly by reducing throttle setting, lowering the airplane angle of attack, and increasing airspeed. Generally, the compressor stall is caused by one or a combination of the following items:

(*a*) A malfunctioning fuel control or governing apparatus is a common cause. Proper maintenance and adjustment is a necessity for stall-free operation. The malfunctioning is most usually apparent during engine acceleration.

(*b*) Poor inlet conditions are typical at high angles of attack and sideslip. These conditions reduce inlet airflow and create nonuniform flow conditions at the compressor face. Of course, these conditions are at the immediate control of the pilot.

(*c*) Very high altitude flight produces low compressor Reynolds numbers and an effect similar to that of airfoil sections. As a decrease to low Reynolds numbers reduces the section $c_{l_{max}}$, very high altitudes reduce the maximum pressure ratio of the compressor. The reduced stall margins increase the likelihood of compressor stall.

Thus, the recovery from a compressor stall must entail reduction of throttle setting to reduce fuel flow, lowering angle of attack and sideslip and increasing airspeed to improve inlet condition, and reducing altitude if high altitude is a contributing factor.

(3) While the *flameout* is a rare occurrence with modern engines, various malfunctions and operating conditions allow the flameout to remain a possibility. A uniform mixture of fuel and air will sustain combustion within a relatively wide range of fuel-air ratios. Combustion can be sustained with a fuel-air ratio as rich as one to five or as lean as one to twenty-five. Fuel air ratios outside these limits will not support combustion due to the deficiency of air or deficiency of fuel. The characteristics of the fuel nozzle and spray pattern as well as the governing apparatus must insure that the nucleus of combustion is maintained throughout the range of engine operation.

If the rich limit of fuel-air ratio is exceeded in the combustion chamber, the flame will blow out. While this condition is a possibility the more usual cause of a flameout is exceeding the lean blowout limit. Any condition which produces some fuel-air ratio leaner than the lean limit of combustion will produce a flameout. Any interruption of the fuel supply could bring on this condition. Fuel system failure, fuel system icing, or prolonged unusual attitudes could starve the flow of fuel to the engine. It should be noted the majority of aviation fuels are capable of holding in solution a certain small amount of water. If the aircraft is refueled with relatively warm fuel then flown to high altitude,