A full-open wastegate directs exhaust straight through the exhaust pipe and overboard, so it doesn't hit the turbine rotor and the compressor doesn't produce pressurized airflow. As the wastegate is moved toward the closed position, more and more exhaust is channeled to the rotor, which causes it to spin faster and faster. From a practical standpoint, the wastegate is like a variable slough that controls the amount of water that goes to a waterwheel. The slough can divert water away from the wheel, channel a little to it, or direct a great amount of it to the wheel.

Early turbocharger systems required the pilot to control the wastegate directly. It would be open for takeoff, and then as the engine began to lose power in the climb, the pilot would close the wastegate gradually to maintain power. Occasionally, pilots would attempt to take off with the wastegate closed. The resultant "overboost" would sometimes provide spectacular takeoff and climb performance, but like trying to stuff 10 pounds of potatoes into a 5-pound bag, the resultant excessive m.p. would eventually destroy the engine. Similarly, some pilots would forget to reopen the wastegate as the aircraft descended and an overboost would occur. Early turbocharger systems did not compensate for changes in airspeed, pressure, or temperature, resulting in disconcerting fluctuations in manifold pressure (m.p.) called "bootstrapping." As a result, three basic wastegate control systems evolved: fixed, throttle-controlled, and automatic.

Types of Wastegate Control Systems

The fixed, ground-adjustable wastegate remains in the same position throughout all engine operations. The exhaust flow is split, some of it dumping overboard and some going through the turbine. A very simple system, the pilot controls m.p. at all times with the throttle. The advantages of such a simple system are minimal maintenance and relatively low cost; however, there are some major drawbacks.

The most obvious drawback to the fixed, ground-adjustable wastegate is the significant loss of potential power in the exhaust dumped overboard. By its very nature, the system has a low critical altitude, though it is better than having no turbocharger at all. Perhaps the most important drawback of the fixed wastegate is that the throttle is the only m.p. control, therefore the compressor may produce more pressure than is necessary, thereby subjecting the engine to more heat than is good for the engine. Finally, the fixed wastegate is susceptible to the nagging problem of bootstrapping.

The next step up is a turbocharger system that has a mechanical linkage connecting the throttle to the wastegate. At low power settings, the throttle opens normally, not affecting the full-open position of the wastegate. Once the throttle reaches a full-open detent, the mechanical linkage then allows further throttle increases in conjunction with automatic closure of the wastegate. This provides some control over the turbocharger, but bootstrapping still can be a problem.

The two types of automatic wastegate controller are the density-reference system and the pressure-reference system. The pressure-reference system maintains a selected manifold pressure as set by the throttle. Engine oil pressure, directed by the controller, moves the wastegate as necessary to maintain the appropriate m.p. The obvious advantages of the pressure-reference system are that the m.p. does not need to be adjusted