CHAPTER VII

ENGINE CONTROLS

The engine controls provide a means for the pilot to accurately control the engine and its accessories under all conditions of operation. Control mechanisms should be designed so (a) their setting is not affected by engine movement, (b) they give positive motion at the engine with a minimum amount of lost motion in the control linkage, (c) they can be easily inspected, lubricated, and maintained, and (d) they provide a uniform rate of control at the point in question.

Control mechanisms of the following types are in common use; flexible wire, bell cranks and push-pull rods, cables and pulleys, hydraulic systems, and so on. Of these, the most successful and commonly used systems today are the cable and pulley arrangement and the bell crank push-pull rod arrangement.

Since modern power plants are all suspended in rubber allowing motion of the engine with respect to the mount, it is necessary to make provision in the controls for this flexibility without introducing variations in the control settings. This provision is sometimes obtained by using flexible controls of the flexible wire type. When the push rod and bell-crank system is used it is necessary to mount bell-cranks in the linkage at the firewall located so their pivots act as hinge points for the links to the engine. Careful location of the bell-cranks will allow for considerable movement of the engine without changing the control setting. With the cable and pulley system slack in the cables due to engine movement can be taken up by a spring loaded tension pulley or by tight rigging of the cable. With either system ball bearings should be used at all hinge points to insure free motion and minimum lost motion.

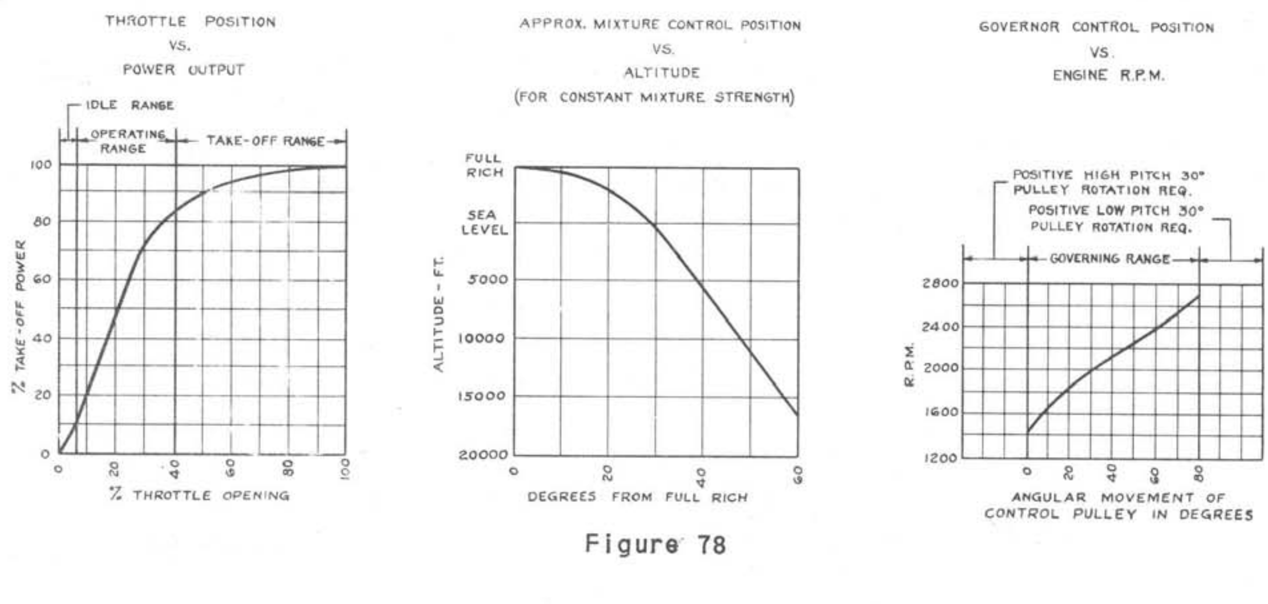

Figure 78

RESULTS OF MODIFICATION OF CONTROLS

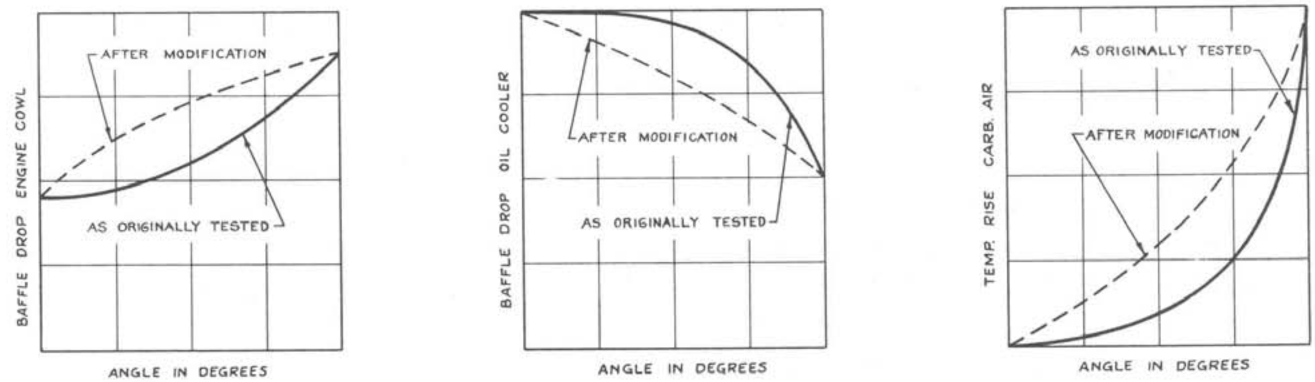

Figure 79

In the design and layout of any engine control system an effort should be made to arrange the linkage so uniform movement of the cockpit control produces uniform change of the condition being regulated. If the characteristic of the engine control is known, the airplane control can be designed to provide this uniform change. Figure 78 shows a representative set of curves on the effect of engine control movement on power, carburetor mixture, and propeller RPM. Data such as this is not available for controls on carburetor heaters, oil cooler shutters, or engine cowl flaps and it is therefore desirable to check such controls during the flight tests on the airplane to determine their characteristics. Figure 79 shows the results obtained after modification of typical control linkages. Having such data the desired sensitivity, or lack of sensitivity, can be obtained by modifying the control linkages accordingly. In the majority of cases uniform change of the condition is preferred.

The carburetors on all Wright engines are equipped with a mixture control having a "fuel shut-off" position. This position is at the extreme lean end of the mixture control travel and with the control in this position the fuel flow through the carburetor main discharge nozzles is shut off. This is accomplished by creating a back suction on the fuel supply chamber equal to the suction existing at the main discharge nozzles, thus, no fuel flows through the nozzles. The "fuel shut-off" feature allows stopping a warm engine without having back fires and at the same time it leaves the fuel chambers filled with fuel for subsequent starting.

MIXTURE CONTROL LEVER POSITIONS ON STROMBERG CARBURETOR

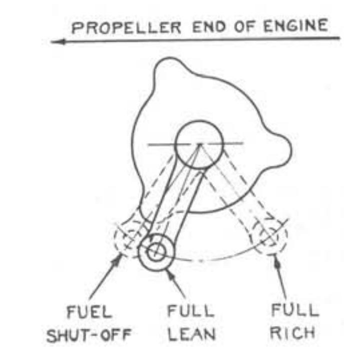

Figure 80

It is important to identify the individual mixture settings by marking or labeling the control quadrant in the cockpit. Figure 80 shows the relation between the mixture control lever and the mixture control disc positions for a Stromberg carburetor. The actual angular dimensions are given on the engine installation drawing.

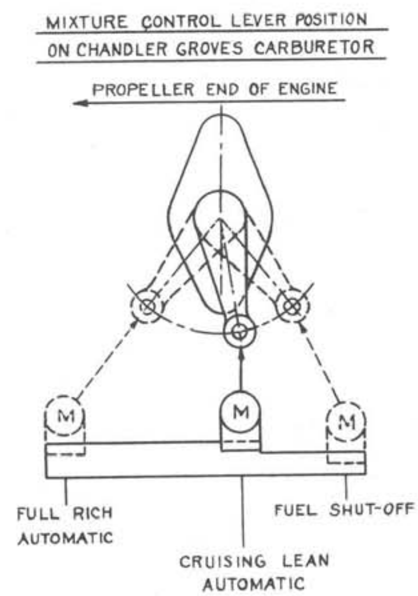

Figure 81

Figure 81 shows the relation between the mixture control lever and the mixture control disc positions for a Chandler-Groves carburetor. The cockpit quadrant for this control is also shown. Although mixture compensation is obtained with this carburetor when the mixture control is in any position from "full rich" down to "cruising "lean", the engine is usually operated with the mixture control in one of three positions. All normal operation above cruising power is conducted with the mixture in "full rich" position. For cruising operation at or below recommended cruising power the mixture control is set in the "cruising lean" position. Beyond the "cruising lean" position the fuel cut-off is obtained and this is used for stopping the engine. These three positions should be clearly labeled on the quadrant in the cockpit. As shown in Figure 82, which is a typical plot of fuel-air ratio versus angular travel of the mixture control lever, the range at cruising lean corresponds to a travel of 20°. The "cruising lean" mark on the quadrant should be located to put the control lever in the mid-portion of this travel, then, engine movement will have no effect on the mixtures even though the lever setting is changed slightly.

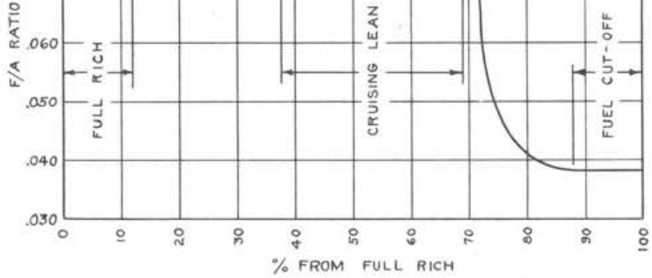

Figure 82

In the past few years considerable effort has been put forth in the development of automatic controls as an attempt to simplify the engine operating problem. These may be divided into two groups: - those having a manual control which selects the desired condition and the automatic unit maintains it; and, those having no control but are set at a predetermined value and the unit regulates at this value. Under the first group are propeller governors, manifold pressure regulators and automatic carburetors. Under the second group are carburetor heat regulators and oil temperature regulators. It is especially important that engine movement have no effect on control setting of the units in the first group.

Two-speed superchargers are available on certain models of Wright engines. The control for this device consists of a valve which applies engine oil pressure to the clutch for the ratio desired. This control is available in two styles, namely: the bellcrank and the push-pull styles. The bellcrank control requires practically no load to transfer the clutches and it is equipped with locating notches to position and hold it in both low and high ratio positions. The push-pull style control does not have a positive lock in the high ratio position and it requires a load of 12 pounds to hold it in this position. Its feature is, that should the airplane control fail, the engine control will snap back into low ratio and thereby provide suitable operation for landing of the airplane. An initial load of 5 pounds is required to pull this control out of low ratio.

The two-speed supercharger control should always be at the extreme positions to avoid clutch slippage and subsequent wear. It is therefore desirable to provide positive positioning of the cockpit control for this device so it cannot be affected by engine movement or be inadvertently moved by the pilot.