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Motorized Throttle Plate

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ABSTRACT

The objective of this project was to develop a throttle plate mechanism that can be used to simulate transient engine operation. This throttle plate was designed so as to regulate the quantity of air flow entering a Port Fuel Injected (PFI) spark ignition engine prior to the combustion of the fuel-air mixture. The throttle plate is linked to a data acquisition system in order to study the port fuel injection characteristics of the fuel-air mixture. This data acquisition system links the throttle plate angular position information to data obtained using a nonintrusive laser based diagnostic technique, therefore enabling the study of the effects of a transient throttle and injector.

INTRODUCTION

Recent studies indicate that the mixing characteristics of fuel and air due to Port Fuel Injected spark ignition engines strongly affect the performance and emissions of the engine. Absent from these studies is the direct relationship between the fuel-air-mix spray characteristics and the resulting engine performance, particularly when transient engine operation is considered. Because of the lack of knowledge in this area of engine performance, a motorized throttle plate was designed. Through the use of this throttle plate, and lab trials, useful design criteria for the injector and intake systems will be made available.

The remainder of this report will be devoted to the documentation of the design parameters and considerations made during the design of the motorized throttle plate.

DESIGN PARAMETERS(MECHANICAL)

The throttle plate is illustrated below in Figure 1. A 1.25"diameter hole allows for air flow. The throttle plate is installed inline with the existing intake valve. The basic throttle plate is shown in Figure 2.

Figure 1: Motorized Throttle Plate

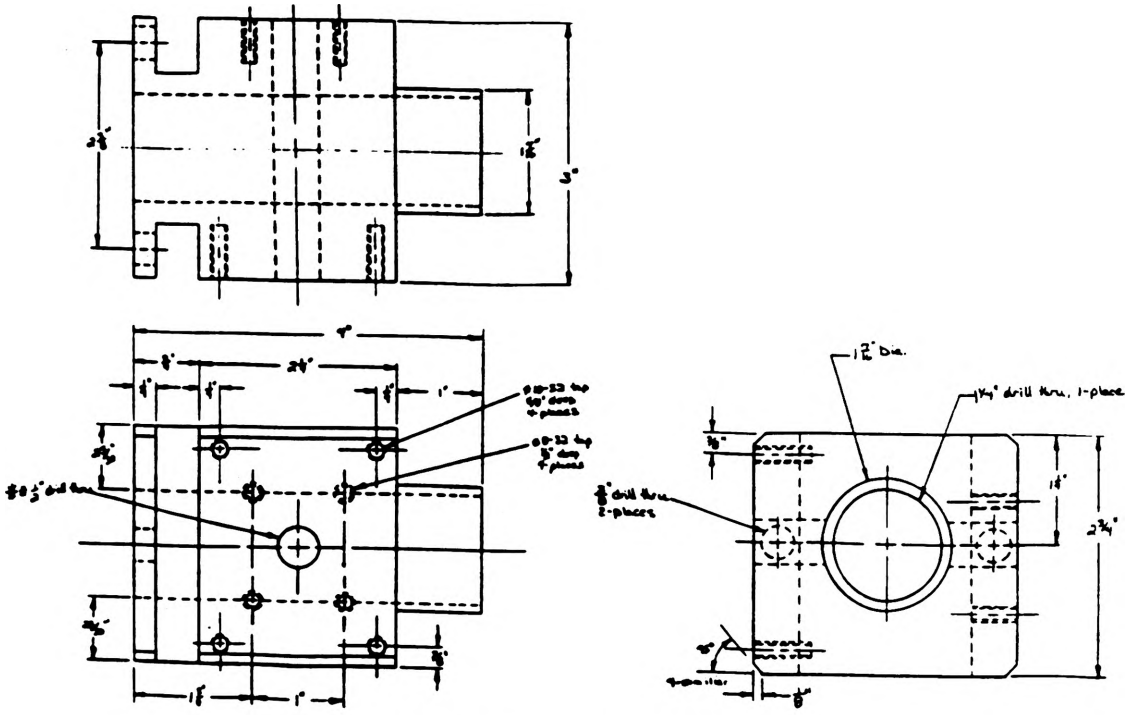


Figure 2: Basic Throttle Plate

The brass butterfly valve and shaft shown in Figures 3 and 4, regulate the quantity of airflow entering the injector port. The butterfly valve can be rotated from 0 to 45°. The butterfly valve is calibrated so that each degree of opening corresponds to an appropriate CFM of airflow.

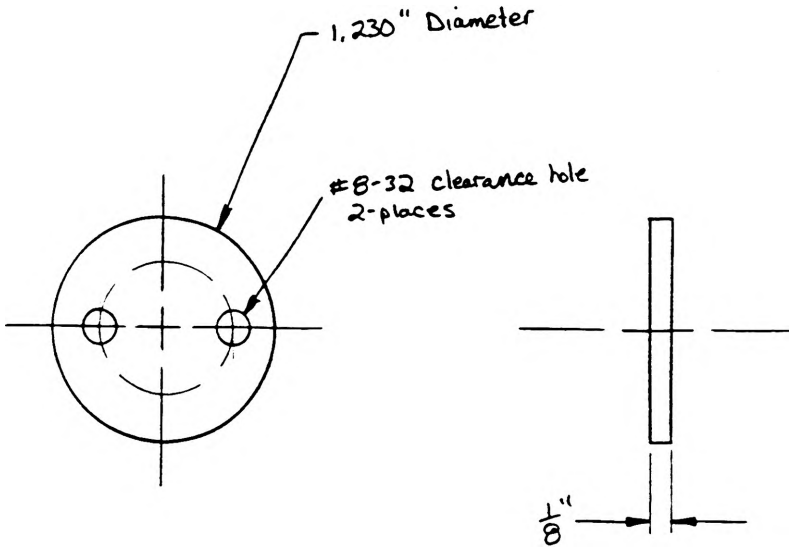


Figure 3: Butterfly Valve Plate

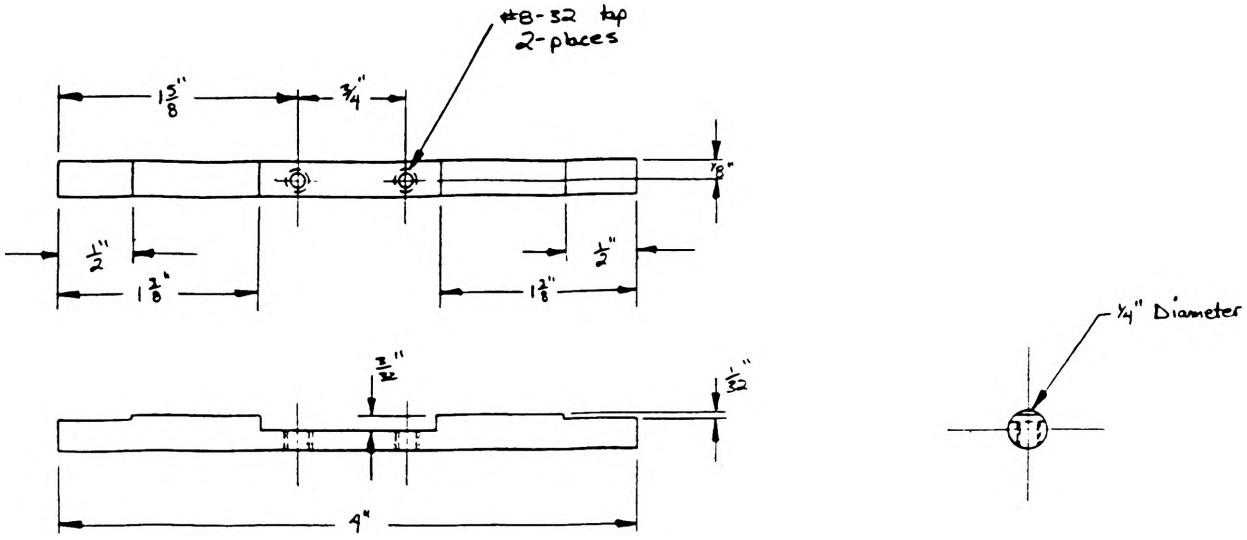


Figure 4: Butterfly Valve Shaft

The butterfly valve is rotated by a Clifton High-Torque Servomotor. The servomotor is fixed to the basic throttle plate via the motor mounting bracket shown in Figure 5. The degree of opening is entered through the data acquisition system therefore causing the servomotor to rotate the valve to the correct setting.

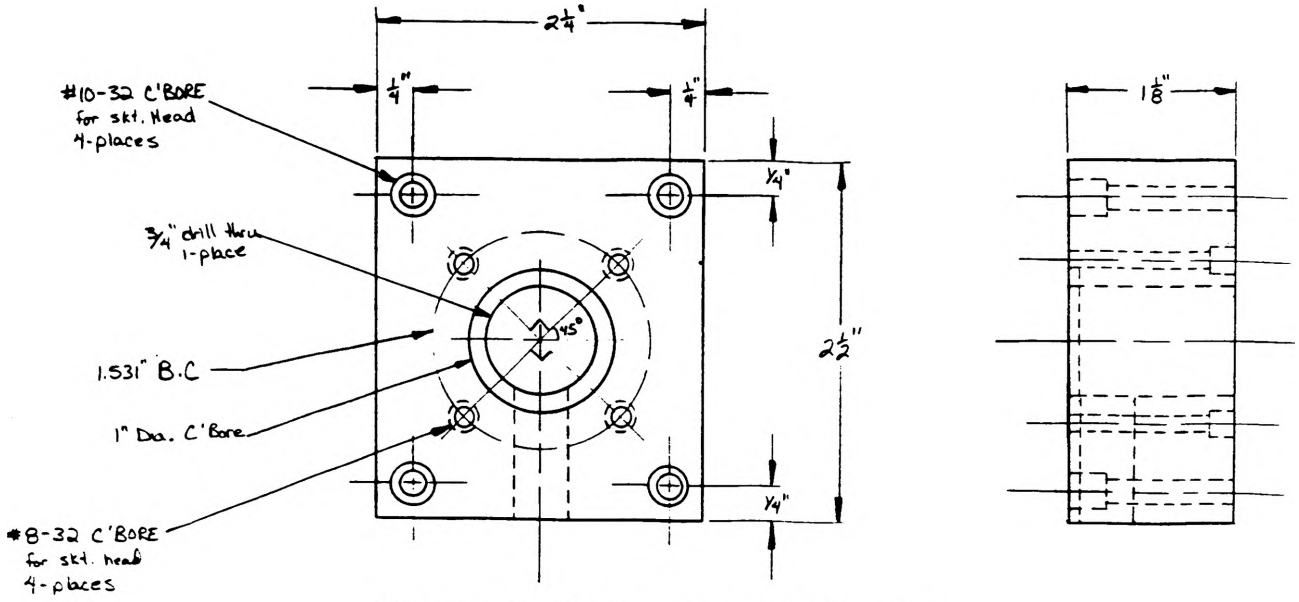


Figure 5: Motor Mounting Bracket

A 5 volt potentiometer is used opposite of the servomotor as a check to ensure the proper valve opening. The potentiometer is held in place by the mounting bracket shown in Figure 6.

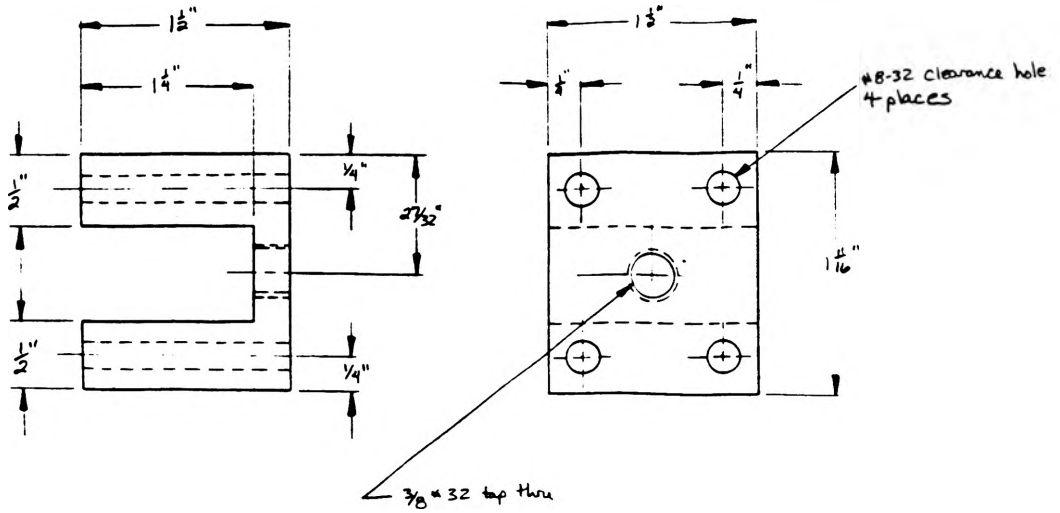


Figure 6: Potentiometer Mounting Bracket

There is a different voltage measurement corresponding to the various valve opening. the data acquisition system checks this against the inputed servomotor setting and adjusts accordingly. A coupler is attached to the potentiometer and butterfly valve shaft. All parts except the brass butterfly valve and bushings are made of aluminum.

Design Parameters(Electrical)

The servomotor is driven by two 24 VDC @ 6 amps multioutput Zytec Power Supplies. An Apex PA12 High Voltage Operational Amplifier is used to control the servomotor. The amplifier circuit, shown in Figure 7 on page 6 gives the resistor and capacitor values used. The electrical hookup schematic is shown on page 7 in Figure 8.

Amplifier circuit:

R1 = R3 = 10K
R2 = R6 = 47K
R4 = R5 = 0.01
C1 = .003
C2 = .001

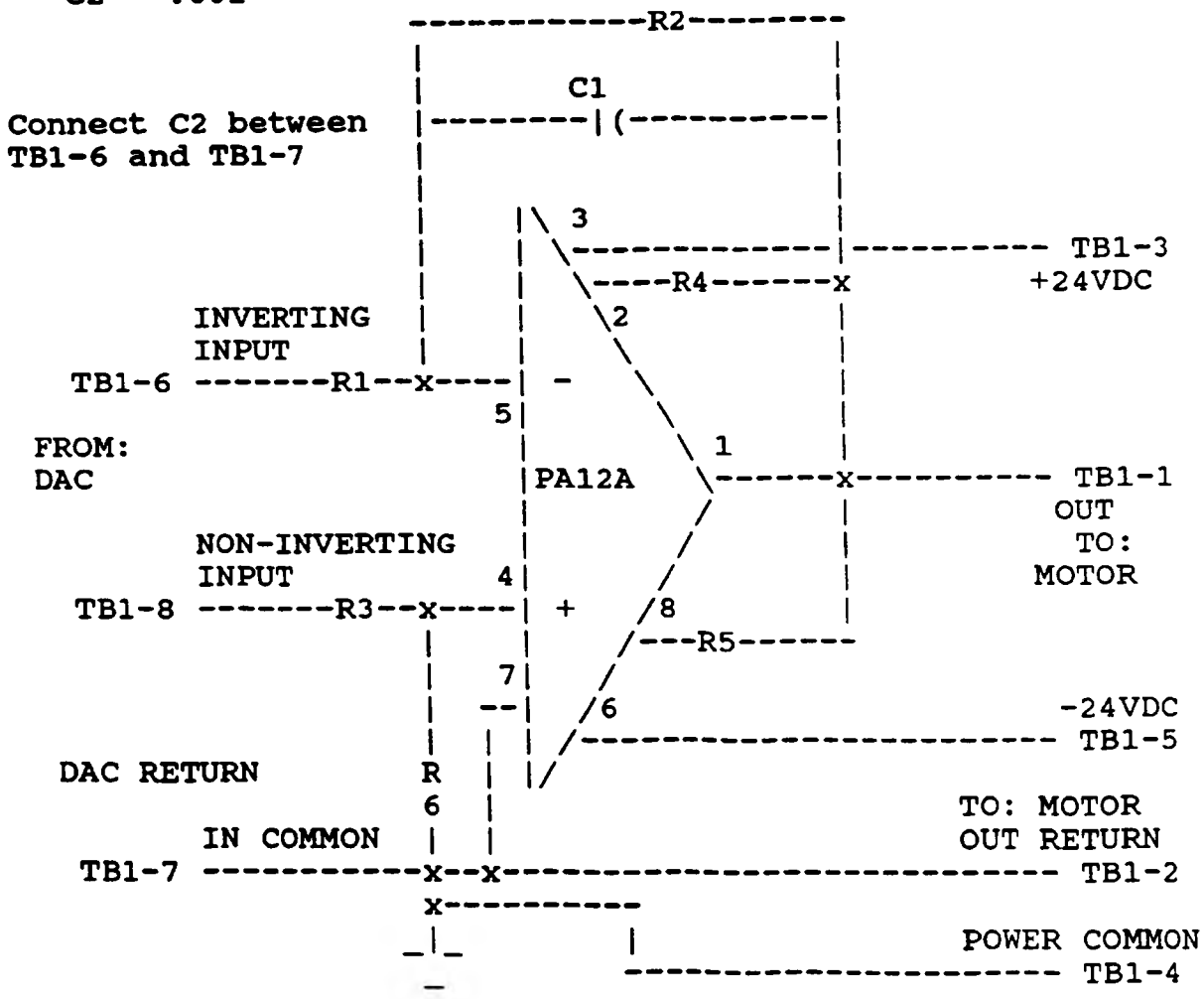
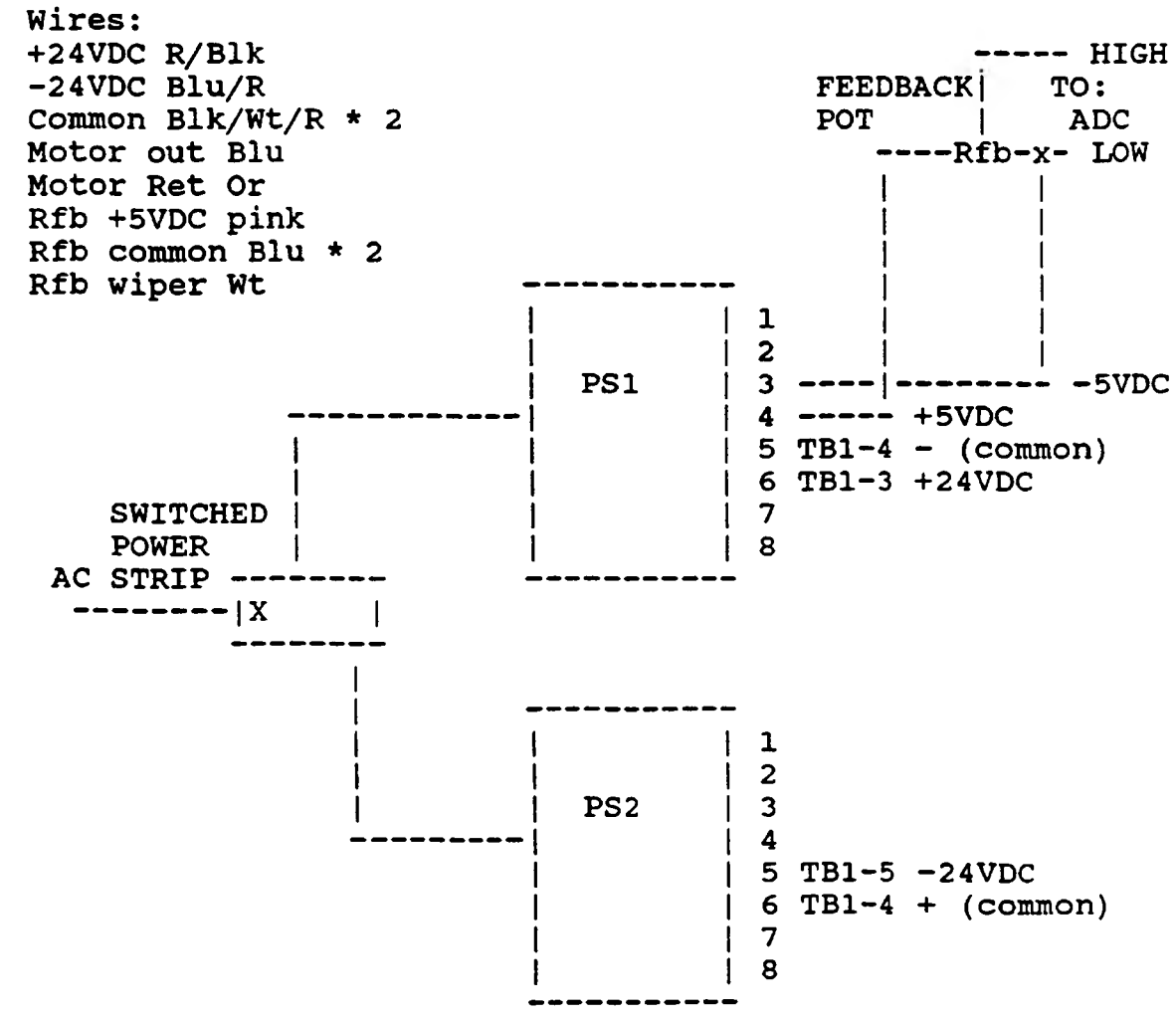


Figure 7: High Voltage Operational Amplifier Circuit

Hookup:



Tape PS power switches ON and control power with the switch on the outlet strip so that both power supplies are switched at the same time.

Figure 8: High Voltage Operational Amplifier Hookup