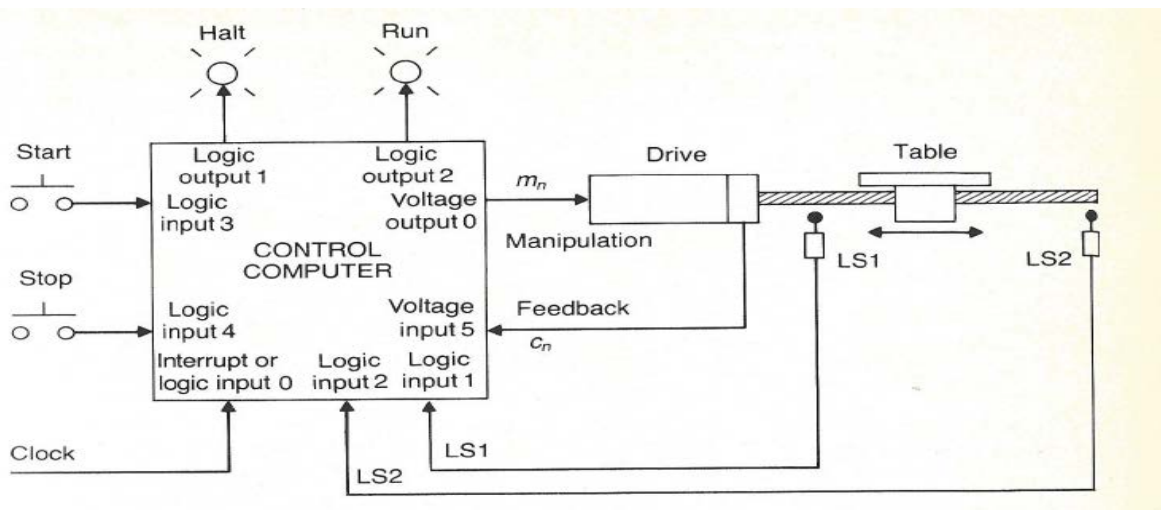


1. Read the description of Bollinger 5.16 (Figure 5.37)

When the START button is pushed in the system shown in figure below, the HALT lamp is turned off, the RUN lamp is turned on, and a proportional controller with gain K and command R is allowed to control the process. The sample period T is established by the time between 0 and 1 transitions in an external signal CLOCK. The control loop remains closed until limit switch LS1, limit switch LS2, or the STOP button is activated, at which point the proportional controller is deactivated, the process manipulation is set to zero, the RUN lamp is turned off, and HALT lamp is turned on. The system then waits for the START button to be pushed again.



- Draw a ladder logic diagram for this operation
 - Write an assembly language program for the system, using the program-driven approach for synchronization with the external clock (part a of Bollinger 5.16)
2. Simplify the following Boolean expressions.

$$A \bullet B + \overline{A \bullet C} + C \bullet \overline{D} + \overline{B} \bullet \overline{D}$$

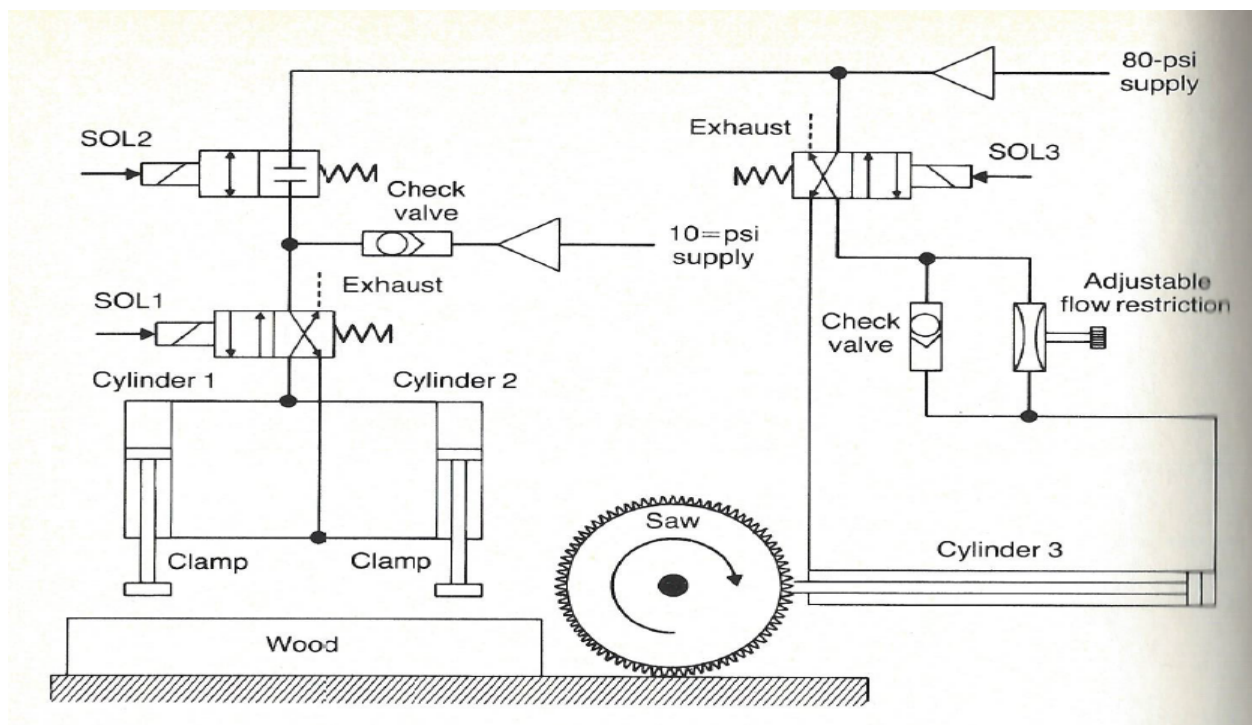
$$(A + B) \bullet (A + \overline{B} + C)$$

3. Bollinger 9.18

A wood cutting machine is shown schematically in figure below. It consists of two pneumatic cylinders that actuate clamps for the workpieces and a third cylinder that moves a saw. The sequence of operation in the system is as follows:

1. Push-button PB1 sets the clamps lightly on the workpiece with 10 psi air pressure. This allows fine adjustment of workpiece position by the operator.
2. A second push-button, PB2, sets the clamps hard on the workpiece with 80 psi air pressure and advances the saw. The speed of the cut can be adjusted by restricting flow into the saw cylinder as shown in Figure below.
3. When the second push-button is released, the saw returns quickly to the retracted position. This is done by application of full pressure to the saw cylinder.
4. Releasing push-button PB1 releases the clamps, which are held open with 10 psi pressure.

It is desired to automate this sequence so that a single person can operate two machines at once. Design the logic and hardware required to control the system.



Hint: Construct a state diagram first using the following four states:

	SOL1	SOL2	SOL3
S1	0	0	0
S2	1	0	0
S3	1	1	1
S4	1	1	0

Then construct a ladder logic diagram.