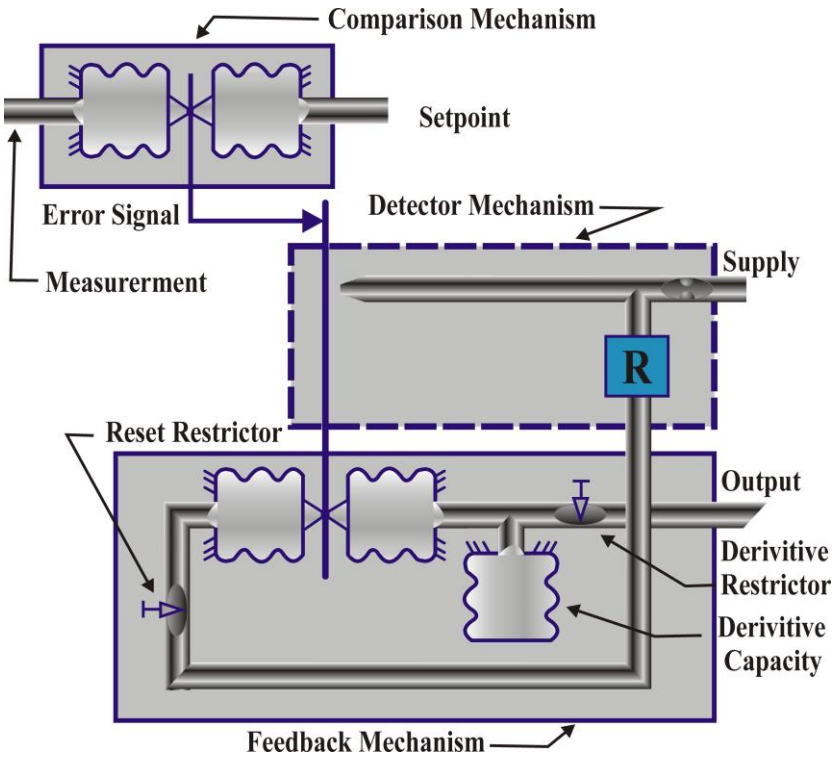
Proportioning Plus Integral Plus Derivitive Controller

A. Derivative mode

1. Derivative is sometimes known as pre-act, rate action, or hyper reset.
2. The Fisher controller under discussion has a variable restriction in the air line to the proportioning bellows. As long as it is fully open, it has no effect.
3. Whether a proportional-only controller, a reset only controller, or a proportional plus reset controller, adding a restriction in the air line to the proportioning bellows adds a derivative function to the controller.
4. The following illustration shows a controller with a derivative function added.

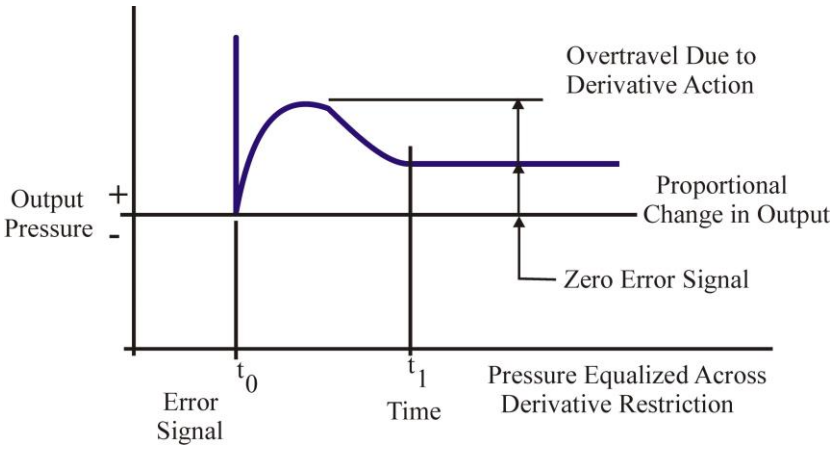


Picture 1, Proportional Plus Derivative Controller

5. Note that there is an extra bellows that appears to have no function. This is called a derivative capacity. Its function is to stabilize the output.
6. The adjustable restriction is placed in the air line to the proportional bellows.
7. If the derivative restriction is completely open, the operation of a proportional plus derivative controller is the same as a proportional-only controller. If the derivative restriction is closed completely, the controller is rendered a high gain controller. By adjusting the restriction from fully open to fully closed, the controller can be changed from a proportional controller with feedback to a controller with no feedback.
8. Assume that the restriction is partially closed and that there is an error signal that moves the lever toward the nozzle.
9. The nozzle backpressure increases, thus increasing the output pressure. Since the derivative restriction is almost closed, the increased pressure will not be sensed by the proportioning bellows immediately. The controller, for a brief period, will act like a high gain controller.
10. The pressure in the proportioning bellows slowly increases. The proportioning bellows slowly moves the lever away from the nozzle, decreasing the output.
11. Eventually, the pressure in the proportioning bellows equalizes to the nozzle backpressure.
12. The derivative restriction affects the system only when there is a difference between the nozzle backpressure and the pressure in the proportional bellows.
13. The derivative restriction delays the proportional feedback action. Any change in nozzle backpressure initially causes a greater output change than if the restriction were not there. As the pressure difference between the

nozzle and the bellows equalizes, the restriction has less and less effect. The derivative restriction acts like a time dependant variable gain control.

14. The graph below is a plot of output pressure versus time.

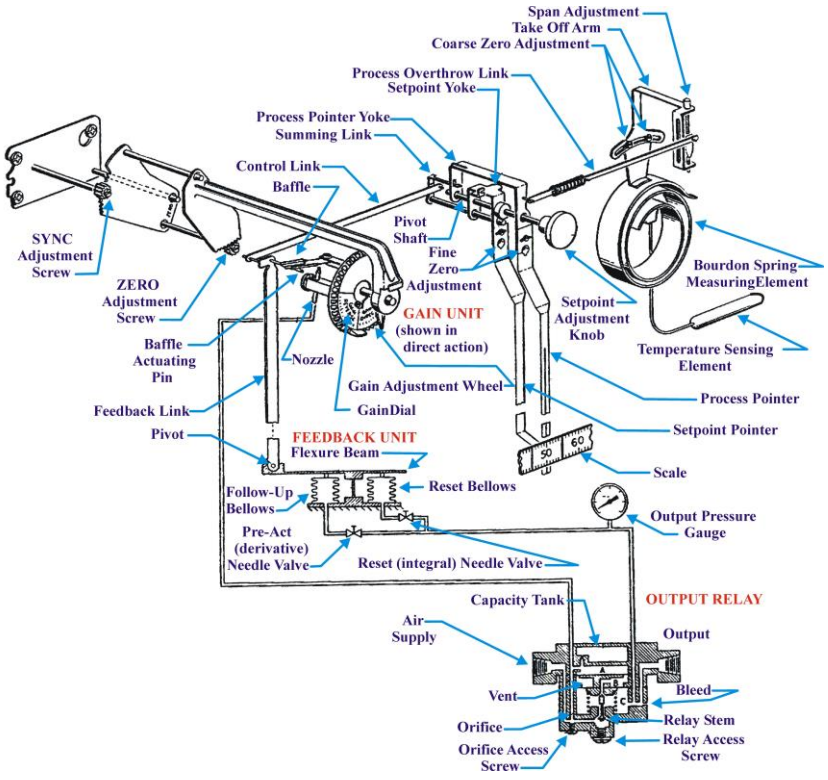


Picture 2, Derivative Effect

15. . The output pressure on a change of error signal increases almost immediately to well beyond the amount that proportional-only would cause. Eventually, the output reduces to the amount that would be obtained with a proportional-only controller...

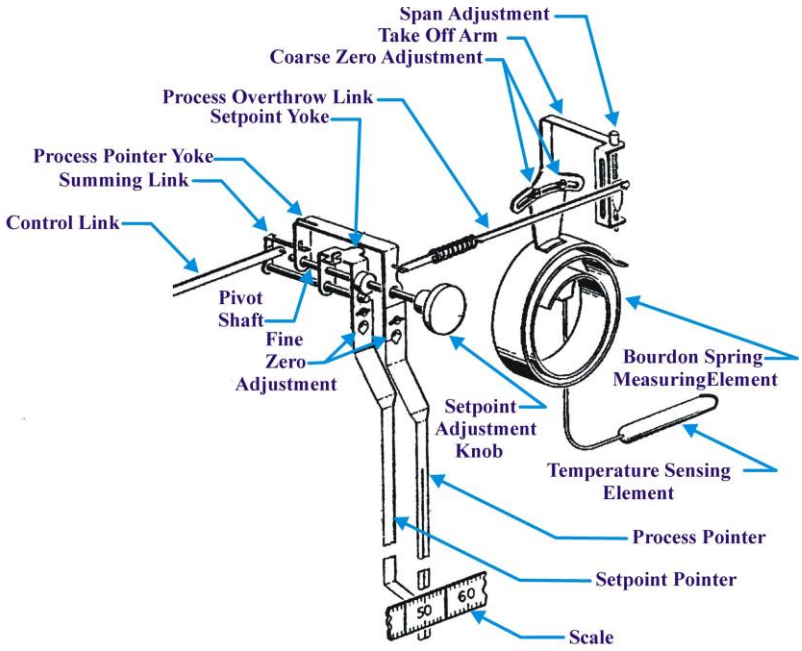
B. Taylor 440R Series Controllers

1. This series of controllers operate on a motion balance principle. Motion from a pneumatic feedback unit balances the motion from a process measuring element.

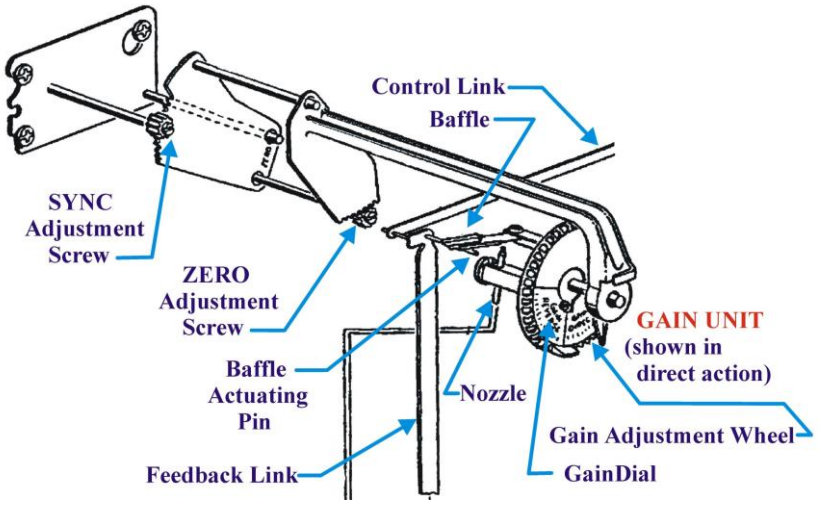


Picture 3, Taylor Model 440R Motion Balance Controller

2. As the temperature at the sensing element increases, the bourdon spring uncoils and moves the process pointer to the right and the baffle actuating pin to the left.

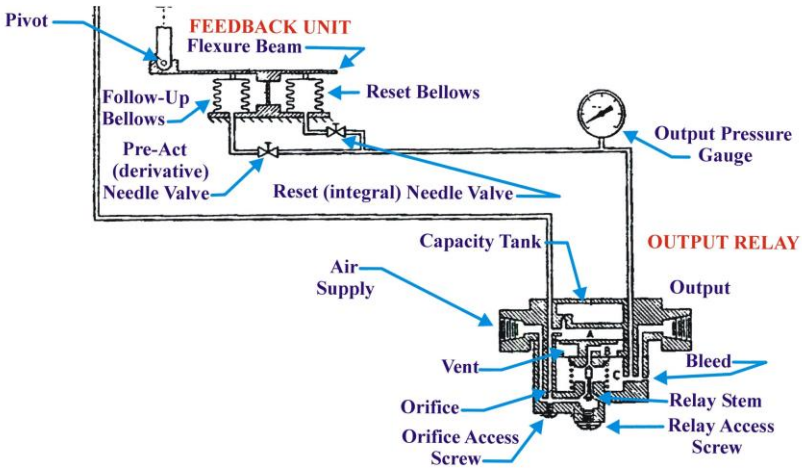


Picture 4, 440R Process Measurement



Picture 5, 440R Gain Unit

3. The movement of the pin lowers the baffle to decrease the nozzle-baffle gap and increase the nozzle backpressure. This pressure is fed to chamber A of the output relay.



Picture 6, 440R Feedback Unit And Output Relay

4. As the pressure in chamber A increases, the diaphragm assembly moves the relay stem downward closing the vent port and opening the air supply port to increase the output. The output increases until it balances the downward force on the diaphragm assembly.

5. With the controller having a proportional response as shown, the output pressure is fed to the follow-up bellows and raises the baffle actuating pin and baffle. Approximately the original baffle gap is restored and equilibrium is established.

6. The proportional response (gain) gives an output change proportional to a change in process measurement. The amount of output change for a given process measurement change can be varied by rotating the gain dial. As the dial rotates, it moves the nozzle-baffle assembly around the baffle actuating pin. This determines the amount of motion the pin transmits to the baffle

due to process measurement changes and feedback action. As the gain is decreased, the baffle becomes less sensitive to feedback action.

7. The reset response automatically returns the process variable to the set-point after a sustained load change. This is accomplished by opposing the action of the follow-up bellows with a reset bellows through a needle valve.
8. The pre-act (derivative) response reduces the offset caused by a process upset as well as reduces the recovery time following the upset. This is accomplished by feeding the output pressure to the follow-up bellows through a need valve.
9. The controller can be set for either direct or reverse action by positioning the gain dial.
10. Direct Action - as process pointer moves to the right, output increases
11. Reverse Action - as process pointer moves to the right, output decreases.

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PRACTICE:

1 What is the major difference between a proportional only controller and a proportional plus derivative pneumatic controller?

2. In a proportional plus derivative pneumatic controller, how can the derivative function be defeated?