General Electric Advanced Technology Manual

Chapter 6.8

Safety Relief Valve Differences

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LIST OF FIGURES

6.8 SAFETY RELIEF VALVE DIFFERENCES

Learning Objectives:

1. List the purposes of the safety relief valves.

2. Describe how each type of safety relief valve operates to accomplish its function(s).

6.8.1 Introduction

The discussion in this section is directed toward the various safety relief valves (SRVs) used throughout the BWR product lines. Safety relief valves prevent over pressurization of the nuclear process barrier from abnormal operational transients. In addition to providing overpressure protection, a selected number of SRVs are used by the automatic depressurization system to rapidly decrease reactor pressure during specific small break loss of coolant accidents.

6.8.2 Two Stage Target Rock SRV

The two stage target rock SRV consists of two principle assemblies, a pilot valve section (top works) and the main valve section (bottom works). The pilot valve section (first stage) provides the pressure sensing and control element while the main valve (second stage) provides the pressure relief function.

The first stage consists of a pilot stabilizer disc assembly with a means for remote actuation, via the attached pneumatic actuator. The pilot valve is the pressure sensing member to which the stabilizer disc movement is coupled. Though not mechanically connected, a small spring (pilot preload spring) keeps the stabilizer in contact with the pilot. The setpoint adjustment spring permits setpoint adjustment (lifting pressure) of the pilot valve and provides pilot valve seating force. The second or main stage consists essentially of a large valve which includes the main valve disc, main valve chamber, main valve preload spring, and piston.

When the reactor is at operating pressure, below the setpoint of the valve, the pilot valve is seated with system pressure acting on the stabilizer disc side (Figure 6.8-1). The second stage of the valve has system pressure on both sides of the main valve piston with the main valve disc seated (closed). As system pressure increases to the setpoint of the SRV (Figure 6.8-2), the pressure acting on the pilot valve produces a force great enough to overcome the opposing force of the setpoint adjustment spring and lifts the pilot valve from its seat. As the pilot valve moves to full open (to the right), the stabilizer disc follows the pilot until the stabilizer is seated. With the pilot valve full open and the stabilizer seated, the area above the main valves piston is vented to the discharge piping via the main valve piston vent passage. This venting creates a differential pressure

across the main valve piston, system pressure below the piston and drywell pressure above, causing the main valve to lift (open). The main valve piston is sized such that the resultant opening force is greater than the combined spring load and hydraulic seating force. The stabilizer disc is designed to control the valve blowdown and reset pressure, by holding the pilot open until the proper reclosing pressure is reached. The stabilizer chamber is connected, by a passage, to the inlet side of the main valve. The stabilizer disc will seat when the pilot lifts. The differential pressure across the stabilizer disc is sufficient to hold the pilot open; however, as system pressure decays, the differential pressure across the stabilizer disc decreases until the setpoint adjustment spring becomes the controlling member causing the pilot valve to reseat. Once the pilot valve has reseated, leakage of system fluid past the main valve piston and the stabilizer disc re-pressurizes the main valve chamber.

When steam pressure equalizes across the main valve piston, the opening force is canceled and permits the main valve spring and hydraulic flow forces the main valve to close. Once closed, the additional hydraulic seating force, due to system pressure acting on the main valve disc, seats the main valve tightly and prevents leakage.

In the relief mode of operation, pneumatic pressure is applied to an air actuator by energizing a solenoid valve. The actuator mechanically positions the pilot assembly to the right, depressurizing the top of the main valve piston causing the main valve to open. The solenoids are energized by switches located in the control room. This type of arrangement provides the control room operator with a means of operating any of the SRVs remotely from the control room.

6.8.3 Three Stage Target Rock SRV

The three stage target rock safety relief valve (Figure 6.8-3) is similar to the two stage SRV with the exception of the upper works. The three stage SRV upper works consists of a pilot section, second stage assembly and pneumatic actuator assembly.

When reactor pressure is at operating pressure, below the setpoint of the valve, the pilot valve is seated by action of the pilot preload and setpoint adjustment spring. The main valve piston is held closed by the main valve preload spring exerting a downward force on the main valve piston.

An increasing system pressure opens the pilot valve (Figure 6.8-4&5) by exerting a hydraulic force on the pilot valve bellows, which moves it to the right. Opening the pilot valve allows system pressure to be felt on top of the second stage piston. When pressure above the second stage piston is sufficient to overcome the upward force of the second stage preload spring, the second stage valve is forced downward, opening the valve. When the second stage valve opens it allows the pressure on top of the main valve piston to vent through the second stage relief passage and into the SRV discharge.

Venting the pressure on top of the main valve piston forces the main valve assembly upward. The main valve piston is sized such that the resultant opening force is greater than the combined spring load and hydraulic seating force. The pilot preload and setpoint adjustment spring is designed to control valve blowdown and reset pressure by holding the valve open until the proper reclosing pressure is reached. When system pressure decays, the pilot preload and setpoint adjustment spring forces the pilot stem to the left against the pilot valve, causing it to close. The closure of the pilot valve allows system pressure to leak past the second stage piston and into the second stage relief passage. The second stage preload spring will lift the second stage valve, closing the valve. Once the second stage valve closes, the main valve piston chamber equalizes with the aid of the drilled passage in the main valve piston. When the main valve preload spring and the pressure above the main valve piston are greater than the pressure below, the main valve will close.

In the relief mode of operation, pneumatic pressure is applied to an air actuator by energizing a solenoid valve. The actuator mechanically positions the second stage valve by exerting a downward force on top of the piston assembly, depressurizing the top of the main valve piston causing it to open. The solenoids are energized by remote switches which allow the control room operator or a pressure switch to operate the valve.

The bellows portion of the pilot assembly ensures operation of the relief mode. If the bellows were to fail, insufficient pressure would exist to open the pilot valve. Therefore, a bellows failure alarm is connected to the area external to the bellows.

6.8.4 Dickers SRV

The Dickers type SRV, shown in Figure 6.8-6, is a spring loaded, sealed bonnet, angled, globe valve with an externally attached pneumatic operating cylinder. The operating cylinder is so arranged that a malfunction cannot prevent the valve from opening to satisfy the safety function. The major parts of the valve are the inlet nozzle, disc, disc holder, spindle, belleville washers (spring), bellows, balancing piston, bonnet, and pneumatic operating cylinder.

The inlet nozzle provides an opening for steam into the valve. The valve disc seats against the top of the nozzle with steam pressure beneath. The disc holder connects the disc to the spindle and provides for an easy removal of the disc during maintenance. The spindle applies the downward loading of the compressed belleville washers to the valve disc and is used to lift the valve disc when the pneumatic operator is used. The bellows provide a seal between the main body of the valve and the bonnet to prevent steam leakage into the bonnet when the disc is in the raised position. This seal prevents back pressure from affecting the spring setpoint. A back pressure balancing piston is also provided on the valve spindle so that valve opening pressure is not affected even if a bellows leak develops. Steam can leak past the balancing piston only in the event of a

bellows rupture and then only when the valve is open and passing steam. The bonnet prevents steam leakage into the drywell when the valve lifts. The bonnet is vented to the suppression pool between the weir wall and the drywell. Each of these vent lines has a check valve to serve as an anti-siphon vacuum breaker.

The pneumatic operating cylinder physically lifts the valve disc against spring force to open the valve. By this means, the SRV can be operated at any steam pressure down to 0 psig. The safety/relief valves are designed to operate in a post accident environment.

6.8.5 Crosby SRV

The Crosby SRV operates identical to the Dickers SRV. Crosby SRVs utilize a spring to provide the force that must be overcome for the valve to open instead of the belleville washers used by the Dickers valves.

6.8.6 Electromatic Relief Valve

Electromatic relief valves are provided to prevent lifting of the safety valves on early BWR product lines. The electromatic relief valves (Figure 6.8-7) are actuated by the solenoid assembly. Steam enters from chamber (A) and passes upward around disc guide to chamber (B). Steam enters chamber (C) through clearance space between the main valve disc and disc guide. The main valve is held in the close position by the steam pressure in chamber (C). Chamber (D) connects the main valve assembly to the pilot valve assembly. With the pilot valve in the closed position, chamber A, B, C, and D are at system pressure. The pilot valve is held closed by the pilot valve spring and the steam pressure in chamber (E). When the solenoid is actuated the plunger head moves downward striking the pilot operating lever. The operating lever opens the pilot valve disc, thus allowing steam from chamber (D) to vent through port (F). The steam is vented from chamber (D) faster than it is supplied to chamber (C) via the clearance between the valve disc and the disc guide. The resultant unbalance of pressure in chamber (B) and (C) produce a force that moves the main valve disc downwards and allows steam to escape. If the actuating signal resets, the solenoid plunger retracts and the pilot valve reseats. The pressure in chamber (C) increases causing the relief valve to reclose.

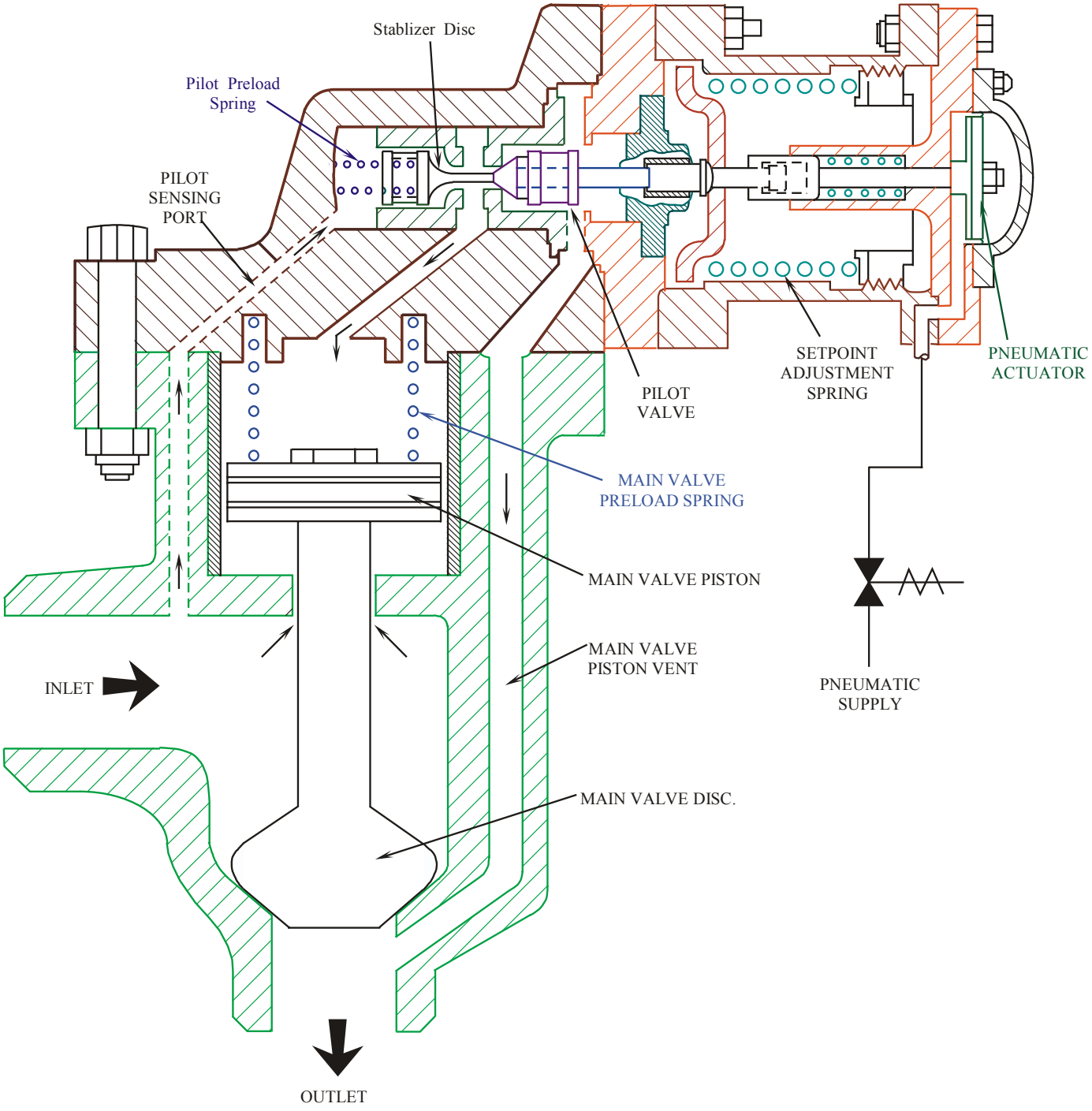

Figure 6.8-1 Two Stage Target Rock SRV (Closed)

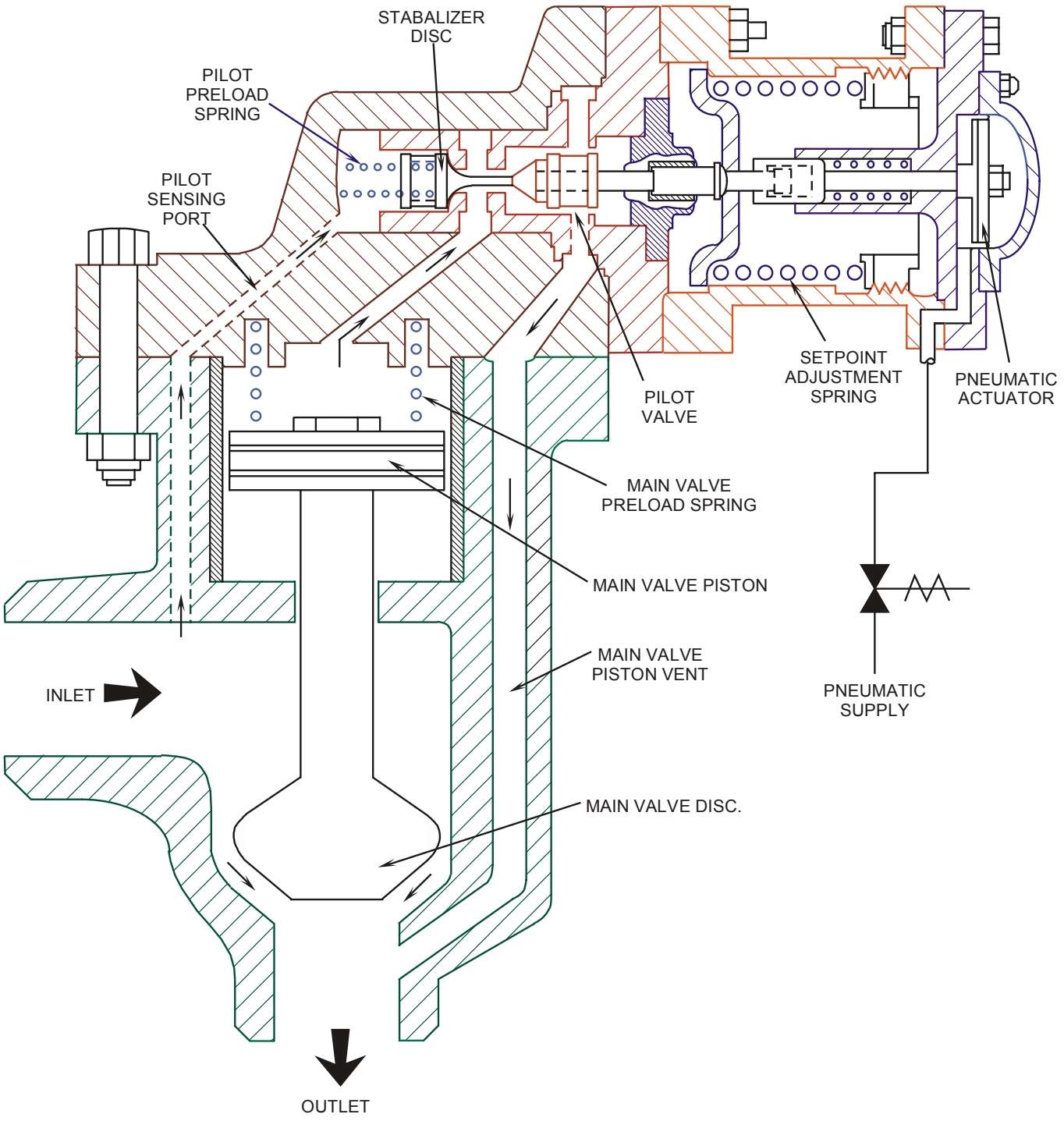

Figure 6.8-2 Two Stage Target Rock SRV (Open)

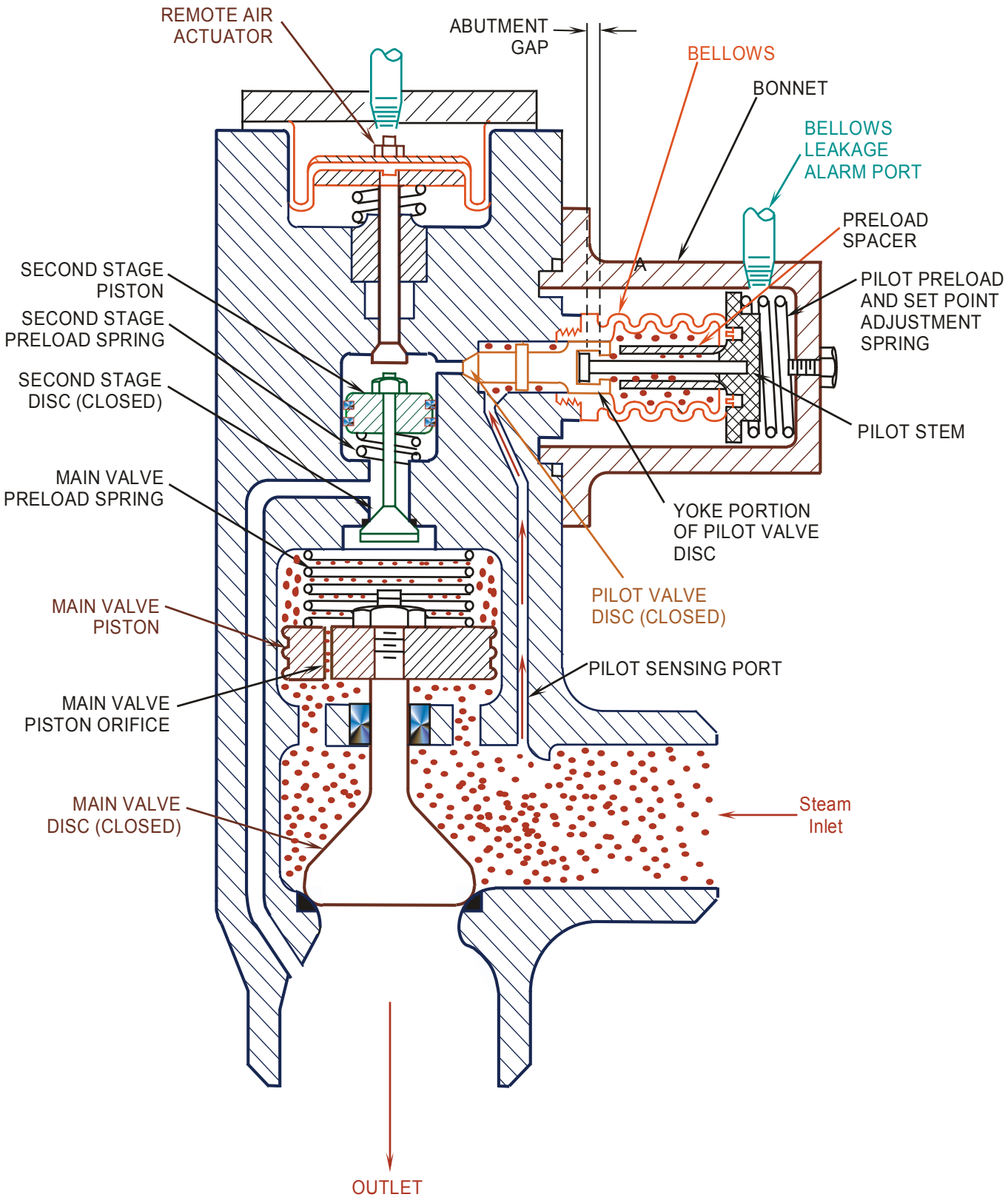

Figure 6.8-3 Three Stage Target Rock SRV (Closed)

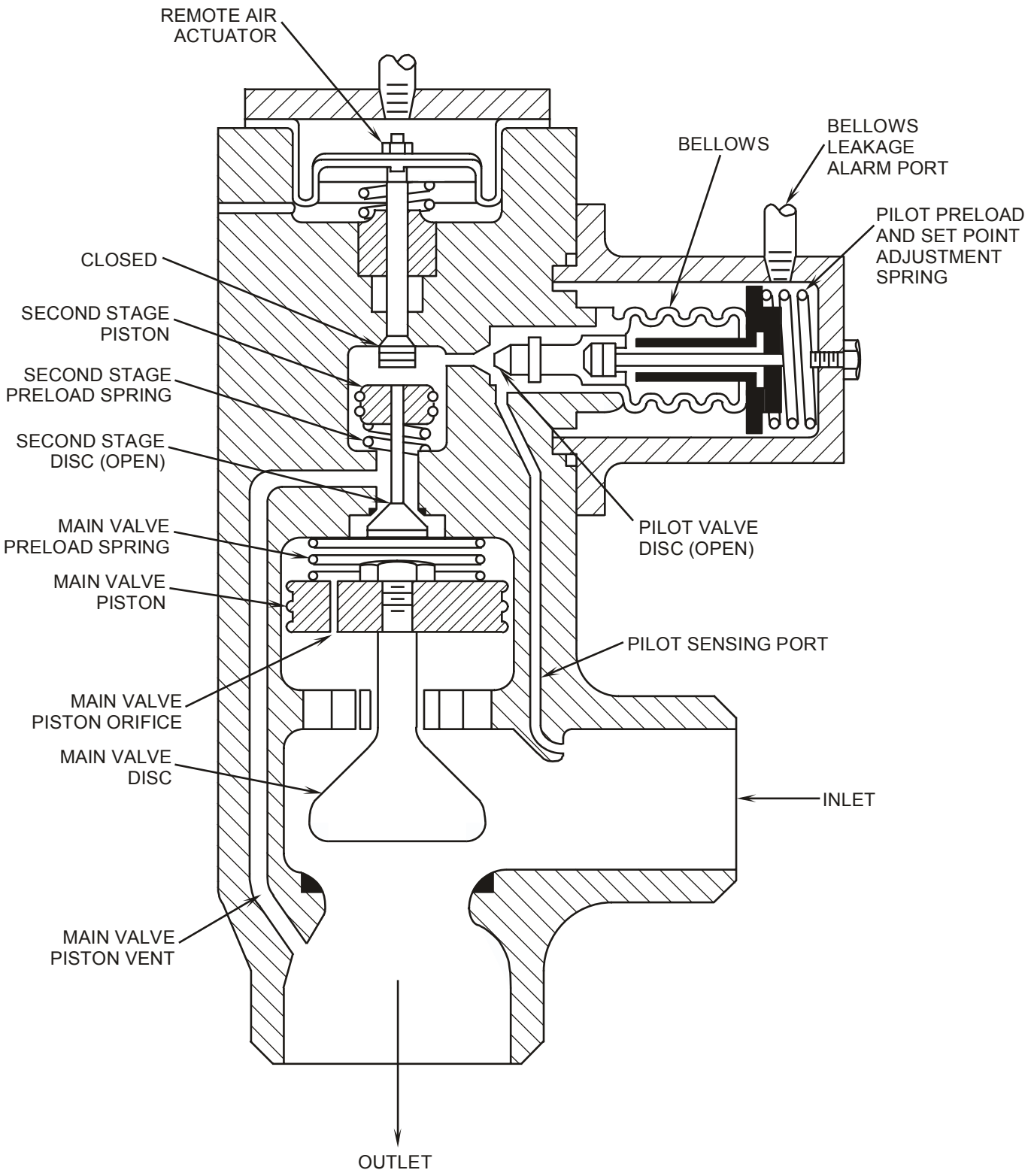

Figure 6.8-4 Three Stage Target Rock SRV (Safety Actuated)

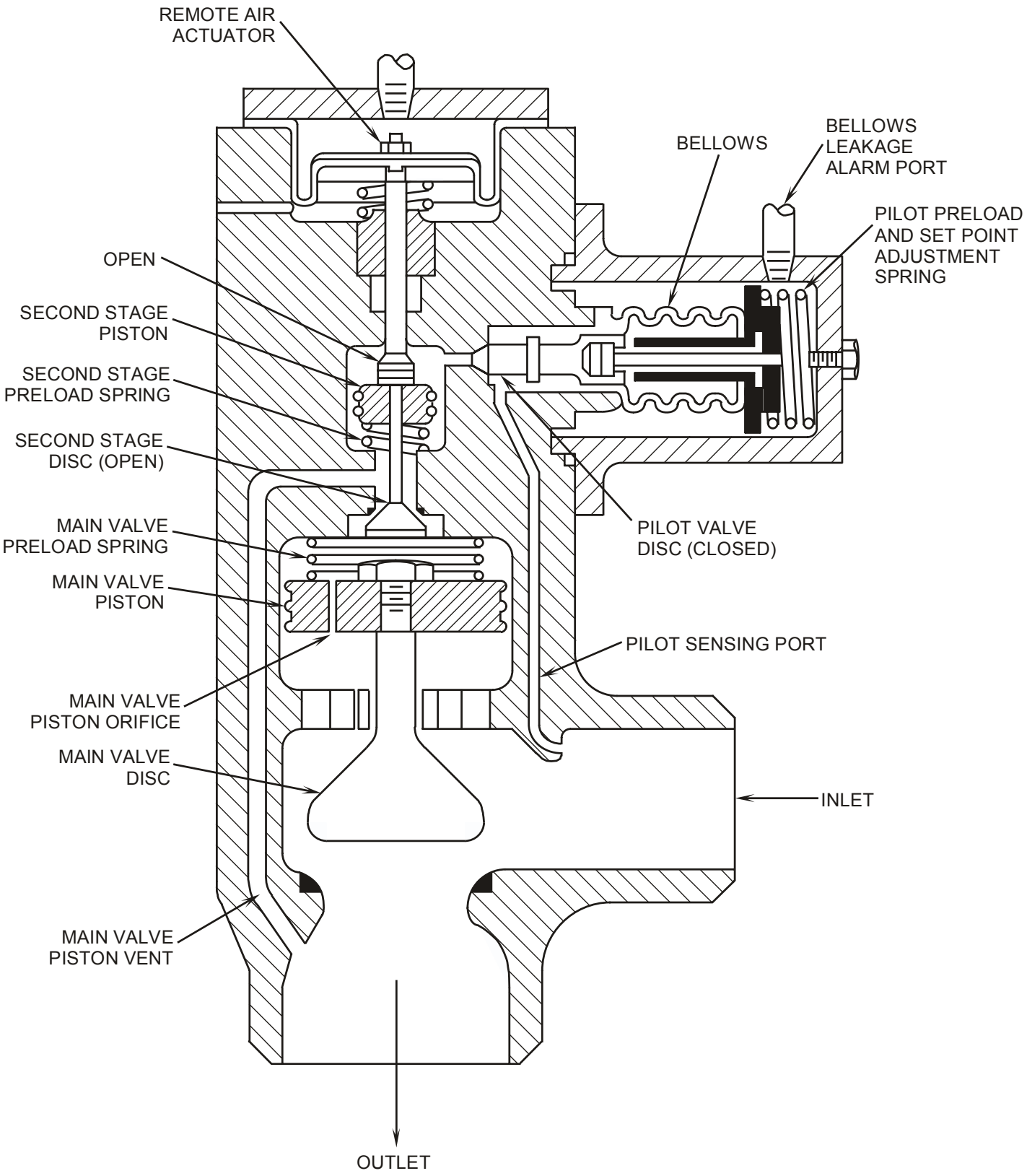

Figure 6.8-5 Three Stage Target Rock SRV (External Actuation)

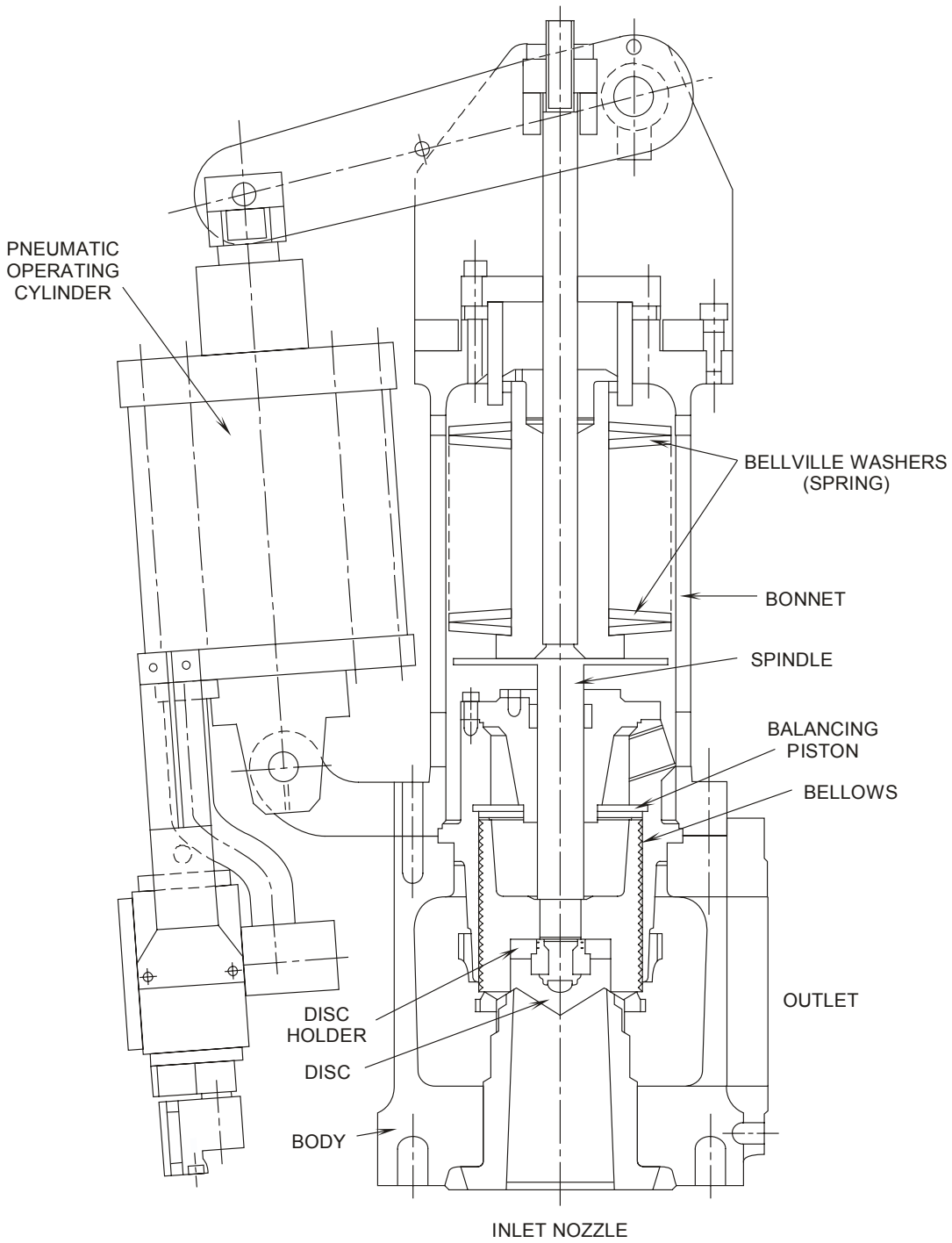

Figure 6.8-6 Dickers SRV

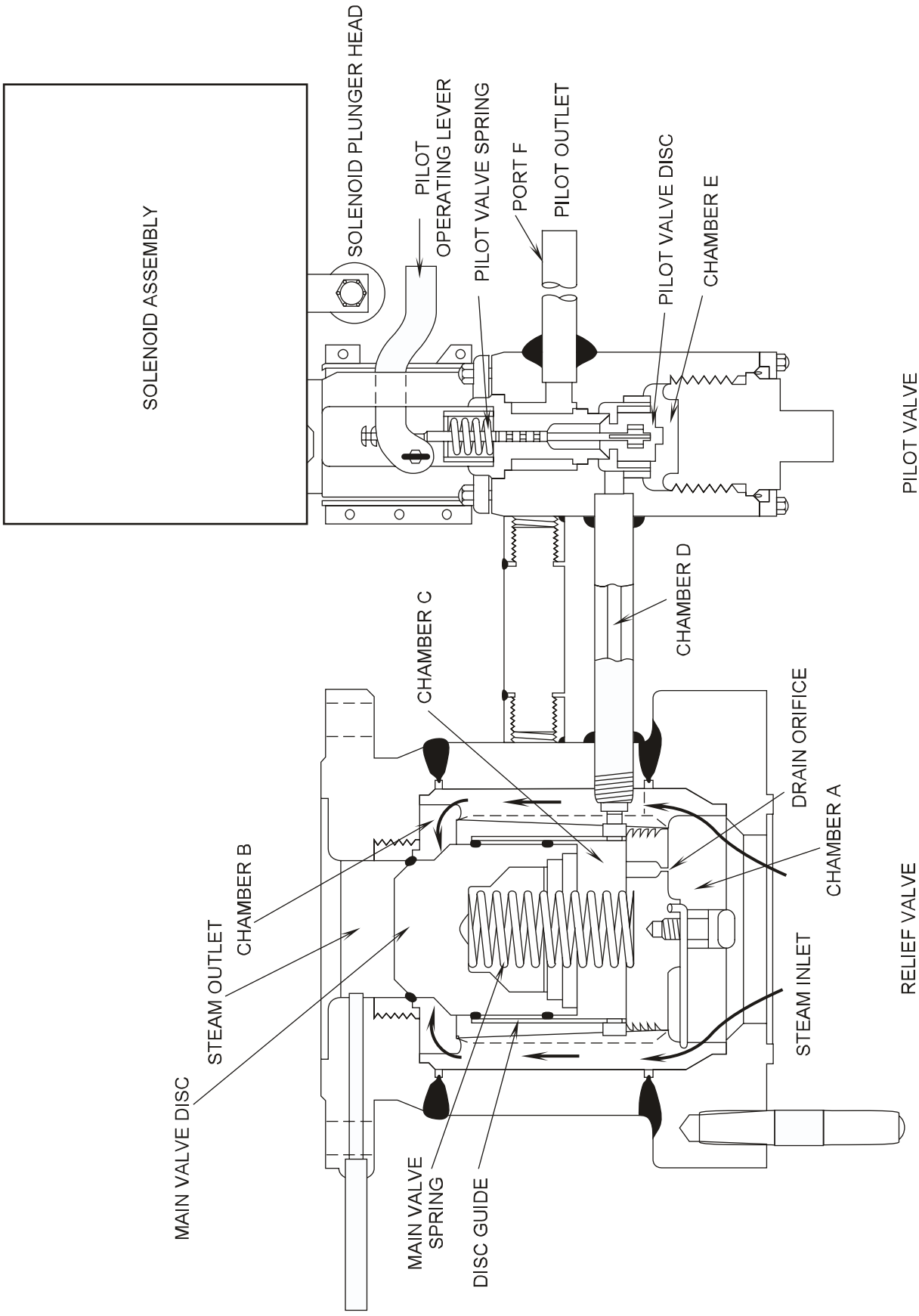

Figure 6.8-7 Electromatic Relief Valve