RUPTURE PIN AND BUCKLING PIN VALVE APPLICATIONS IN OIL AND GAS DRILLING, PRODUCTION AND TRANSPORTATION

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ABSTRACT
A new technology is available that provides a more accurate and dependable method of opening a valve to relieve pressure, closing a valve to isolate pressure, or switching a valve to divert pressure. An expendable pin, known as the buckling pin, obeys Euler's Law and acts both as a sensor and valve actuator to open, close, or divert flow at an exact set pressure.

THE PRINCIPLE OF OPERATION

The principle of the Buckling Pin valves is simple. A slender pin with a precise diameter and length retains a piston in an open or closed position. System pressure acting on the piston itself, in the case of a relief valve, or on the piston stem, in the case of an emergency shutdown valve, puts an axial force on the pin. At an exact set point, the pin will buckle by Euler's Law and in milliseconds the valve will open, in the case of a relief valve, or close in the case of an emergency shutdown valve. (See figure 1)

There is a definite need in drilling, production and transportation sections of the energy industry for Rupture Pin (pressure relief) and Buckling Pin (pressure isolation) valves.

Let's look at a few of the applications individually.

DRILLING APPLICATIONS (Mud Pump)

In drilling, a key component is the mud pump. It is important that the pump, piping and rotary hose be protected from excess pressure. The primary valves used for pressure relief are shear pin valves, spring or belville washer loaded valves or valves with spring latches. All have problems with accuracy, maintenance and, in the case of shear valves, going open early. This is an ideal application for a rupture pin relief valve because of its simplicity of operation. Set pressures from 800 psi to 15,000 psi are possible. The pin is ideal for the application because the pin cannot fatigue with the pulsating pressure. This is because the buckling point is below the elastic limit of the material. The seal is good for hundreds of opening cycles and the piston comes to a cushioned stop. You change the valve set point by changing pins. (See figure 2)

PRODUCTION APPLICATIONS (Production Separators and Treaters)

In the production operation, there are several applications for buckling pin valves. One application is to replace rupture discs and spring loaded relief valves. A common application is on production separators where settings are 125 psi and 1440 psi. Rupture Pin relief valves should be used in place of rupture discs because you do not have to break the line to change the pin and the pin cannot fatigue and go early as rupture discs do. The Rupture Pin valve should be considered as a replacement for spring loaded relief valves as well, particularly on separators or treaters where there is little chance of overpressuring. The biggest advantage is that no annual inspection or test is required. Rupture Pin relief valves for this application are price competitive with spring relief valves and rupture discs. (See figure 3)

PRODUCTION APPLICATIONS (Pumping Unit)

On a pumping unit where there is flow line blockage due to a freeze up or a valve malfunction, pressure builds up on the stuffing box, causing it to leak or break and spill well fluids on the location. Cleanup and crop damage can be expensive. Even if there is a pressure shutoff sensor at the well head, it takes time to stop a pumping unit and you can still have pressure damage.
A way to stop this is to install a Rupture Pin Model "CT" Rupture Pin relief valve at the casing to open and discharge the produced fluid to the casing. The Model "CT" is downstream balanced so there is no change of set pressure if there is pressure in the casing. A proximity switch, sensing the opening of the Model "CT" to bypass, can be used to shutoff the pump motor. (See figure 4)

TRANSMISSION APPLICATIONS (Wellhead to Central Processing or Transportation Facility)

In the oilfield, fluids are transported from metal pipe at the wellhead to plastic pipe for some distance to a central

processing or transportation facility. The plastic pipe has a pressure rating of about 120 psi. This rating is usually below the possible upstream delivery pressure from a gas or oil well. The plastic pipe must be protected.
A model "D" emergency shutdown valve mounted at the junction of metal to plastic pipe can sense the excess pressure and close before the plastic pipe can be affected. (See figure 5)

TRANSMISSION APPLICATIONS (Waterflood Pumps)

On waterflood pumps, in case of a pressure buildup on the discharge side, a Rupture Pin Model “D” relief valve can relieve the excess pressure by directing the discharge fluid to the pump suction. A proximity switch on the Rupture Pin valve can send a remote signal that the pump discharge has opened the bypass valve and the fluid is being circulated. In this application, you want a full capacity valve that will remain open. Any flow restriction will build up heat in the circulating fluid. (See figure 6)

PRODUCTION APPLICATIONS (Pressure Vessels)

On pressure vessels where you need a bubble tight class VI seal, but high volume emergency relief at set pressure, the Rupture Pin Model “B” valve is used. (See figure 7)

TRANSMISSION APPLICATIONS (Gas Wells)

On gas wells where wellhead pressure is greater than that allowed by DOT, the transmission line is usually limited by a choke at the wellhead. If the choke cuts out, you now have full wellhead pressure on the meter run and transmission line. This can cause meter failure, filter failure and a fine for exceeding the DOT mandated pressure limit. To prevent this, a Buckling Pin Model “A” valve is mounted in the line before the meter house. On sensing excess pressure, the Model “A” emergency shutdown valve will instantly close to isolate wellhead pressure. This eliminates the need to have a relief valve and flare system to vent the excess pressure. Venting means pollution and wasting your valuable gas.
The valve also senses excess flow impinging on the piston bottom, causing the piston force to buckle the pin and close the valve in an event of a downstream line break. (See figure 8)

TRANSMISSION APPLICATIONS (Meter House)

In the meter house where the gas is filtered and metered, a damaging differential pressure across a filter or meter can occur if the filter becomes clogged or the meter locks up. To remove the damaging differential pressure, a Rupture Pin Model “O” sensing the differential pressure will open to allow gas flow to bypass the filter and meter. A proximity switch on the Rupture Pin valve can warn the operator that the filter and meter is being bypassed. An alternative to the bypass is to close a Buckling Pin emergency shutdown valve upstream from the filter. The advantage here is that no gas goes downstream unless it is metered. (See figure 9)

PRODUCTION APPLICATIONS (Offshore)

Shell Offshore is using our Model “H” valve to protect their positive displacement chemical injection pumps. Shell found when using conventional spring loaded pressure relief valves, the pulsation was fatiguing the spring and the valves were failing. The Rupture Pin valve is installed because pulsation will not affect the set pressure of the valve. The Rupture Pin valve will keep a bubble-tight seal until the pin buckles at the set pressure. With a proximity switch installed, Shell Offshore will get an alarm when the valve reaches set pressure and starts to relieve. The savings to Shell Offshore has been quoted as “two to four million dollars”. (See figure 10)

RIG APPLICATIONS (Offshore)

On offshore rig tensioning systems, pneumatic cylinders give flexibility to the rig anchoring system. However, in rough seas, pressure on the accumulator cylinders becomes excessive and must be relieved. This is done with Rupture Pin Model “A” relief valves. (See figure 11)

TRANSMISSION APPLICATIONS (Pipeline Stations)

At pipeline stations where pipelines converge and are redirected, it is necessary to protect against accidental valve closings and control valve failures. Rupture Pin Model “D” relief valves open with excess pressure and direct the liquid to storage tanks. (See figure 12)

PRINCIPLES OF OPERATION

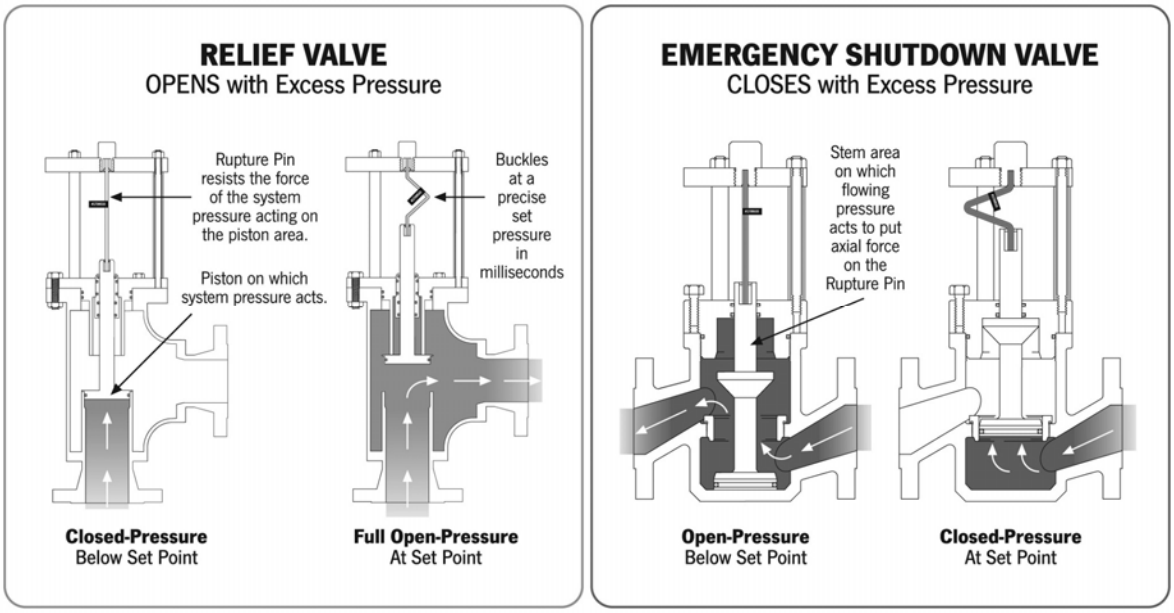


Figure 1

MODEL “I” RUPTURE PIN RELIEF VALVE FOR DRILLING MUD AND MINE SLURRIES

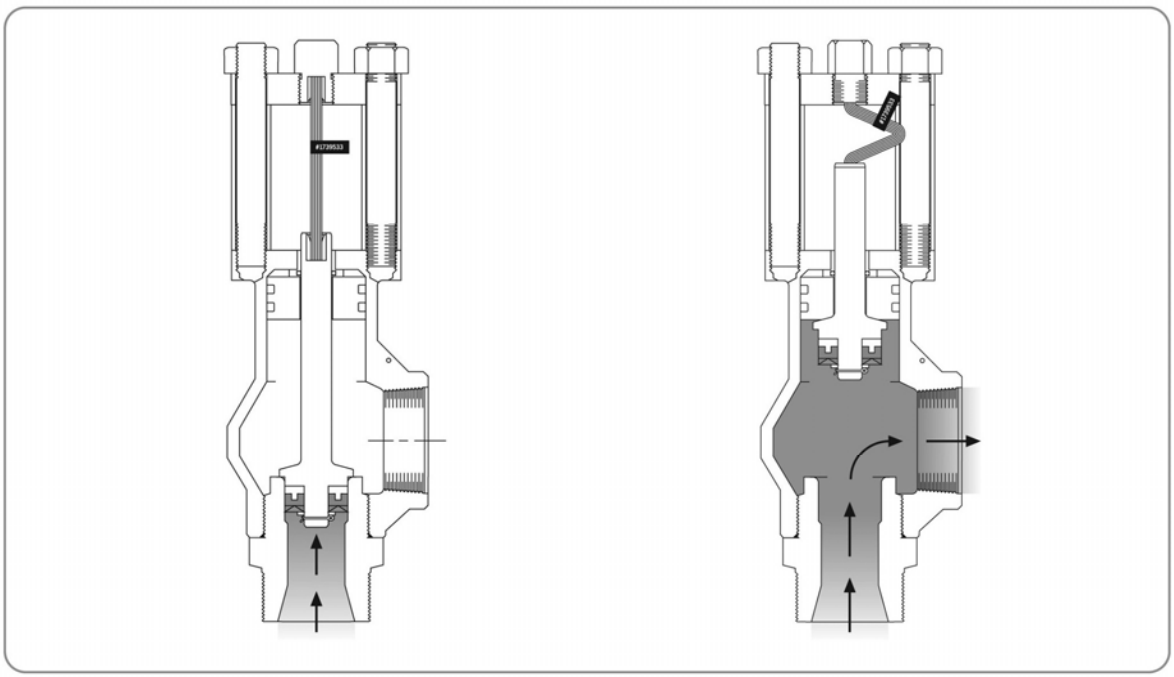


Figure 2

MODEL “CT” RUPTURE PIN RELIEF VALVE

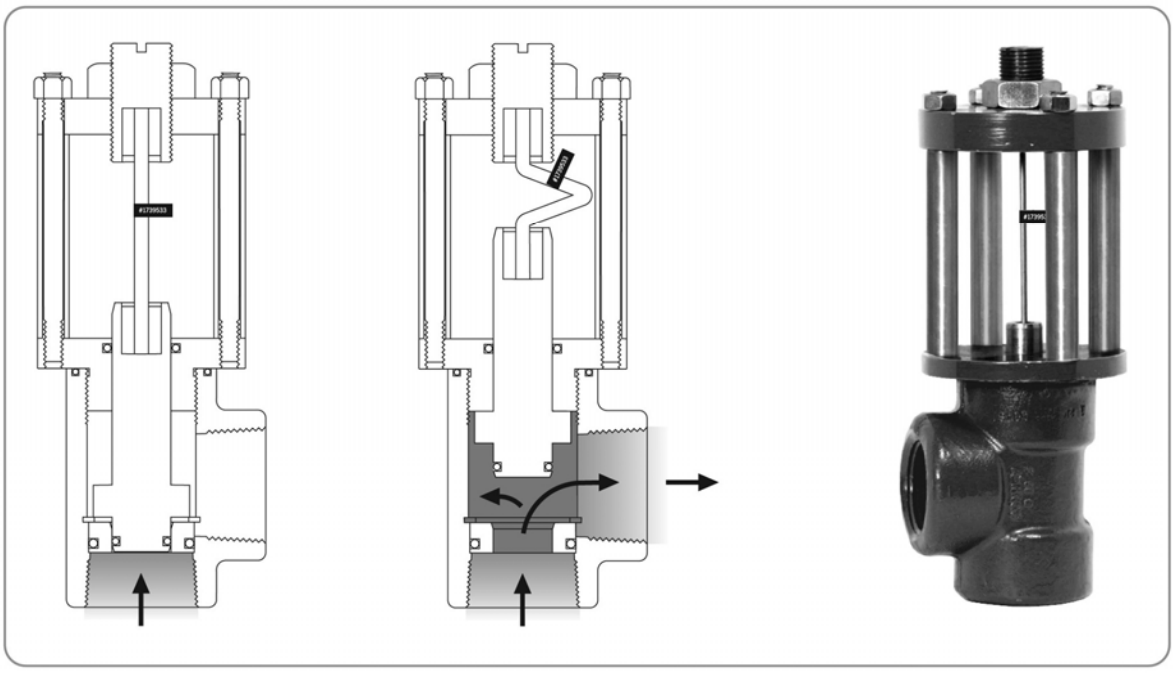


Figure 3

MODEL “CT” RUPTURE PIN RELIEF VALVE PROTECTING OILFIELD ROD PUMPS

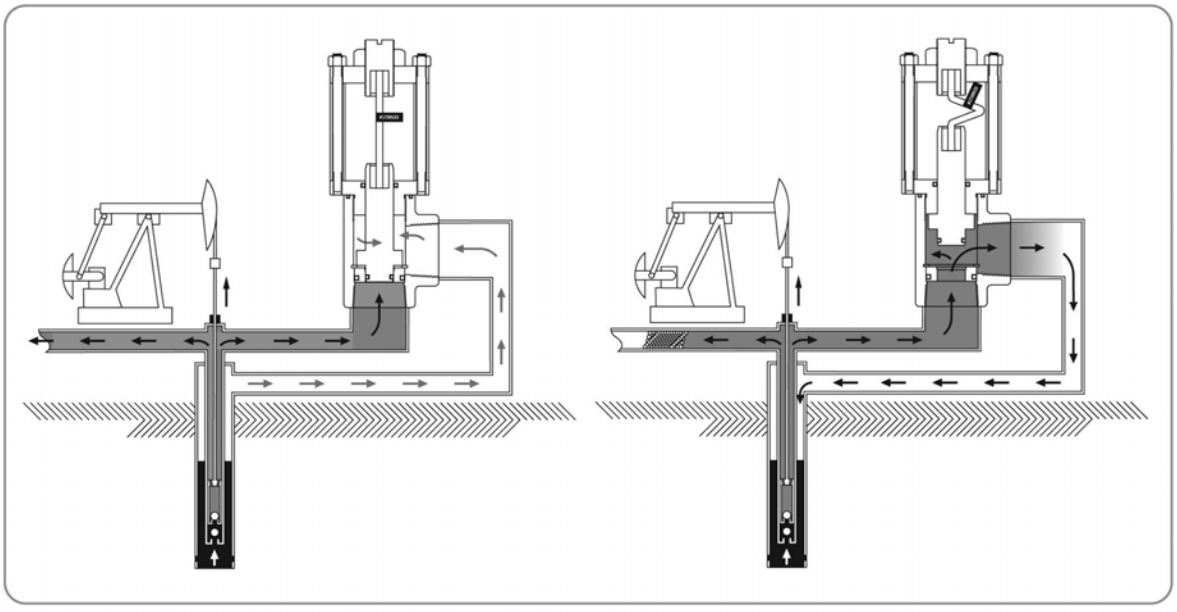


Figure 4

MODEL “D” BUCKLING PIN EMERGENCY SHUTDOWN VALVE

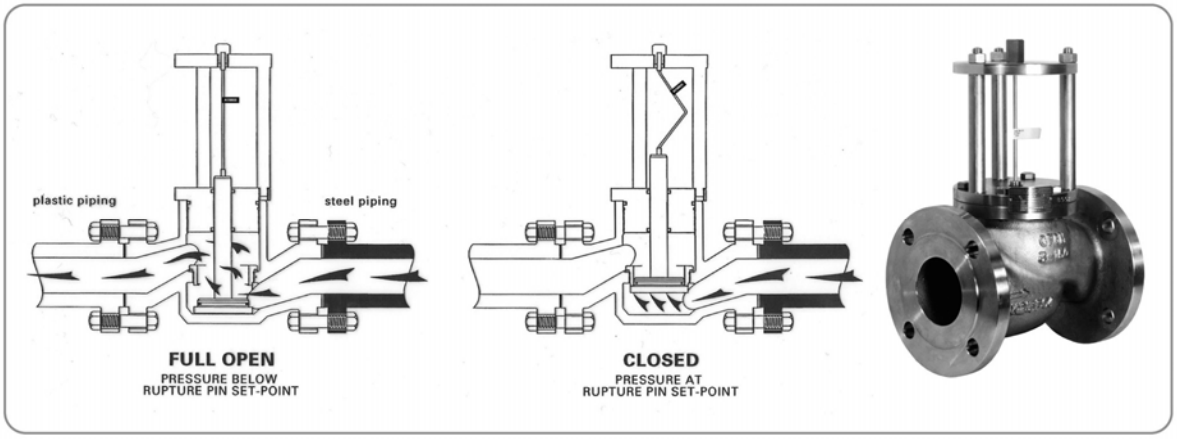


Figure 5

MODEL “D” RUPTURE PIN RELIEF VALVE

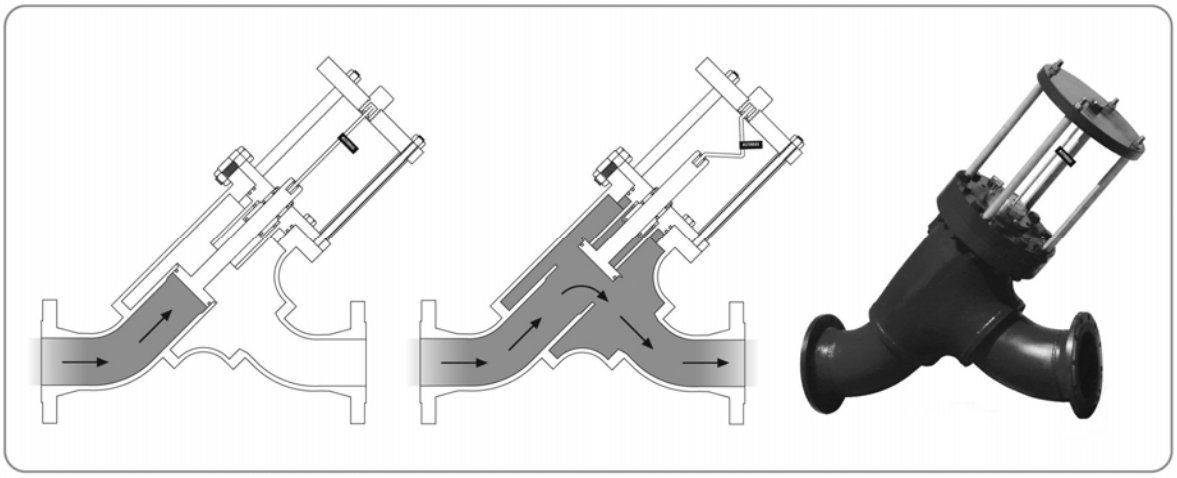


Figure 6

MODEL “B” RUPTURE PIN FUSE VALVE (PRESSURE RELIEF TO ATMOSPHERE)

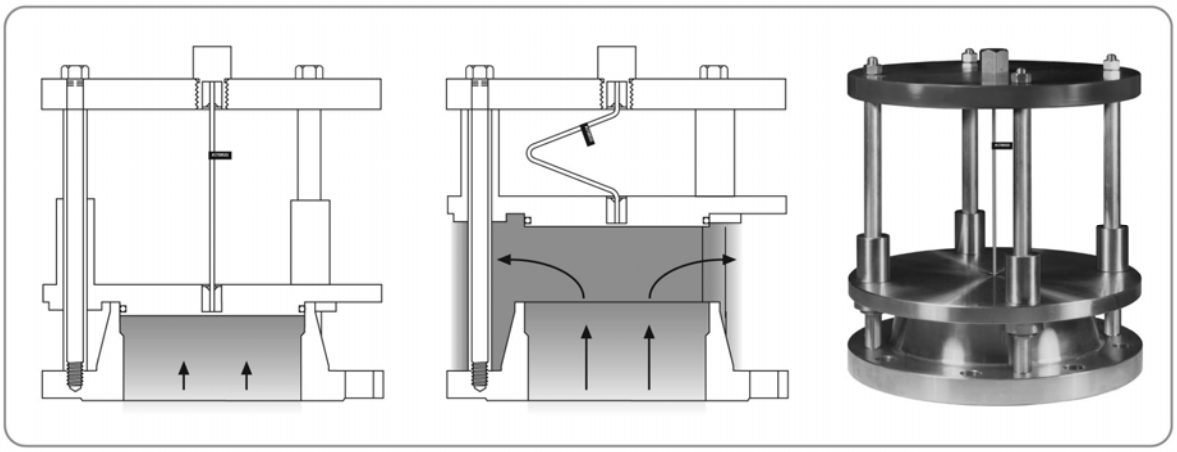
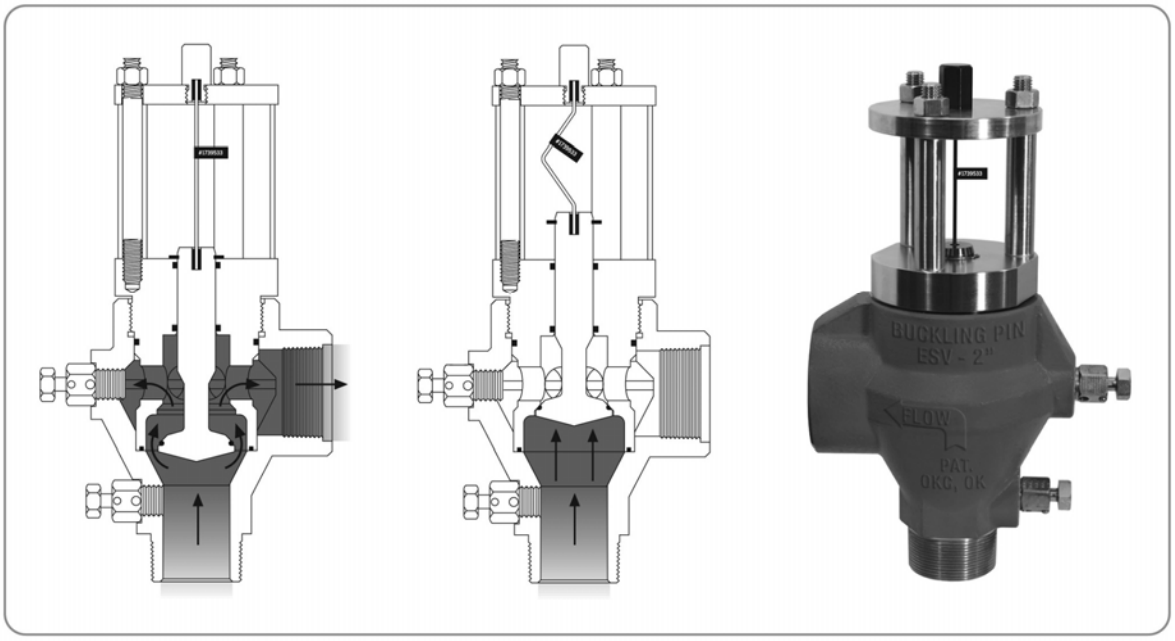


Figure 7

MODEL “A” BUCKLING PIN EMERGENCY SHUTDOWN VALVE



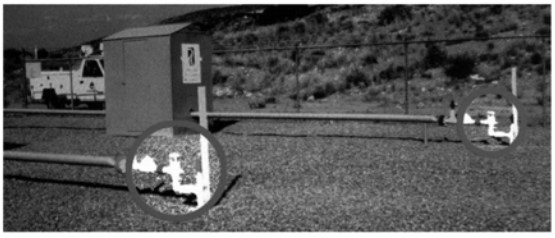


Figure 8

MODEL “O” RUPTURE PIN DIFFERENTIAL PRESSURE RELIEF VALVE

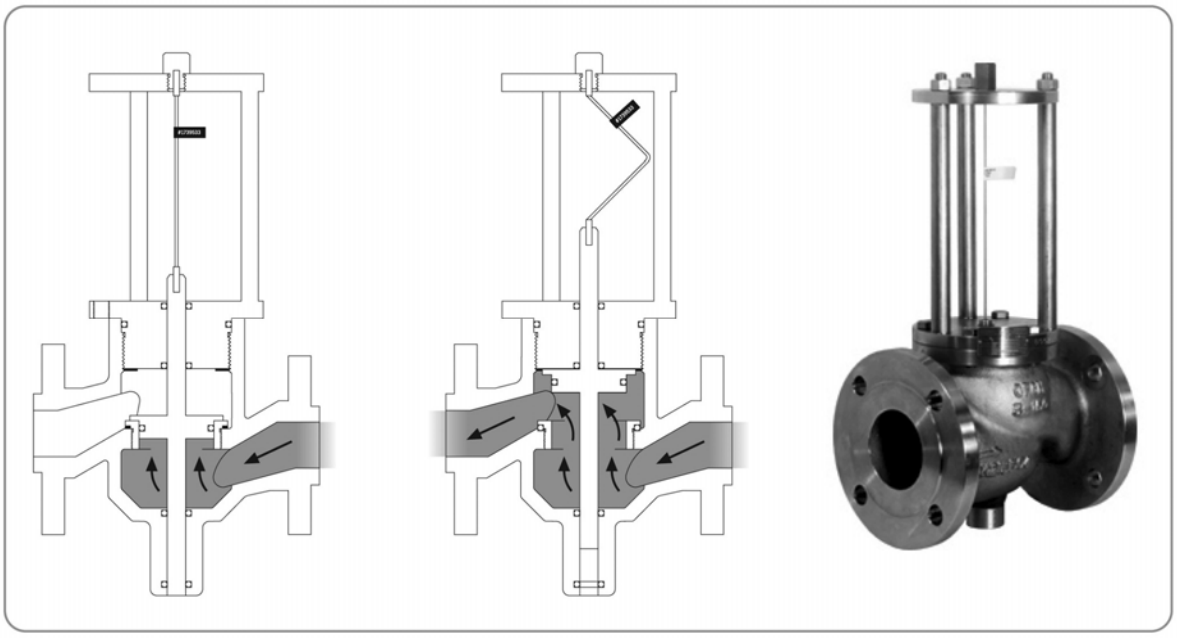


Figure 9

MODEL “A” BUCKLING PIN EMERGENCY SHUTDOWN VALVE

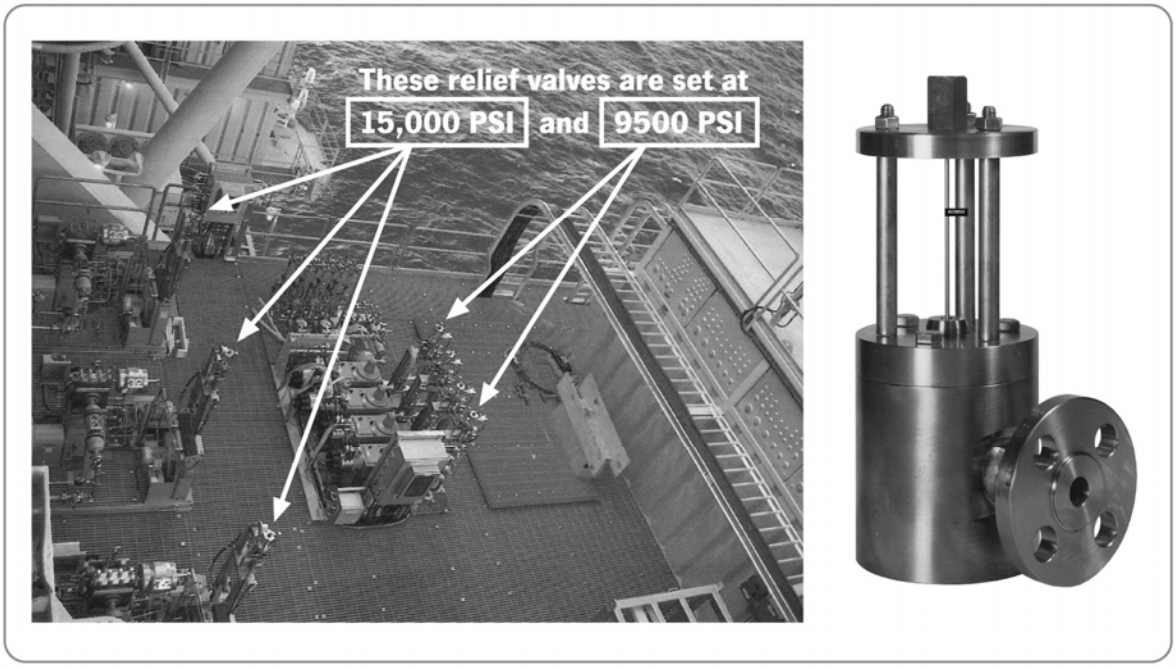


Figure 10

MODEL “A” RUPTURE PIN FUSE VALVE (PRESSURE RELIEF TO ATMOSPHERE)

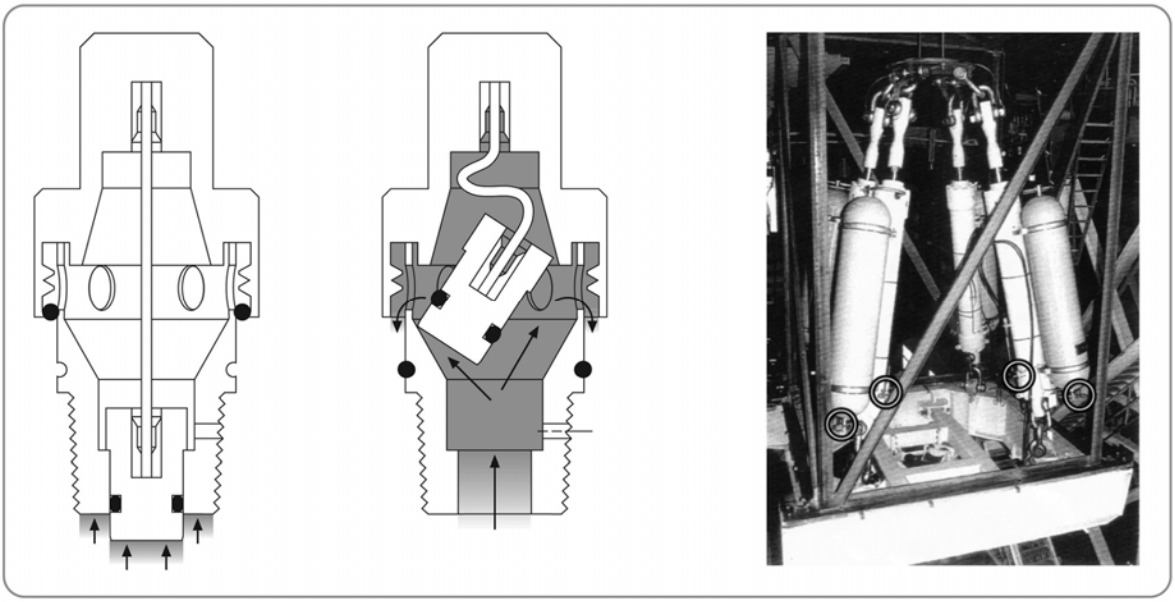


Figure 11

MODEL “D” RUPTURE PIN RELIEF VALVE

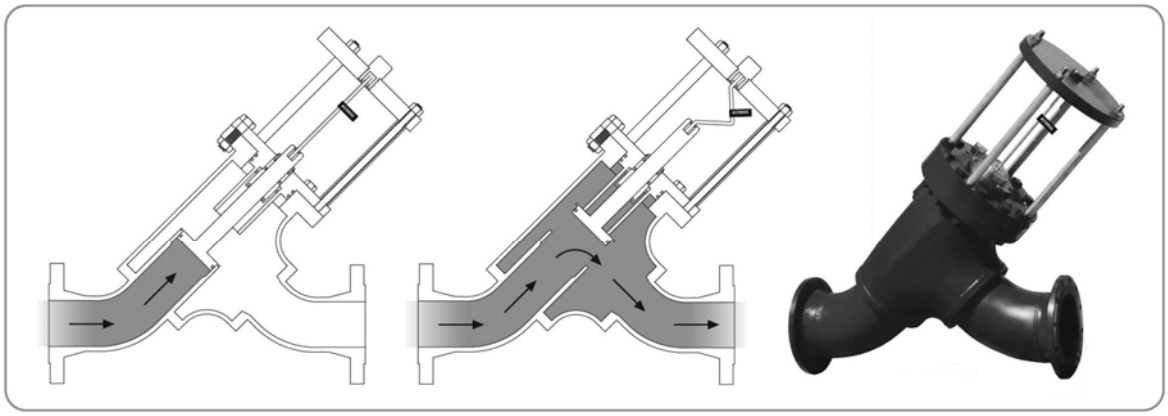


Figure 12