Collage of health and medical technology

Department of anesthesia

Lecture of anesthesia equipment

Teaching by

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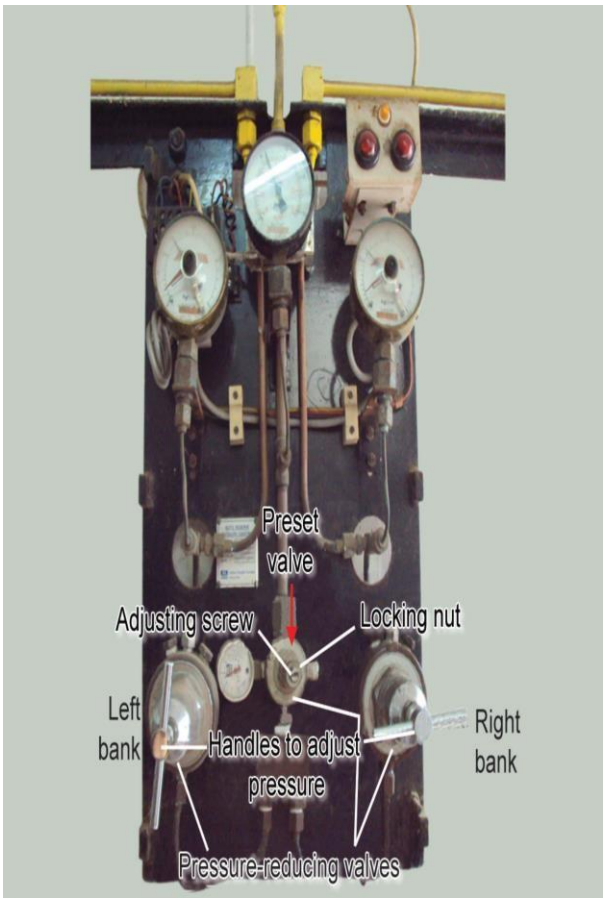
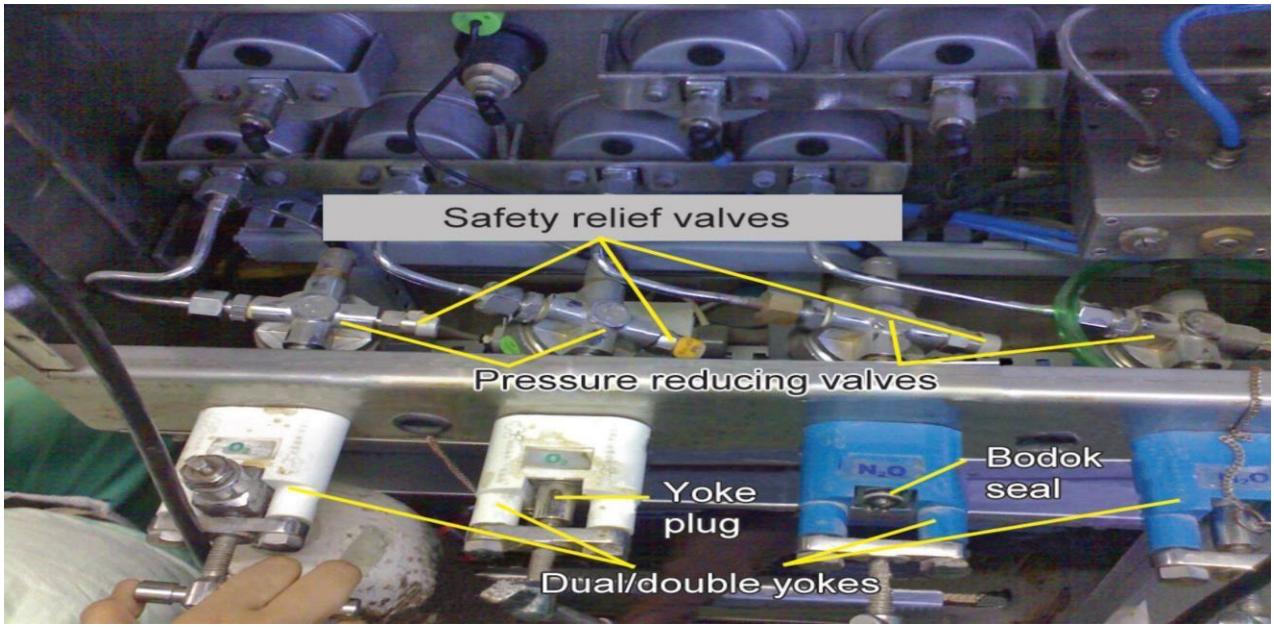
Pressure-reducing Valves (Pressure Regulators):

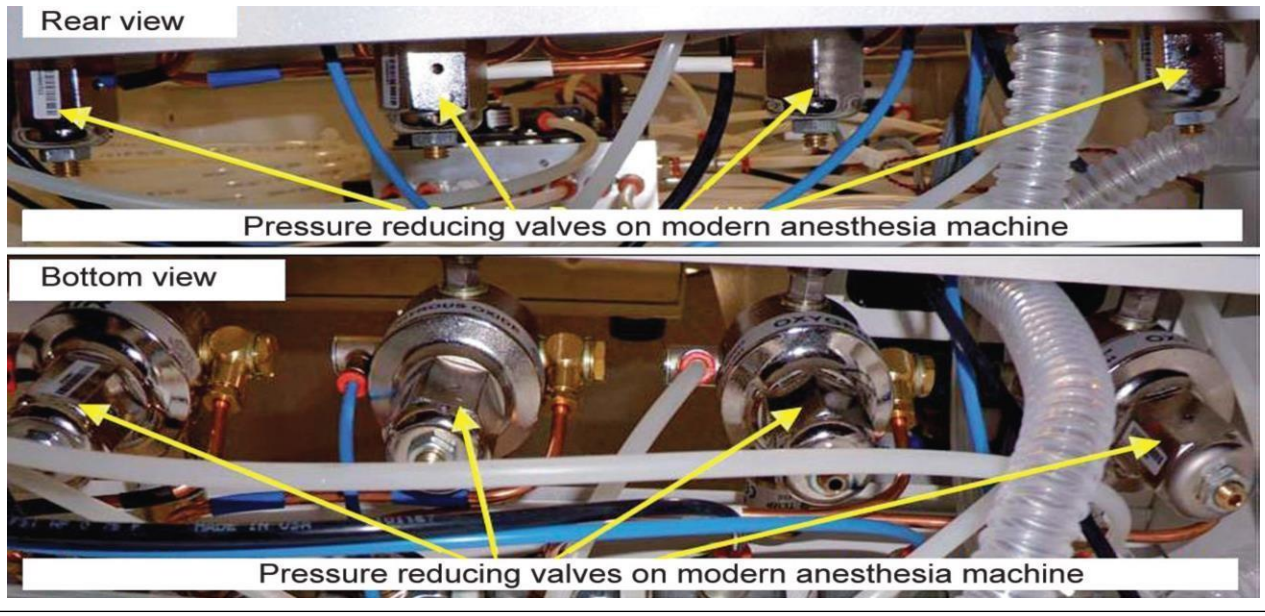
Pressure-reducing valves (pressure regulators) are used on anesthesia machines or central pipeline systems to convert the high variable pressure of gas from cylinders (entering into the pressure regulators) to a low constant working pressure (4 bar, 60 psi) of the gas (emerging out from the pressure regulators) so as to prevent damage to the structures of flowmeters, of wall outlets or anesthesia machines, especially the flow control valve needles.

The use of pressure regulators allows low-pressure piping and connectors to be used in the machine. This makes the consequences of any gas leak much less serious.

They are positioned between the cylinders and the rest of the anaesthetic machine.




Safety relief valves
Pressure reducing valves
Yoke plug
Bodok seal
Dual/double yokes


Rear view
Pressure reducing valves on modern anesthesia machine
Bottom view
Pressure reducing valves on modern anesthesia machine


Oxyden O2

Components

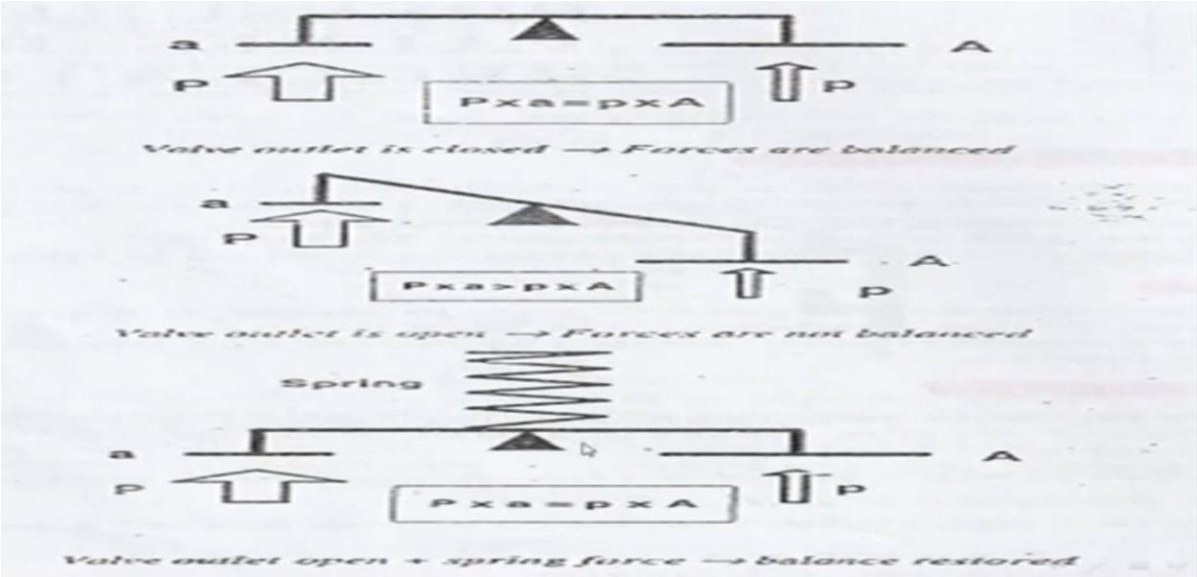
1. An inlet, with a filter, leading to a high-pressure chamber with a valve.
2. This valve leads to a low pressure chamber and outlet.

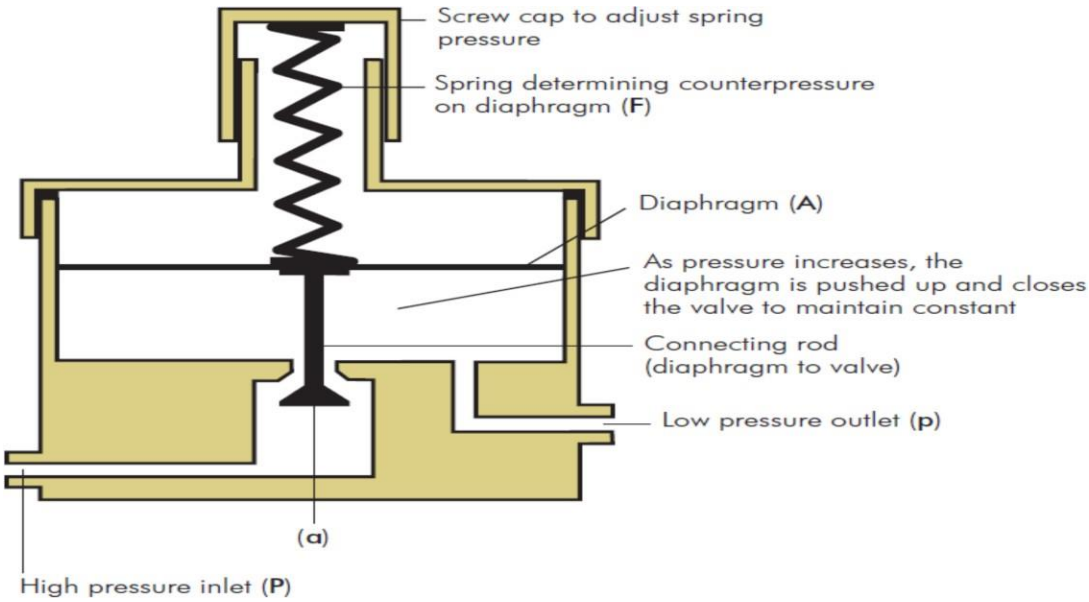
3. A diaphragm attached to a spring is situated in the low pressure chamber.

Mechanism of action

1. Gas enters the high-pressure chamber and passes into the low-pressure chamber via the valve.

2. The force exerted by the high-pressure gas tries to close the valve. The opposing force of the diaphragm and spring tries to open the valve. A balance is reached between the two opposing forces. This maintains a gas flow under a constant pressure of about 400 kPa.





F = Force acting on conical valve +Force acting on diaphragm = Pa + pA

Important note:
If F is constant, a decrease in pA (drop in supply pressure due to increased demand) causes an increase in Pa (increased flow from cylinder). Alternatively if Pa decreases (due to cylinder pressure falling as it empties), pA will increase (increased flow from cylinder). Thus the pressure regulator not only reduces the cylinder pressure to a suitable supply pressure but also compensates for changes in demand or cylinder pressure.

Type of reducing valve:

1. Single – stage valve: suitable of anesthesia machine and O2 therapy
2. Two stage valve
3. Demand valve: it supplies gas to patients during inspiration only it's used in N2O/O2 administration for dental and obstetric analgesia

4. Entonox valve: consist of two valves single stage + demand valve

Important note: **non-return valves** may be present in the hanger yoke of anesthesia machine or in the pressure-reducing valve. They prevent empty cylinders from being refilled by other cylinders if the empty cylinder is left turned on. Pressure regulators can be either adjustable or preset.

SAFETY RELIEF VALVES ON REGULATORS

Important note: safety blow-off valves are often fitted on the downstream side of regulators to allow escape of gas if by accident the regulators were to fail and allow a high output pressure. These valves are generally spring loaded, in which case they close when pressure falls again. But if they operate by rupture, then they remain open until repaired by service engineer. Relief valves (usually set at 700 kPa).

Important note: Some machines also use a second regulator to drop both pipeline and cylinder pressure further (two-stage pressure regulation). A second-stage pressure reduction may also be needed for an auxiliary oxygen flowmeter, the oxygen flush mechanism, or the drive gas to power a pneumatic ventilator.

Problems in practice and safety features

1. Formation of ice inside the regulator can occur. If the cylinder contains water vapour, this may condense and freeze as a result of the heat lost when gas expands on entry into the low-pressure chamber.

2. The diaphragm can rupture.

Best wishes