Al-Mustaqbal University College
Department of anesthesia

Lecture of anesthesia equipment

Teaching by

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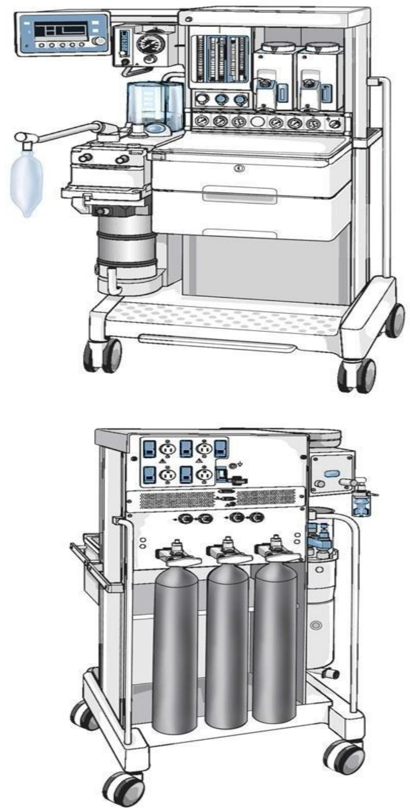
Anesthesia machine and anesthesia delivery:

The anesthetic machine receives medical gases (oxygen, nitrous oxide, air) under pressure and accurately controls the flow of each gas individually.



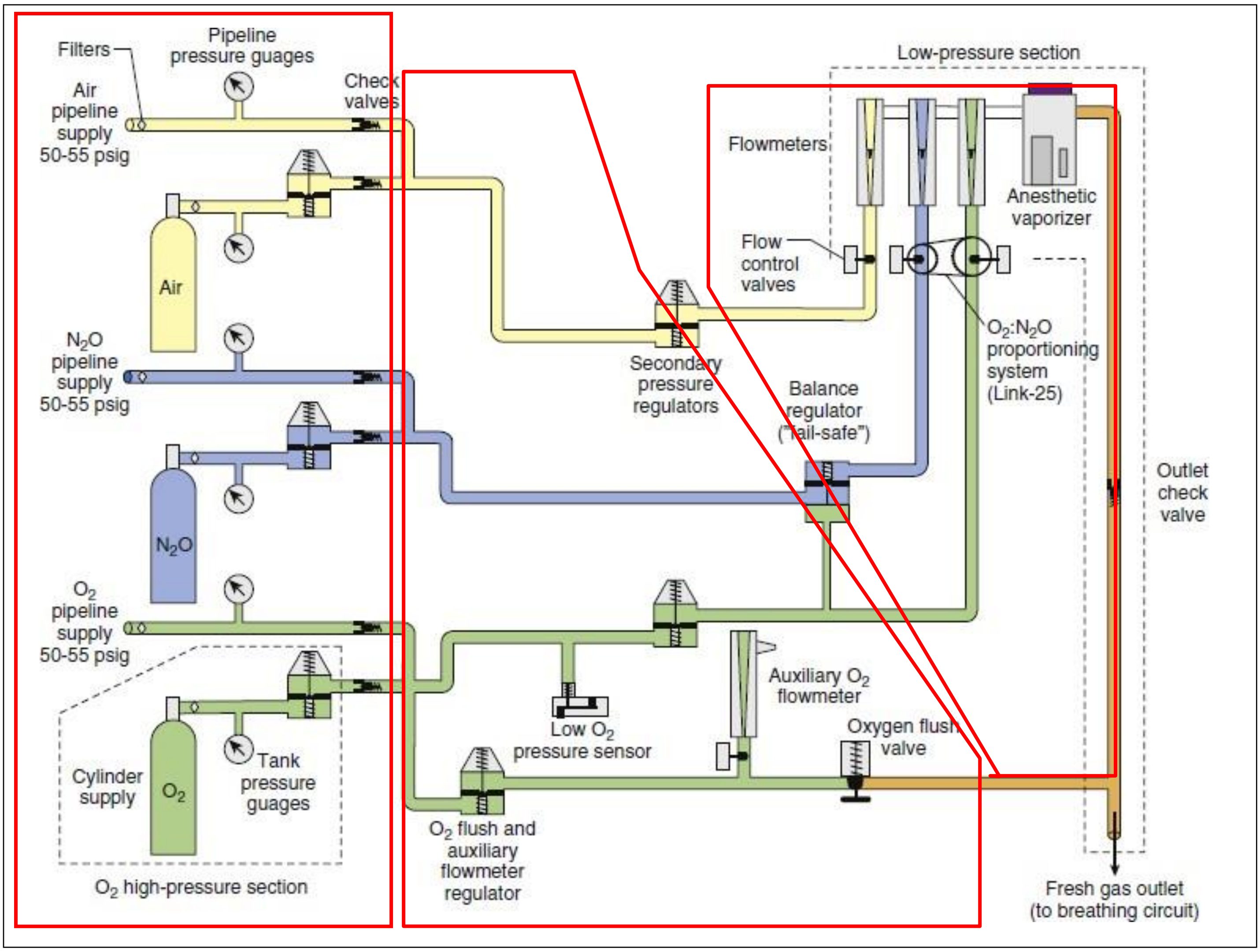
DThe Datex-Ohmeda Aestiva S/5 anaesthetic

The following components are likely to be encountered in sequence:

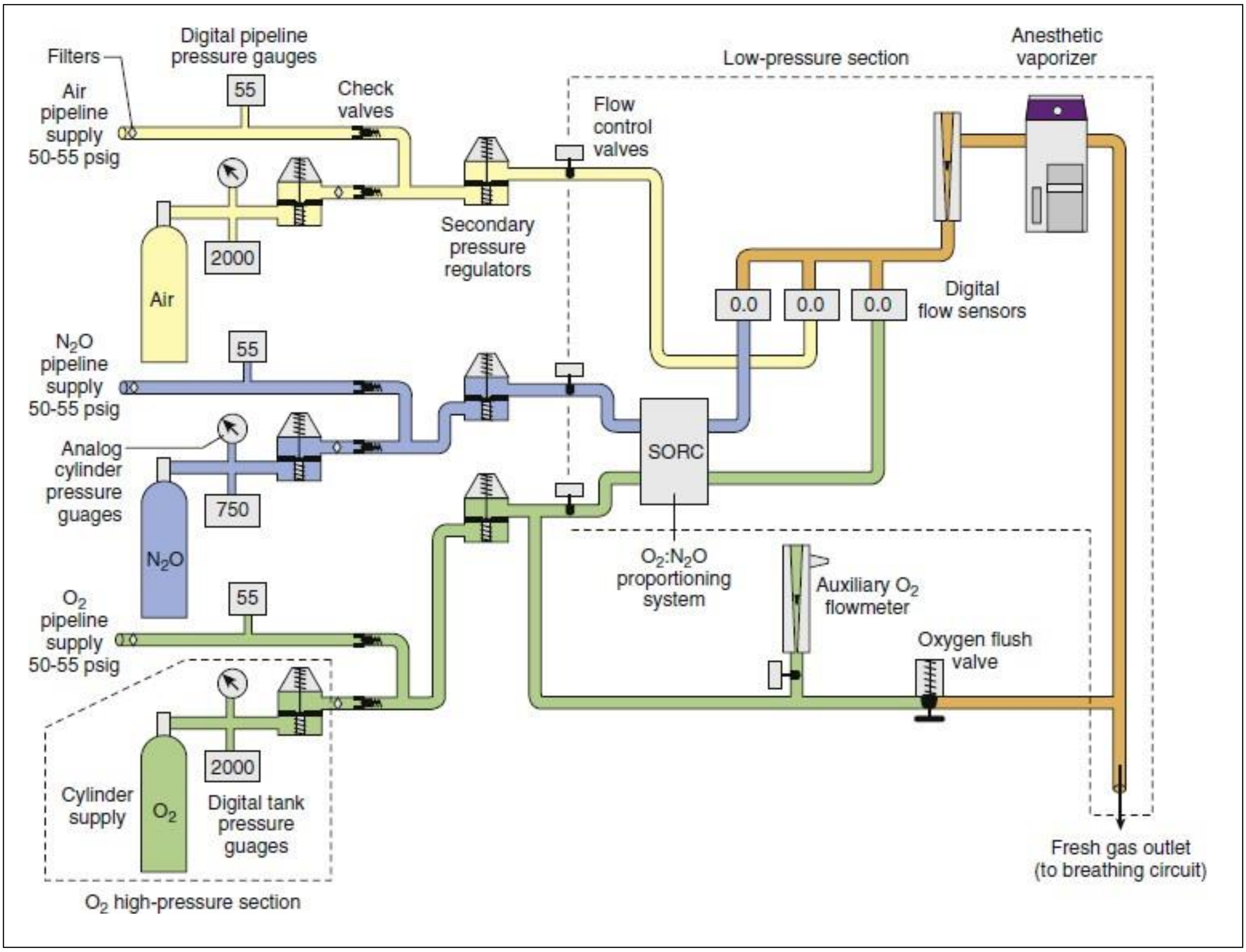
1. Source of gas supply
2. Yoke assembly
3. Pressure gauge
4. Pressure regulators
5. Oxygen (O2) pressure failure safety/warning devices
6. Oxygen ratio control devices
7. Flowmeters
8. Vaporizers
9. Common gas outlet
10. Breathing systems.

The pressure regulators, flow meters, vaporizers, and breathing systems are discussed separately. The other components will be discussed briefly to give a comprehensive view of the whole machine.

Anatomy of anesthesia machine :



The high-pressure system extends from the gas cylinders to the high-pressure regulators (*dashed lines* around 02 high-pressure sections). The intermediate-pressure section extends from the high-pressure regulators to the flow control valves and also includes the tubing and components originating from the pipeline inlets. The low-pressure section (*dashed lines*) extends from the flow control valves to the breathing circuit.



High-Pressure Section:

. Cylinder P.G & reg

.pipeline inlet & reg

.fail-safe

.Flowmeter valve

.O2 flush

During normal operating conditions, the hospital's central gas supply system serves as the primary gas source for the anesthesia machine. However, it is a requirement to have at least one attachment for an oxygen cylinder to serve as a backup source of oxygen in case of failure of the hospital supply source. Many machines have up to three and sometimes four E-cylinder attachment points to accommodate oxygen, air, and nitrous oxide. Some machines have attachments for two oxygen tanks, and some rare systems can accommodate carbon dioxide or helium tanks used for special applications.

Each cylinder supply source line must therefore have a pressure-reducing mechanism known as the high-pressure regulator, which reduces the variable high pressures present in the cylinders to a lower, nearly constant pressure suitable for use in the anesthesia machine.

#important note: The high-pressure regulators are adjusted to provide gas from the E-cylinders at a pressure of approximately 45 psig (but it can be as low as 35 psig). Although this specific value may vary among machines, the principle is to keep high-pressure regulator output pressure lower than the normal pipeline supply pressures. This approach ensures that the hospital's central gas supply will serve as the main supply of gas to the machine if a cylinder is open as long as the hospital supply line pressure remains higher than the regulator output pressure. In other words, the E-cylinders, even when open, will not provide gas to the anesthesia machine if the hospital supply line pressure is within or higher than the normal range.

Intermediate-Pressure Section:

Oxygen Flush Valve: The oxygen flush valve is probably one of the oldest safety features on the machine, and it remains a machine standard today. The valve provides manual delivery of a high flow rate of 100% oxygen directly to the patient's breathing circuit. Flow from the oxygen flush valve bypasses the anesthetic vaporizer. The intermediate-pressure segment of the gas supply system feeds the valve, which remains closed until the operator opens it. The feature is usually available even when the machine is not turned on because the valve is usually located upstream from the machine's pneumatic power switch.

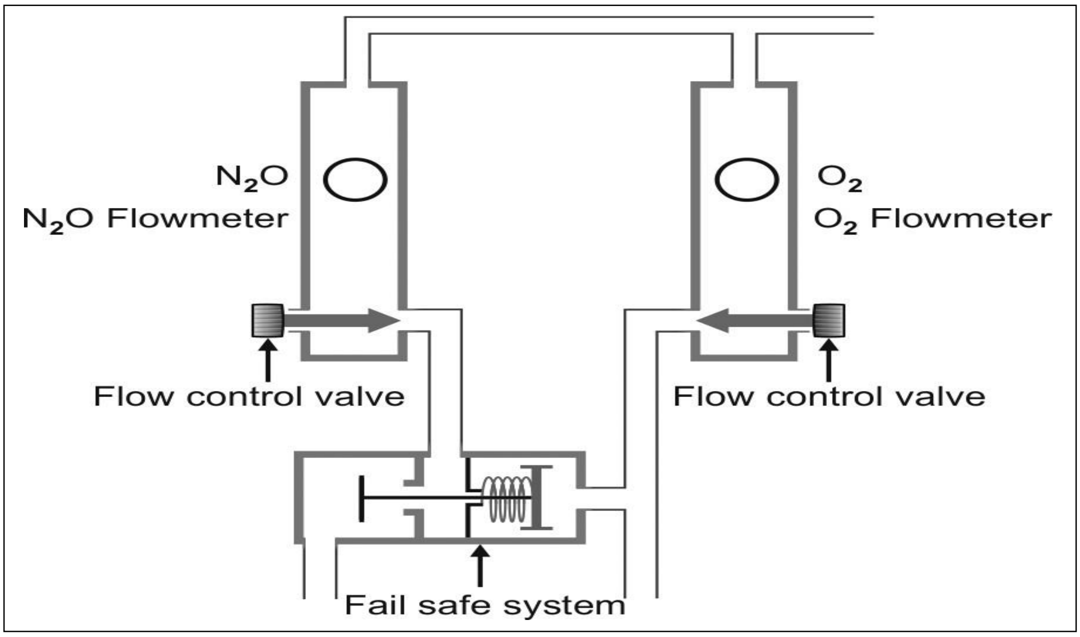
OXYGEN PRESSURE FAIL SAFE SYSTEM:

This device is designed to prevent delivery of anesthetic gas without O2 when the O2 supply fails.

This is incorporated at the level of the pressure regulators. The O2 pressure regulator works as the primary regulator. The output from this regulator controls the secondary regulators or the slave regulators that are located in the N2O line. In such systems, if the pressure from the O2 regulator falls, the slave regulator of N2O will automatically close and will not allow flow of N2O.

These are two types:

one, in which the N2O regulator will be totally cutoff when the O2 pressure falls below a critical level; **and the other**, where the N2O outlet pressure will also fall proportionate to the fall in O2 pressure and so the proportional flow will be maintained, though the total flow will fall and finally stop.



 # important note2: If there is any possibility that the workstation or the breathing circuit is a potential cause of difficulty with ventilation or oxygenation, switching to a self-inflating resuscitation bag is an appropriate decision. Ventilate and oxygenate first -troubleshoot later. **# important note 2:** The most important part of the preuse anesthesia workstation checkout procedure is verifying the presence of a self-inflating resuscitation bag.

#important note: If the hospital pipeline becomes crossed or contaminated, two actions must be taken. The backup oxygen cylinder valve must be opened, and the wall supply sources must be disconnected. Otherwise, hospital pipeline gas will continue to flow to the patient.

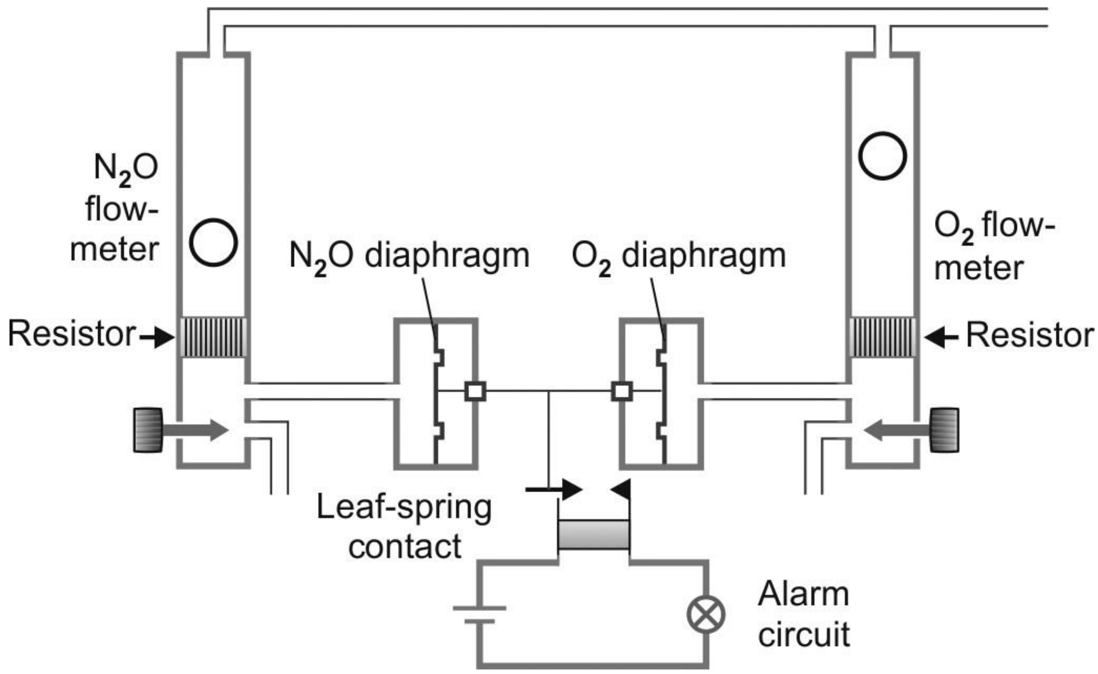
Oxygen Pressure Failure Warning Devices

It is mandatory that in addition to cutting off N2O flow, there should be an alarm when the O2 pressure falls, which alerts the anesthesiologist to failing O2 supply. Devices have been developed which activate an alarm when the O2 pressure fails. The alarm may be visual, audible or both. With the activation of alarm, the device either cuts off the N2O flow or directs the N2O flow to the atmosphere.

Oxygen Ratio Control Devices (Proportioning Devices)

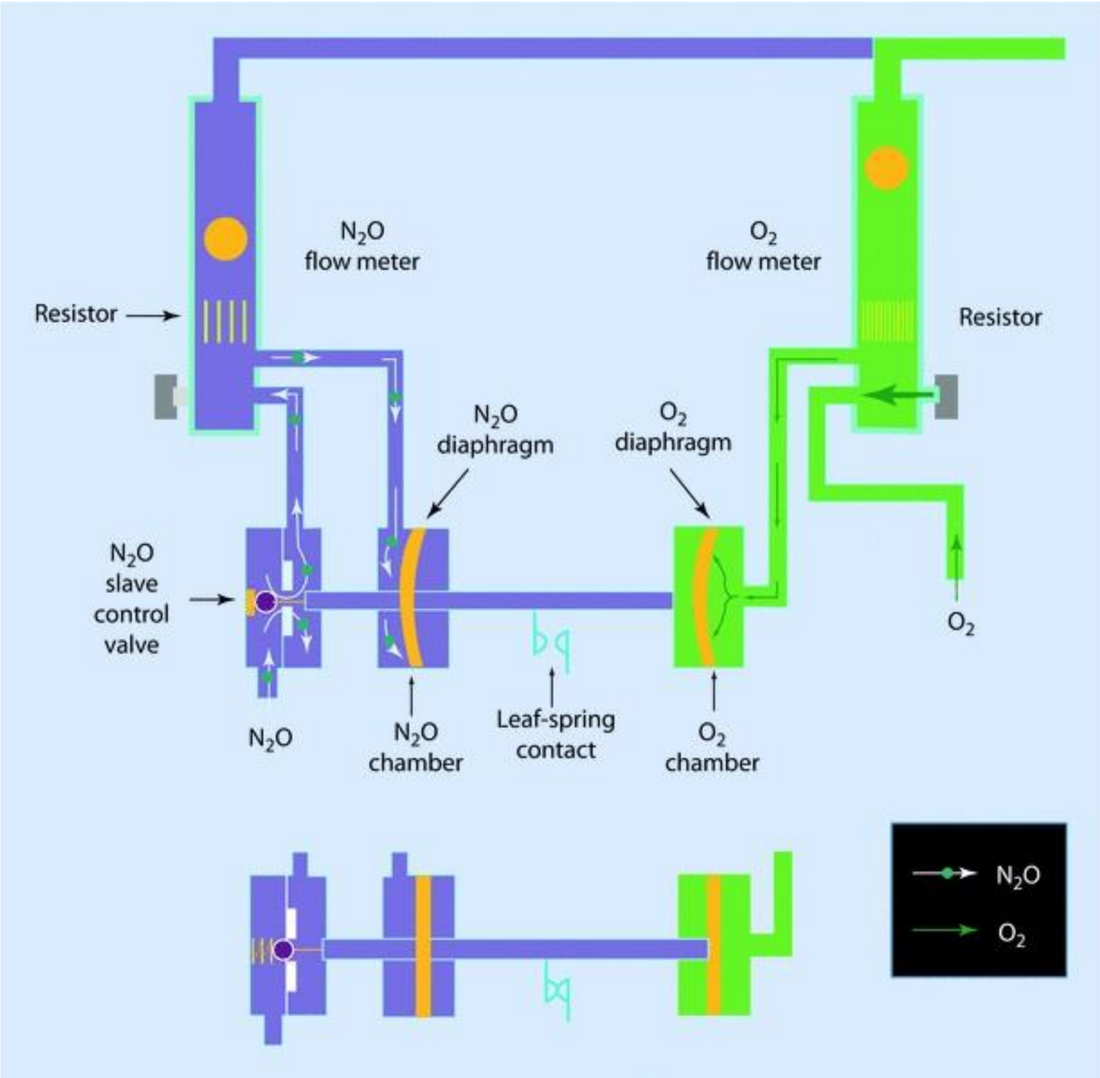
Most modern machines used in all developed countries utilize proportioning systems in an attempt to prevent delivery of a hypoxic mixture. Oxygen and N2O are interfaced either mechanically or pneumatically so that the minimum O2concentration at the common outlet is 25%.

Oxygen Ratio Monitor:



Note: The ORM generates an alarm but does not actively control the gas flow. It will not sound an alarm if a hypoxic mixture is administered when the O_2 piping system contains a gas other than O_2.

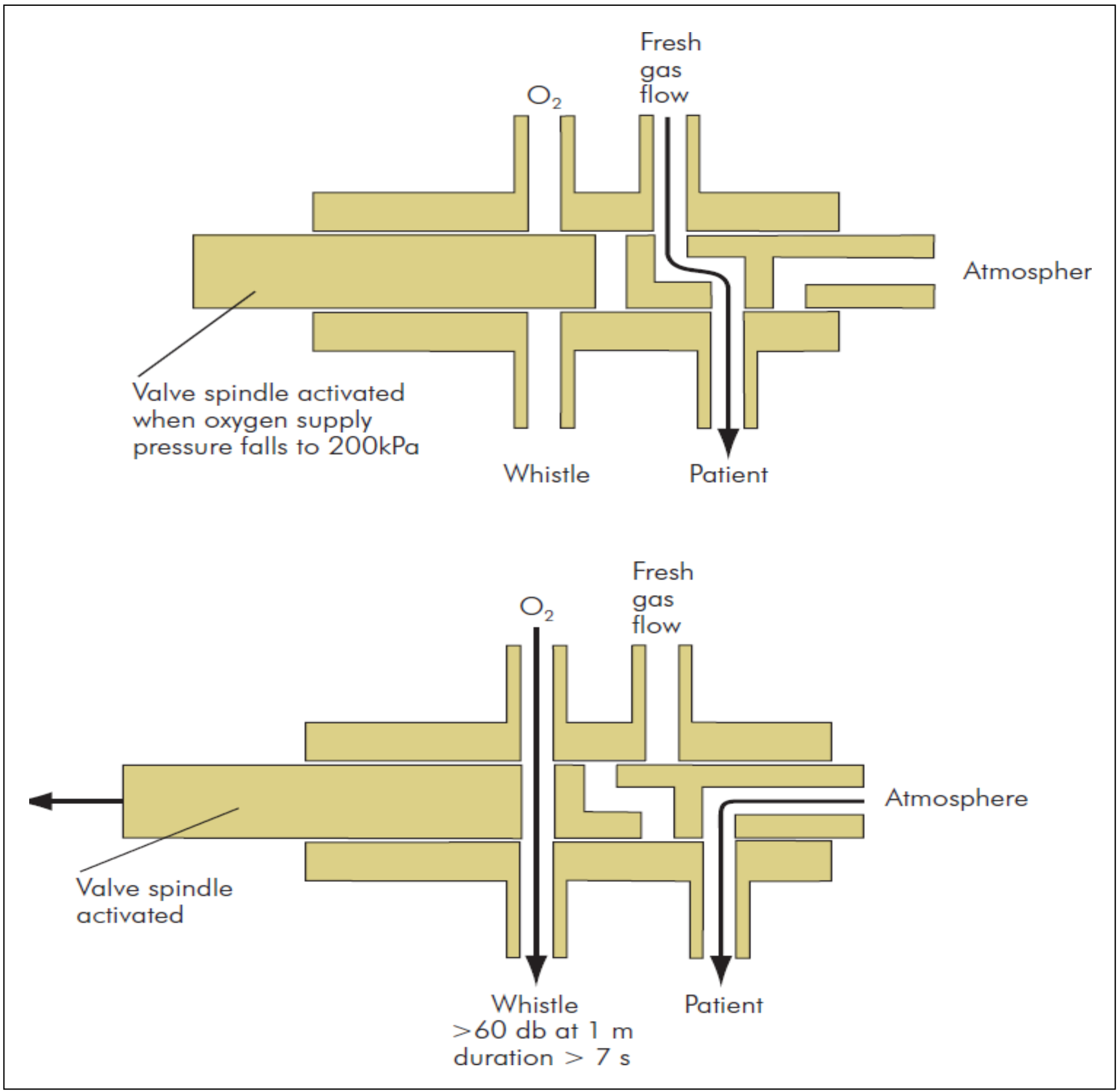
The oxygen ratio monitor controller (ORMC) is used in the North American Dräger machine. The ORMC is a pneumatic oxygen-nitrous oxide interlock system designed to maintain fresh gas O2 concentration of at least 25% ± 3%. ORMC controls the fresh gas oxygen concentration to levels substantially higher than 25% at oxygen flow rates of less than 1 L/min. ORMC limits nitrous oxide flow to prevent delivery of a hypoxic mixture. In this system, the pressure of the oxygen chamber controls the flow of nitrous oxide through the slave valve. If the pressure in oxygen falls, the opening in the slave valve will narrow and decrease nitrous oxide flow. However, if the pressure in the oxygen chamber is high, it will open the sleeve valve and increase nitrous oxide flow



Oxygen failure warning device: Monitoring of the delivered fresh gas oxygen concentration is mandatory, but the anaesthetic machine also has a built-in oxygen failure device. This is mounted upstream of the rotameter which include:

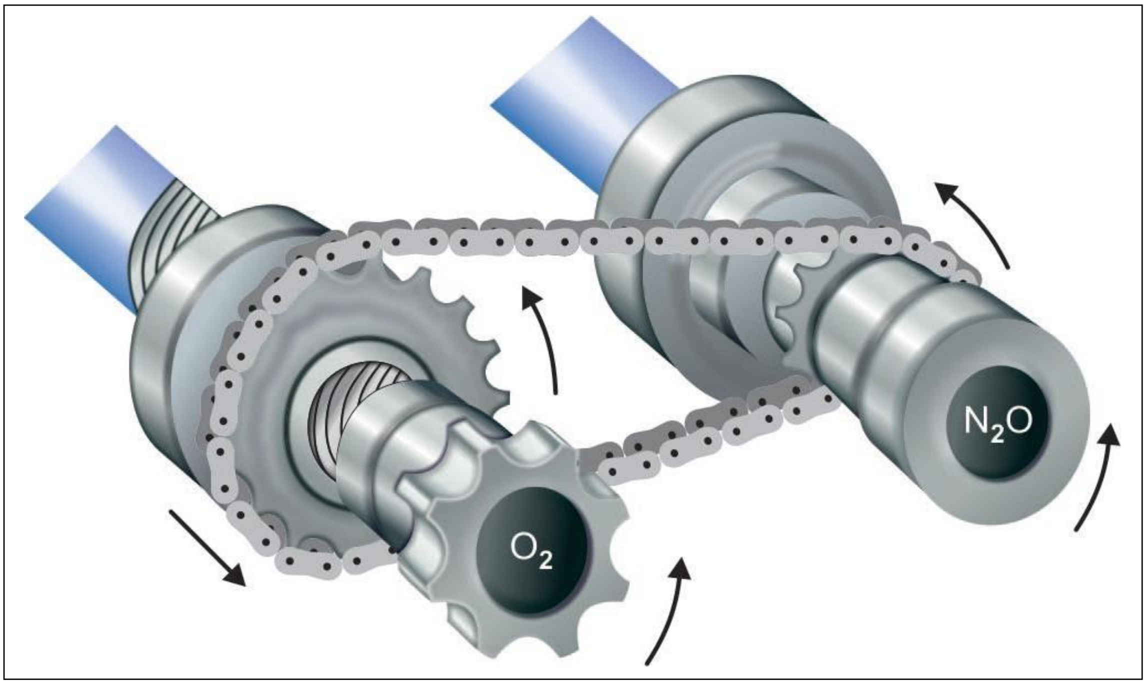
◦ Audible alarm > 60 db at a distance of 1 metre from the machine, for 7 seconds or more.
◦ Activation when the oxygen supply falls to 200 kPa
◦ Alarm that cannot be switched off or reset until the oxygen supply is restored
◦ Alarm coupled to a gas cutoff valve that cuts off anaesthetic gases and opens the machine pipeline circuitry to air.

An early oxygen failure warning device was the Ritchie whistle (1960), and many modern devices are similar in principle.



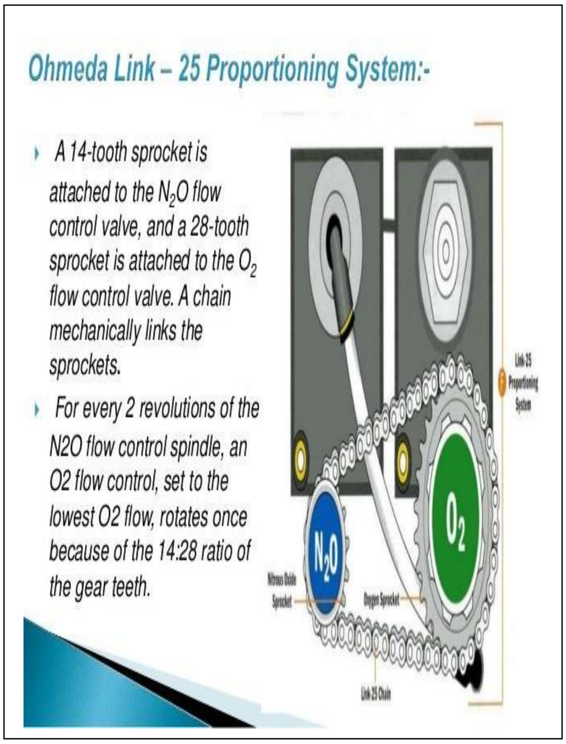
Link-25 Control System:

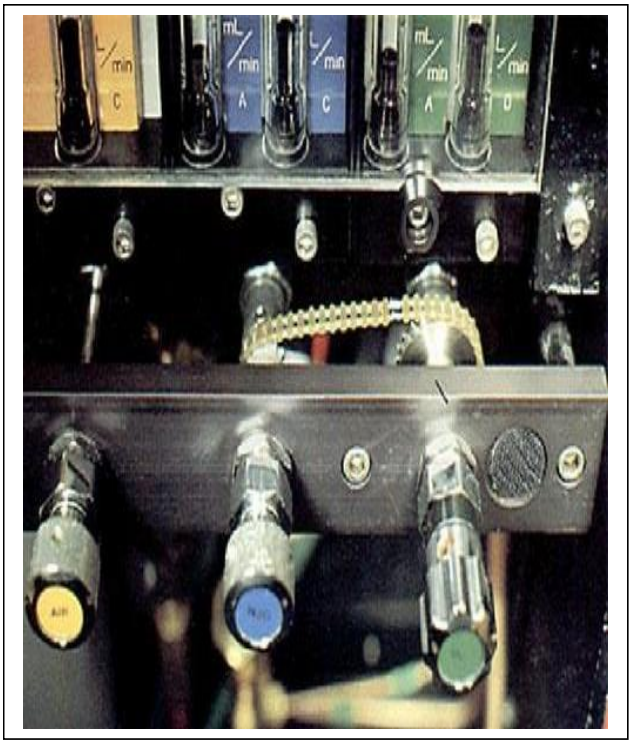
Conventional Detxa- Ohmeda machines use the link 25 system. The heart of the system is mechanical integration of nitrous oxide and oxygen flow control valves. It allows independent adjustment of either valve. Yet automatically intercedes to maintain minimum 25% oxygen concentration with maximum nitrous oxide-oxygen flow ratio of 3:1 the link-25 automatically increase oxygen flow to prevent delivery of a hypoxic mixture.

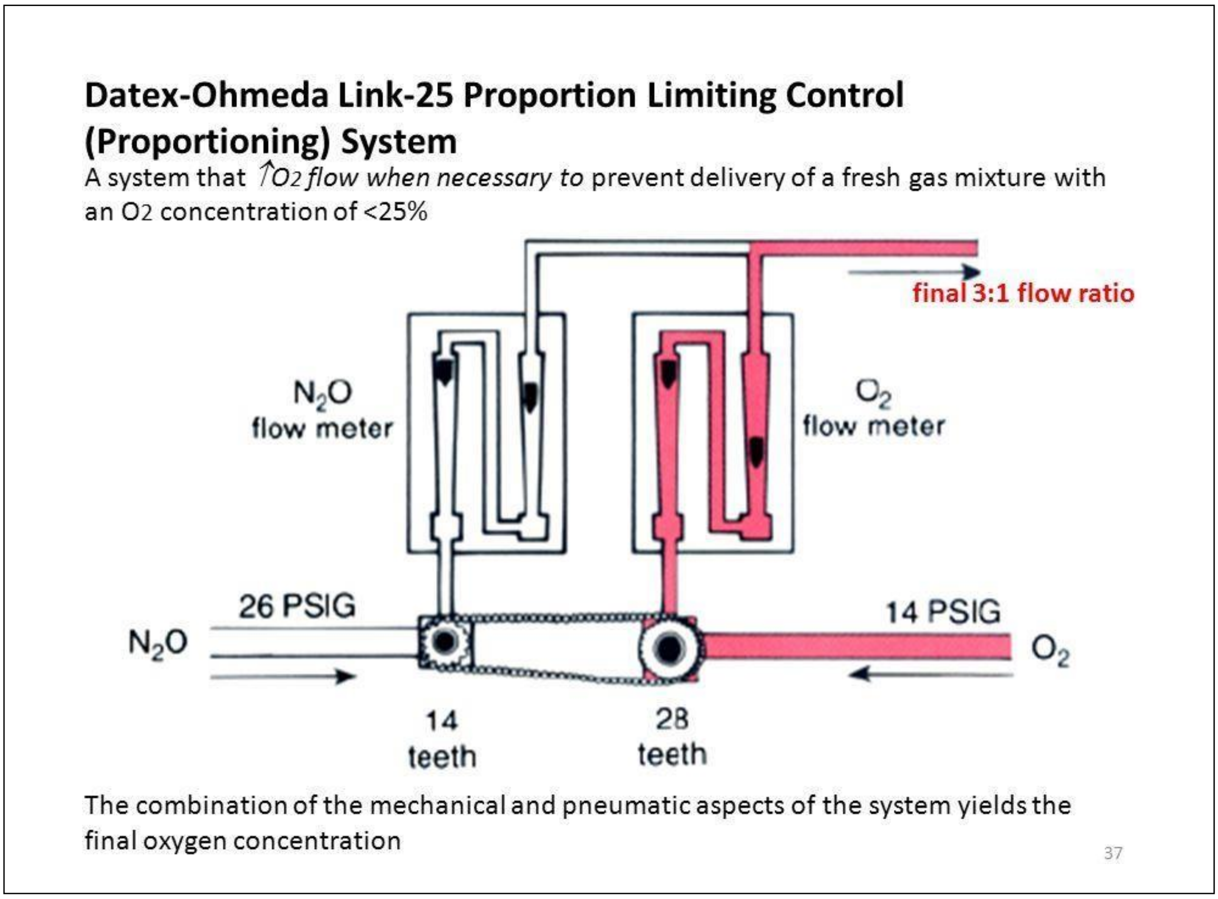


The nitrous oxide and oxygen flow control valves are identical. A 14-tooth sprocket is attached to N2O flow control valve and 28-tooth sprocket to oxygen flow control valve. A chain physically links sprockets. When nitrous oxide flow control is turned through two revolutions, the flow control valve will revolve once because of the 2:1 gear ratio. The final 3:1 ratio results because the N2O flow control valve is supply by approximately 26psig whereas the oxygen flow control valve is supplied by 14psig. Thus the combination of mechanical and pneumatic aspect of system yields the final oxygen concentration.

The disadvantage of this system is in the mechanical linkage. If the spindle and the gear are not properly aligned, or if the threads in the spindle undergo wear and tear, the link system is likely to malfunction. Secondly, the proportioning devices can link only O2 and N2O. If a third gas like air is included in the flowmeter assembly then it no longer assures a 25% O2 delivery in the mixture. Most of the modern machines allow an air flowmeter in the flowmeter block.







BEST WISHES