SNS COLLEGE OF ALLIED HEALTH SCIENCE

Affiliated to The Tamil Nadu Dr. M.G.R Medical University, Chennai

DEPARTMENT OF OPERATION THEATRE AND ANESTHESIA TECHNOLOGY

COURSE NAME : 1138 - PRINCIPLES OF ANESTHESIA - 1

UNIT : 1. ANAESTHESIA MACHINE & MEDICAL GAS SUPPLY

TOPICS : Safety Features of Anesthesia Machine

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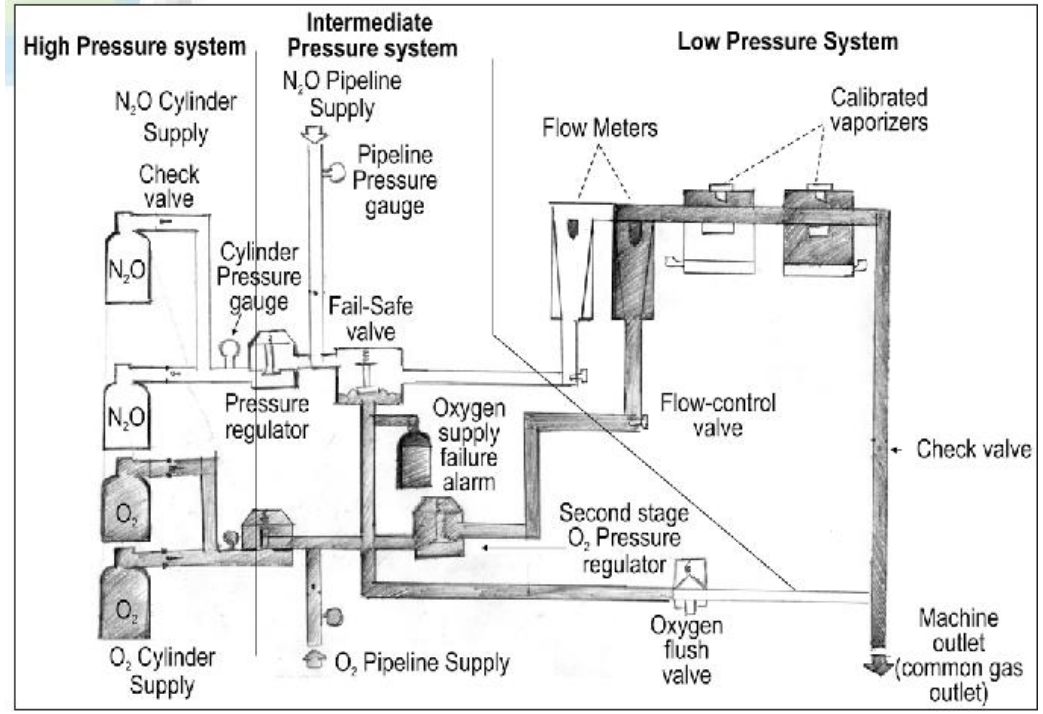
INTRODUCTION (Define)

- Anesthesia machines are critical devices used to deliver controlled mixtures of gases and anesthetic agents to patients during surgery.
- Evolution from basic continuous flow machines (e.g., Boyle's machine in 1917) to modern workstations with integrated safety mechanisms.
- **Purpose**: Ensure patient safety by preventing hypoxia, gas misdelivery, and other hazards.
- **Standards**: Governed by ASTM, ASA, and international guidelines for minimum safety requirements.

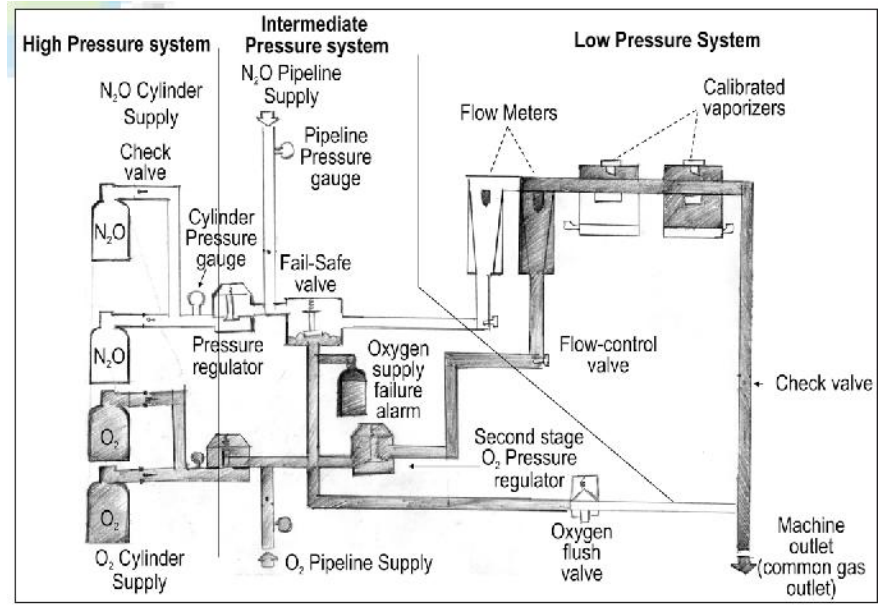
High-Pressure System Safety Features

- **Pin Index Safety System (PISS):** Unique pin configurations on cylinder yokes prevent attachment of incorrect gas cylinders
- **Color Coding**: Cylinders and hoses color-coded to avoid misidentification.
- **Pressure Relief Devices:** Rupture discs or fusible plugs prevent explosions from over-pressurization.
- **Pressure Regulators:** Reduce cylinder pressure to a safe intermediate level, with dual regulators for redundancy.



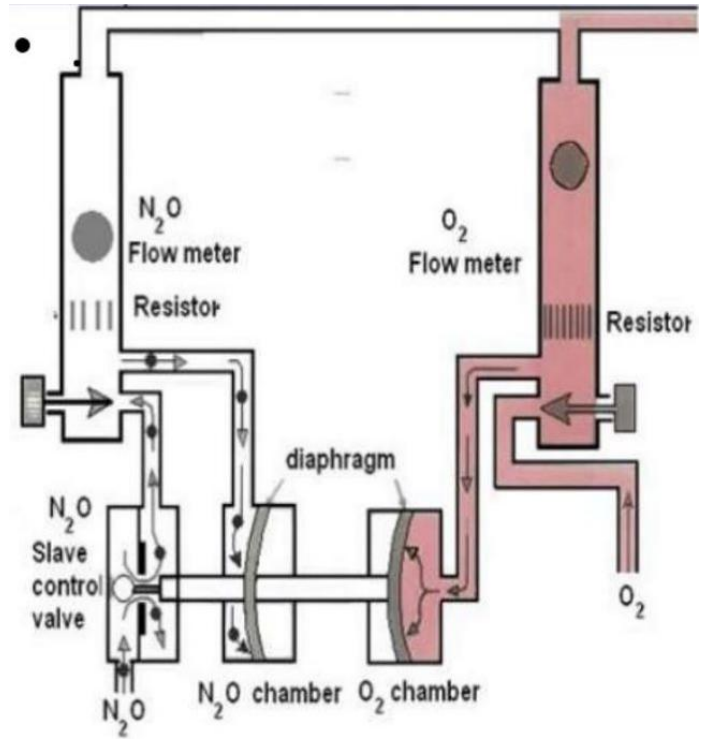
Intermediate Pressure System Safety Features

- **Diameter Index Safety System (DISS):** Non-interchangeable connectors for pipeline inlets prevent cross-connections.
- **Non-Interchangeable Screw Thread (NIST):** Ensures correct hose connections with unique diameters and threads.
- **Unidirectional Check Valves:** Prevent backflow of gases and maintain supply integrity.
- **Pipeline Pressure Gauges:** Monitor supply pressures to detect failures early.
- **Preferential Pipeline Utilization:** Machine prioritizes pipeline oxygen over cylinders when both are available



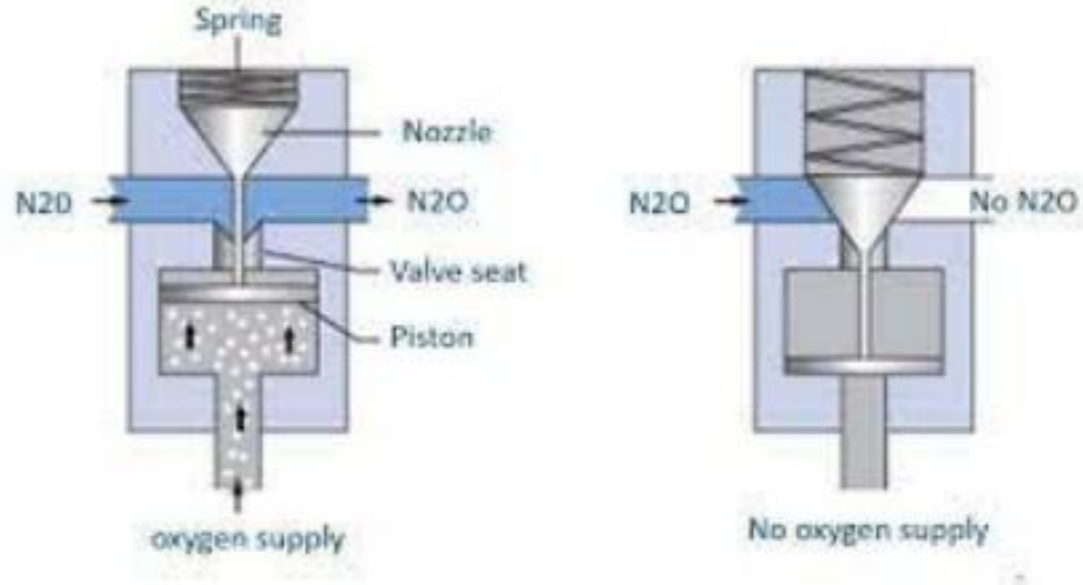
Low-Pressure System Safety Features

- **Flow Meters Arrangement:** Oxygen flow meter positioned at the extreme right (U.S. standard) and downstream to ensure delivery even with upstream leaks.
- **Touch-Coded Knobs:** Oxygen knob is fluted and larger for tactile identification, reducing errors.
- **Color-Coded Flow Meters:** Unique colors (e.g., green for oxygen) to prevent wrong adjustments.
- **Minimum Oxygen Flow:** Automatically delivers 50-250 ml/min of oxygen to prevent complete shutdown.



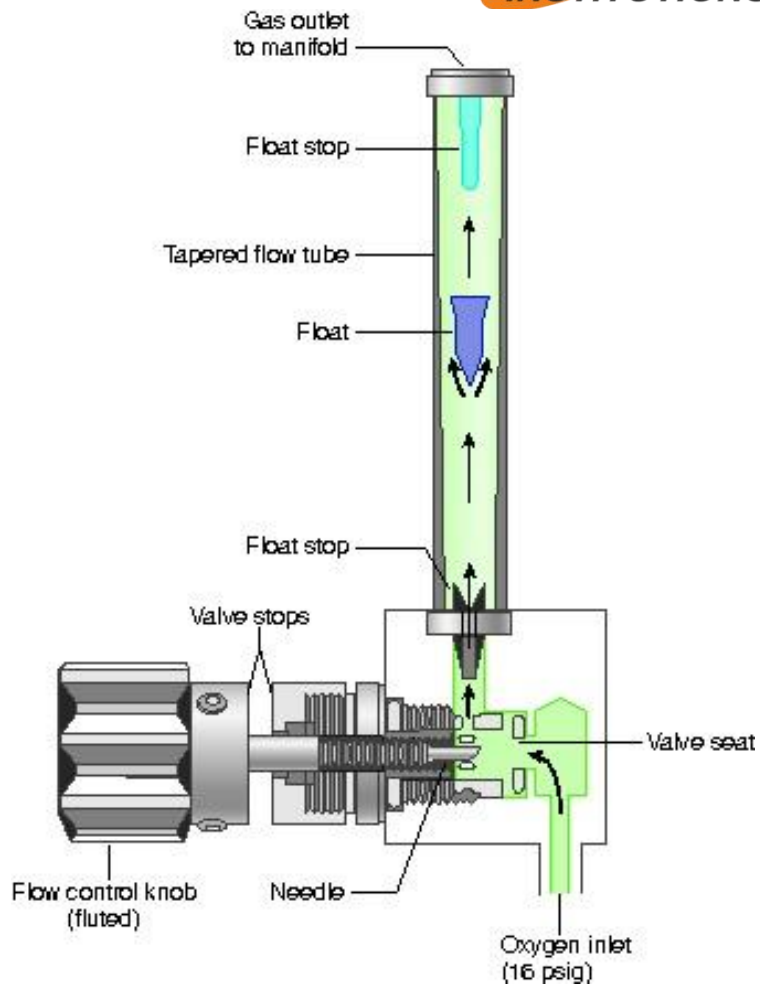
Oxygen Failure Protection Devices

- **Fail-Safe Valve:** Shuts off nitrous oxide and other gases if oxygen pressure drops below a threshold (e.g., 20-30 psi).
- **Oxygen Supply Failure Alarm:** Audible alarm activates within 5 seconds of low oxygen pressure; cannot be silenced permanently.
- **Pressure Sensor Shutoff Valve:** Part of the hypoxic guard, ensures no hypoxic mixtures are delivered.
- **Ritchie Whistle:** In older models, provides audible alert and gas cutoff.



Hypoxic Mixture Prevention

- **Proportioning Systems:** Mechanical or electronic linkages ensure nitrous oxide flow does not exceed 75% of oxygen flow, maintaining at least 21-25% oxygen.
- **Oxygen Ratio Monitor/Controller:** Alarms or adjusts flows to prevent hypoxic mixtures.
- **Oxygen Flush Valve:** Delivers 35-75 L/min of pure oxygen, bypassing vaporizers to avoid barotrauma; recessed to prevent accidental activation.
- **Single Oxygen Flow Control Knob:** Reduces risk of selecting wrong gas.

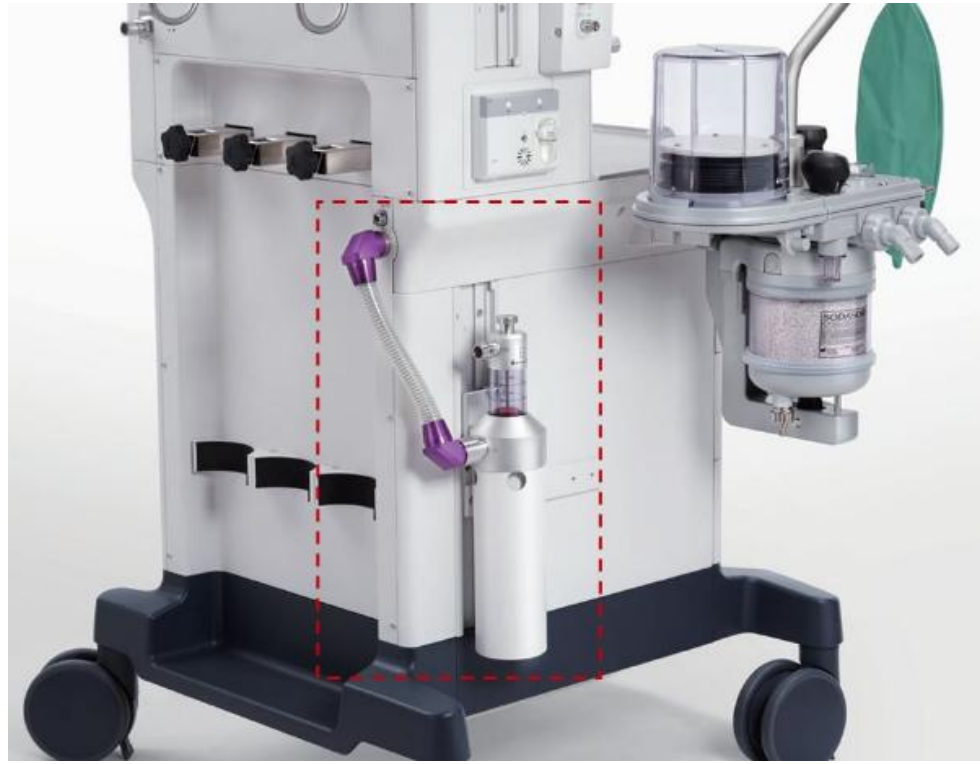


Vaporizer Safety Features

- **Interlock Systems:** Prevents simultaneous activation of multiple vaporizers, avoiding overdose.
- **Keyed Filling Systems:** Agent-specific adapters and color-coded bottles prevent filling with wrong anesthetic (e.g., isoflurane: purple).
- **Pressure Relief at Common Gas Outlet (CGO):** Protects against over-pressurization.
- **Transport Settings:** Locks vaporizers to prevent spillage during movement.

Scavenging Systems

- **Distinct Connections:** 30 mm fittings (different from 15/22 mm breathing circuit) to avoid misconnections.
- **Pressure Relief Valves:** Negative for active systems, positive for passive, to prevent dangerous pressures.
- **Kink-Resistant Tubing:** Ensures reliable waste gas removal.
- **OSHA Guidelines**: Limits exposure to waste anesthetic gases, with leak-free designs mandatory.

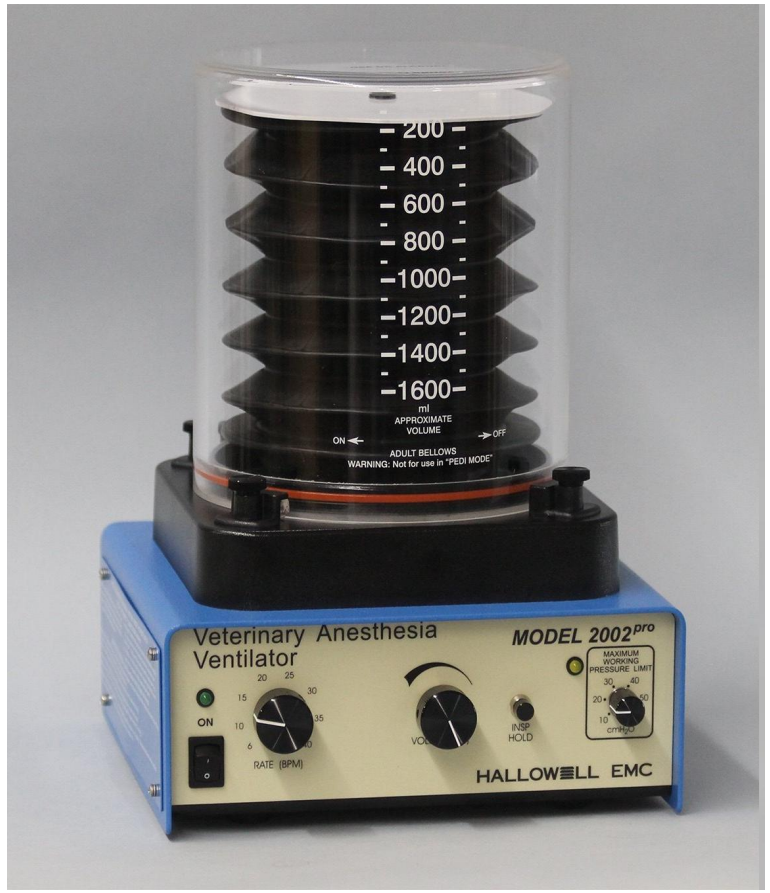


Monitoring and Alarms

- **Oxygen Concentration Monitor:** Measures FiO2 with low alarms (≥21%); requires calibration.
- **Airway Pressure Monitors:** High/low alarms for disconnections or blockages.
- **Spirometers and Capnography**: Detect disconnections via volume or CO2 monitoring.
- **Carbon Dioxide Apnea Alarm**: Cannot be disabled during ventilation.

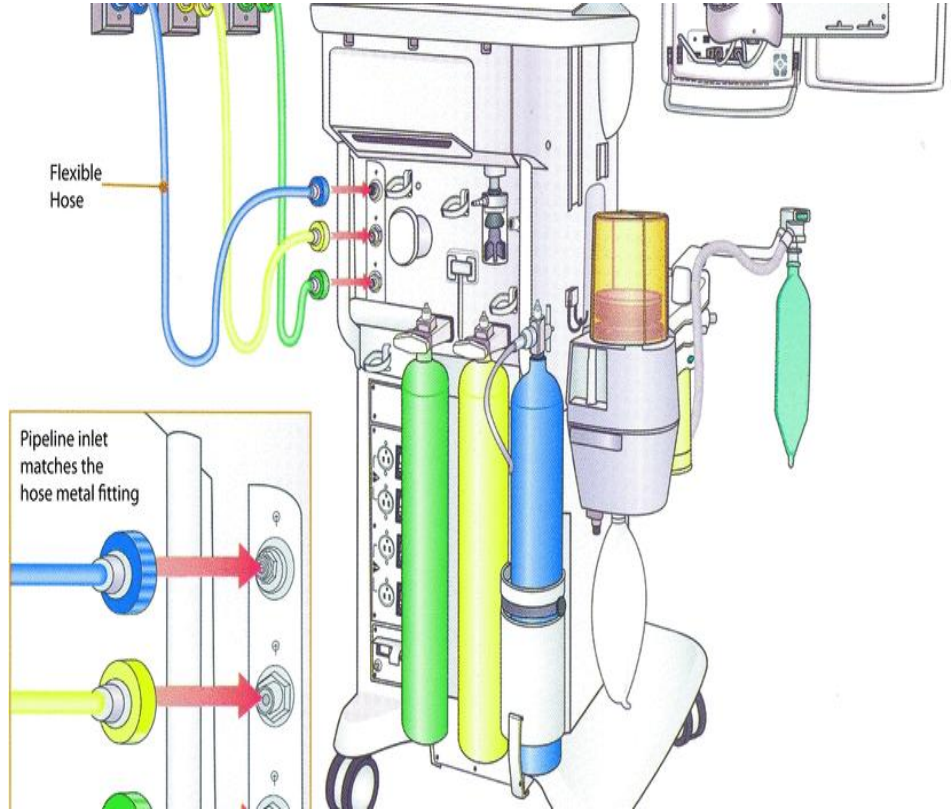
Ventilator Safety Features

- **Ascending Bellows Design:** Collapses on disconnection, providing visual cue.
- **Fresh Gas Decoupling:** Prevents volutrauma by isolating fresh gas flow from tidal volume.
- **Reservoir Bag in Circuit:** Visual confirmation of ventilation during mechanical modes.
- **Battery Backup:** At least 45-90 minutes of operation during power failure.



Modern Advanced Features

- **Computerized Self-Checkout**: Automatic pre-use checks; limited bypasses in emergencies.
- **Microprocessor-Controlled Gas Flow:** Digital displays for precise control.
- **Stand-Alone Mechanical Flow Meter:** Backup in case of electronic failure.
- **Ambient Oxygen Function:** Allows operation without pipeline or cylinder oxygen in piston ventilators.



Pre-Use Checkout Importance

- **Recommended by ASA and AAGBI:** Verify all systems before each use to prevent equipment-related incidents.
- Checks include: Gas supplies, flow meters, vaporizers, breathing circuit integrity, alarms, and scavenging.
- **Historical Context:** 72/3791 ASA claims (1962-1991) linked to equipment misuse, emphasizing user vigilance.
- **Obsolescence Criteria:** Machines lacking PISS, alarms, or interlocks should be replaced.

Summary

- Gas supply safety features like PISS and DISS prevent misconnections and ensure correct gas delivery.
- Hypoxia prevention through fail-safe valves, proportioning systems, and oxygen monitors safeguards against low oxygen mixtures.
- Alarms and monitoring (e.g., oxygen failure alarms, apnea alarms) provide timely alerts to potential issues.
- Vaporizer and ventilator interlocks reduce risks of overdose, disconnection, or volutrauma.
- Scavenging and pre-use checks protect both patients and staff from waste gases and equipment failures.

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