## *The Humphrey ADE breathing system*

This is a very versatile breathing system which combines the advantages of the Mapleson ***A, D and E*** systems. It can therefore be used efficiently for ***spontaneous*** and ***controlled*** ventilation in both ***adults*** and ***children***. The mode of use is determined by the position of one ***lever*** which is mounted on the ***Humphrey block***

### *Components*

1. Two lengths of 15-mm smooth-bore ***tubing*** .One delivers the ***fresh gas*** and the other carries away the ***exhaled gas***. Distally they are connected to a ***Y-connection*** leading to the patient. Proximally they are ***connected to the Humphrey block.***

2. The ***Humphrey block is at the machine end*** and consists of

an ***APL valve*** featuring a visible indicator of valve performance

b.***2-L reservoir bag***

c.***lever*** to select either spontaneous or controlled ventilation

d.***port*** to which a ***ventilator*** can be connected. a ***safety pressure relief valve***

which opens at pressure in excess of ***60 cm H2O***. a modified design incorporating

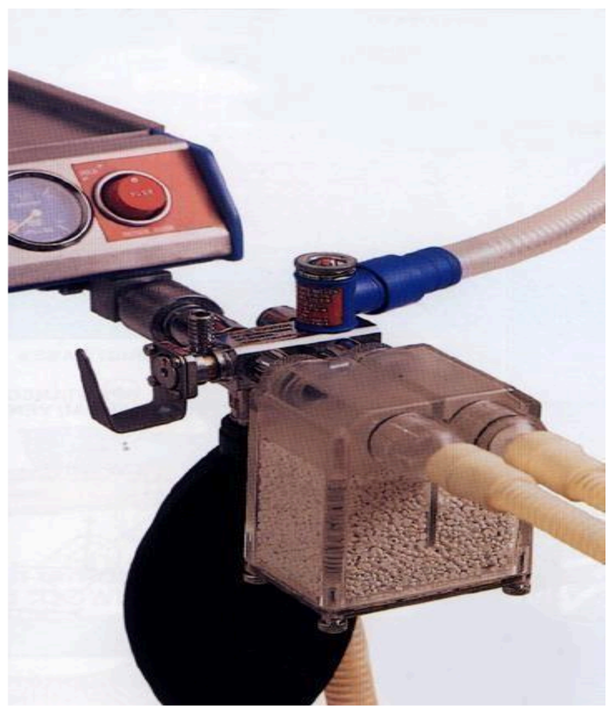
a soda lime canister.

*Some important notes*

***1. During spontaneous ventilation*** With the ***lever up in the spontaneous mode***, the ***reservoir bag and APL valve are connected*** to the breathing system as in the Magill system.

***2. During controlled ventilation***

With the ***lever down*** in the ***ventilator mode***, the ***reservoir bag and the APL valve are isolated*** from the breathing system as in the Mapleson E system. The expiratory tubing carry the exhaled gas via the ventilator port. Scavenging occurs at the ***ventilator's expiratory valve***.



***Soda lime and the circle breathing system*** Over 80% of the anesthetic gases are wasted when FGF of 5 L/min is used. Typically, the reduction of FGF from 3 L/min. to 1 L/min results in a saving of about 50% of the total consumption of any volatile anesthetic agent. In this breathing system, soda lime is used to absorb the patient's exhaled carbon dioxide. FGF requirements are low, making the circle system very efficient and causing minimal pollution. As a result, there has been renewed interest in low-flow anesthesia due to the cost of new, expensive inhalational agents, together with the increased awareness of the pollution caused by the inhalational agents themselves.

***Depending on the FGF, the system can be one of the following:***

- ***Closed circle anesthesia.*** The FGF is just sufficient to replace the volume of gas and vapour taken up by the patient. No gas leaves via the APL valve and the exhaled gases are rebreathed after carbon dioxide is absorbed. Leaks from the breathing system should be eliminated. In practice, this is possible only if the gases sampled by the gas analyser are returned back to the system.

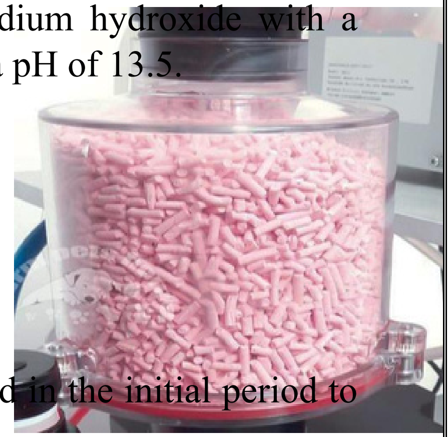
- ***Minimal-flow anesthesia.*** The FGF is reduced to 0.5 L/min.

- ***Low-flow anesthesia.*** The FGF used is less than the patient's alveolar ventilation (usually below 1.5 L/min). Excess gases leave the system via the APL valve.

***Components***

1. A vertically positioned ***canister*** containing ***soda lime***. The canister has two ports, one to deliver inspired gases to the patient and the other to receive exhaled gases from the patient.
2. Inspiratory and expiratory tubings connected to the canister. Each port incorporates a ***unidirectional valve*** .
3. FGF from the anaesthetic machine is positioned ***distal to the soda lime*** canister, but proximal to the inspiratory valve .
4. An ***APL valve*** is positioned ***between the expiratory valve and canister*** and connected to a 2-L reservoir bag.

5. ***Soda lime*** consists of 94%calcium hydroxide and 5%sodium hydroxide with a small amount of potassium hydroxide(less than 0.1%). It has a pH of 13.5.



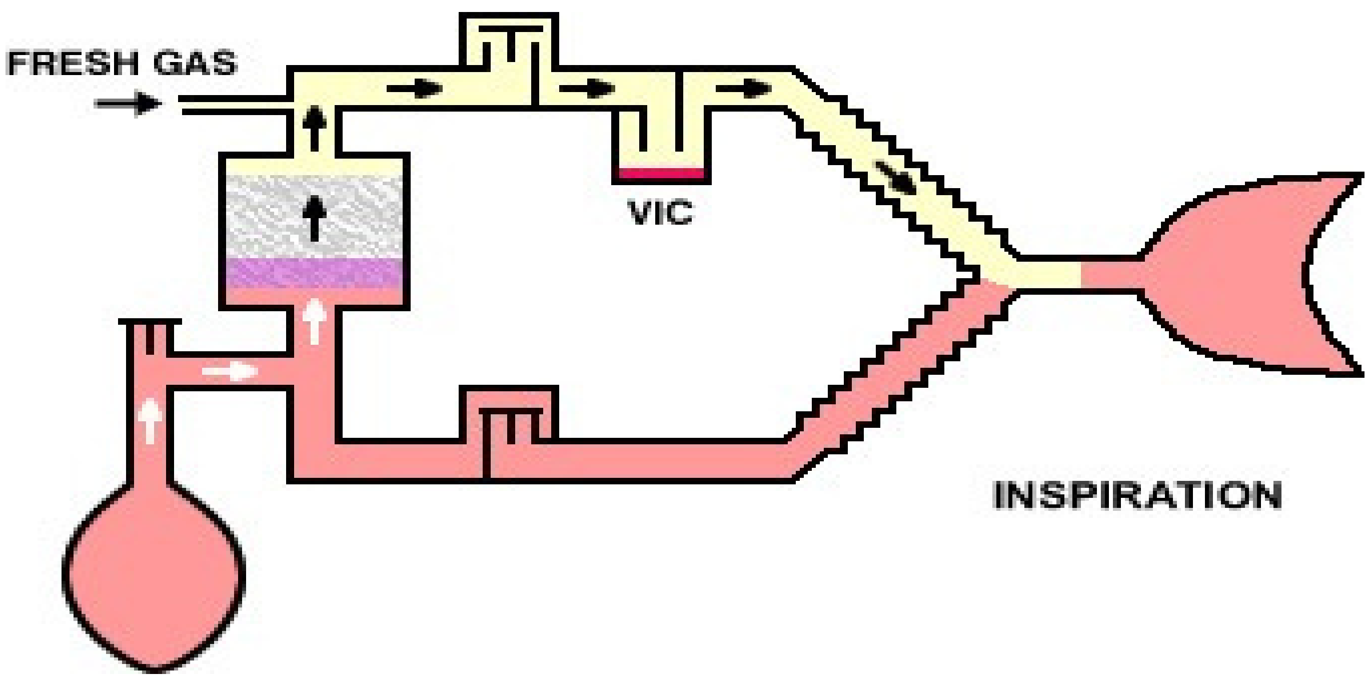
👉👉👉 A ***dye*** or ***color indicator*** is added to change the granules' color when the soda lime is ***exhausted***. Color changes can be from ***white to violet/purple***(ethyl violet dye), from ***pink to white*** (titan yellow dye) or from ***green to violet.*** Colour changes occur when the ***pH is less than 10***

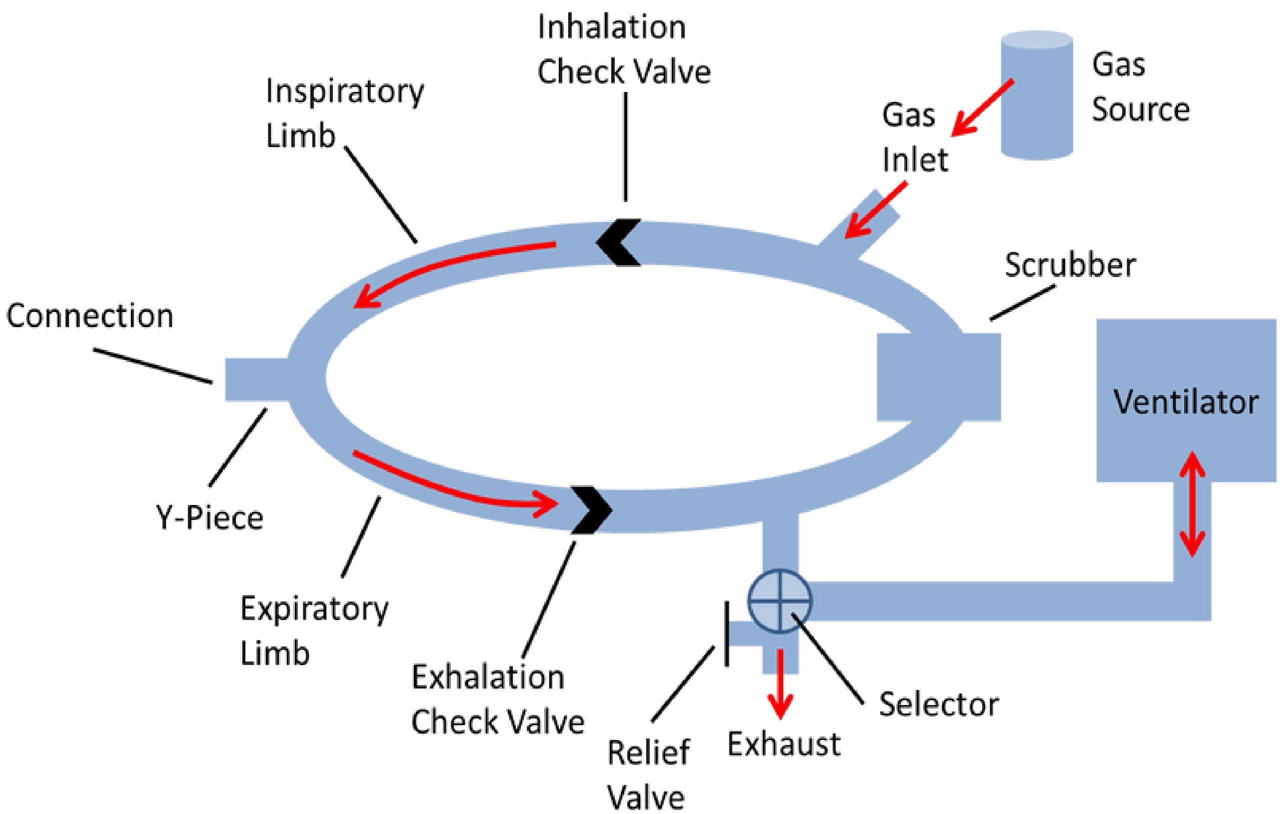
***Mechanism of action*** 1- High FGF of several L/min is needed in the initial period to ***denitrogenate*** the circle system and the functional residual capacity (FRC). This is important to avoid the ***buildup of unacceptable levels of nitrogen*** in the system. In closed circle anesthesia, a high FGF is needed for up to 15 minutes.

2- ***Exhaled gases are circled back to the canister*** , where carbon dioxide absorption takes place and ***water*** and ***heat*** (exothermic reaction) are produced. The ***warmed*** and ***humidified*** gas joins the FGF to be delivered to the patient.

3- The canister is positioned ***vertically*** to prevent exhaled gas passaging through unfilled portions

4- The circle system can be used for both ***spontaneous*** and ***controlled*** ventilation.




Inhalation
Check Valve
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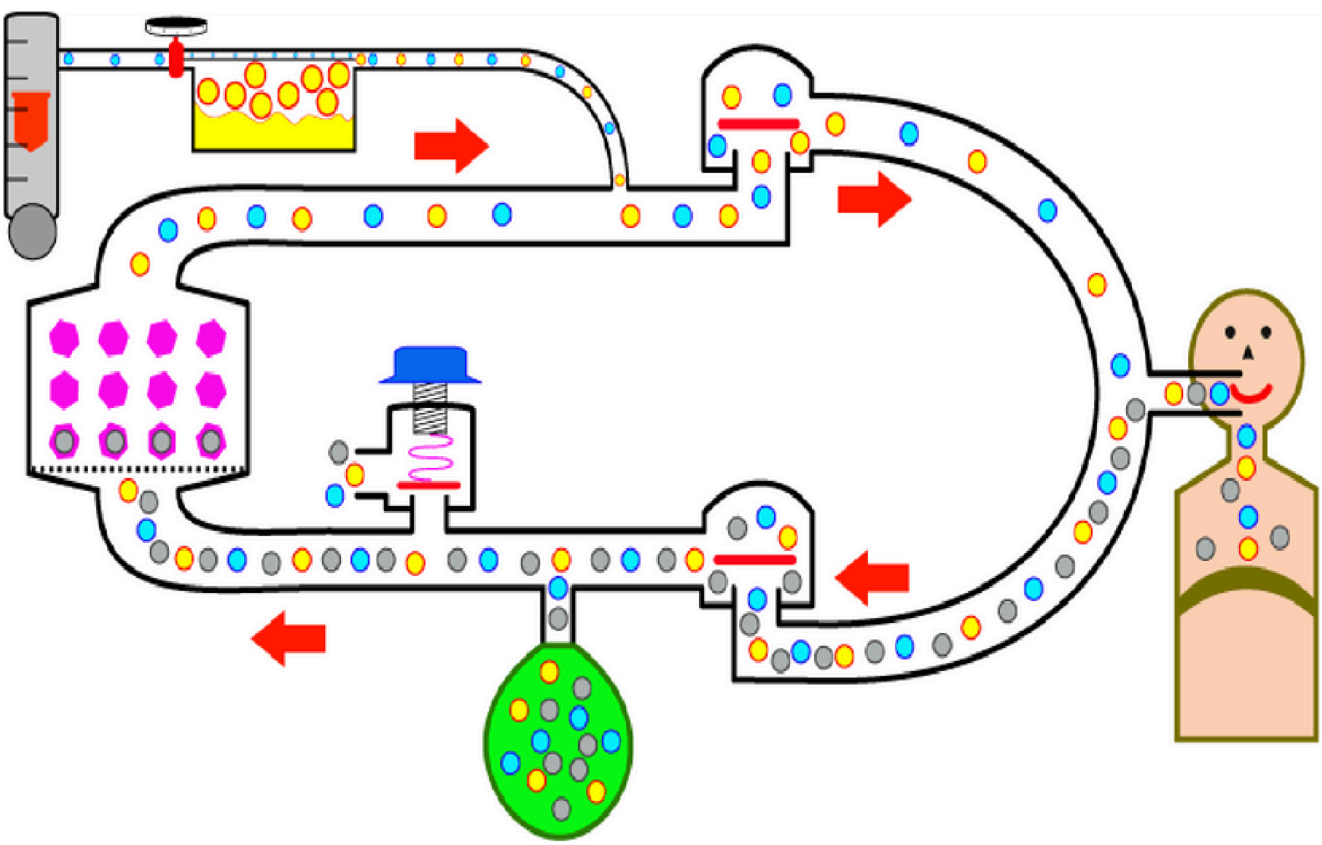

***Problems in practice and safety features***

1. Adequate monitoring of inspired oxygen, end-tidal carbon dioxide and inhalational agent concentrations is essential and mandatory.

2. The unidirectional valves may stick and fail to close because of water vapour condensation.

3. The resistance to breathing is increased during spontaneous ventilation due to the unidirectional valves.

4. Compound A is produced when sevoflurane is used in conjunction with soda lime. This is due to the degradation of sevoflurane.

5. Uneven filling of the canister with soda lime leads to passage of gases .

6. The circle system is big, less portable and more difficult to clean.

7. Soda lime is corrosive. So clothing, gloves and eye/face protection can be used.

8. Because of the many connections, there is an increased in leaks and disconnection.

***Breathing System Check Procedure***

Checking a breathing system involves a systematic approach to ensure functionality, typically starting with a high-pressure leak check and a low-pressure check.

***Key steps*** include verifying the oxygen supply, checking the anesthetic circuit, testing the ventilator, and ensuring all valves and soda lime are functional, ideally performing these checks before every patient.

High-Pressure Leak Test:

1. Connect the oxygen pipeline or turn on the cylinder.

2. Close the APL (Adjustable Pressure Limiting) valve entirely.

3. Occlude the patient end of the circuit (e.g., with a 5ml syringe plunger or red adapter).

4. Press the oxygen flush button to fill the circuit and check for a stable pressure gauge reading (usually up to 30cmH2O).

5. Confirm the pressure holds, indicating no leaks.

Low-Pressure Check & Circuit Check:

1. Ensure the oxygen flowmeter is working and the bobbin moves freely.

2. Check all hoses for cracks, leaks, or proper connections.

3. Verify the soda lime canister (if used) is not exhausted (no color change) and check that the unidirectional valves (inspiratory/expiratory) move correctly.

Finalizing the Check:

Open the APL valve to the fully open position for spontaneous breathing and Remove the occlusion from the patient end and ensure the bag is attached and the ventilator is connected