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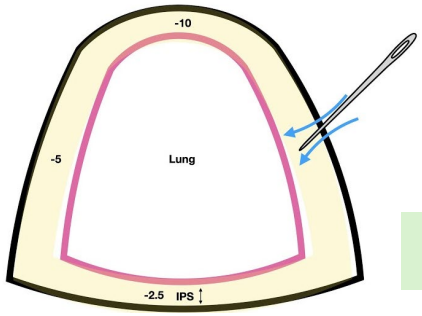
AKCİĞER SAĞLIĞI KONGRESİ
25-28 MART 2026
Sueno Deluxe Hotel, Belek/Antalya
Sizin Sesiniz, Sizin Kongreniz...
ASYOD
AKCİĞER SAĞLIĞI VE YOĞUN BAKIM DERNEĞİ

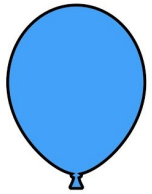
Mekanik Ventilasyon Cihazı: Devre, Ekipman ve Kurulum

Dr Davut AYDIN

KTÜ Tıp fakültesi, Göğüs Hastalıkları ABD, Yoğun Bakım BD

Mekanik ventilatör





$P_{TP}=P_A-P_{PL}$

‘’Enerjiyi bir sürüş mekanizması aracılığıyla basınca dönüştürerek, önceden belirlenen şekilde hastanın solunum kaslarınını destekleyen veya onların yerini alan otomatik bir makinedir.”

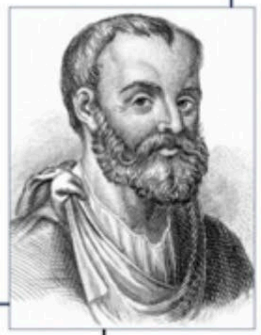
Robert L. Chatburn

Ancient Egypt

The Ebers Papyrus describes insertion of reeds into the windpipe to maintain airway patency

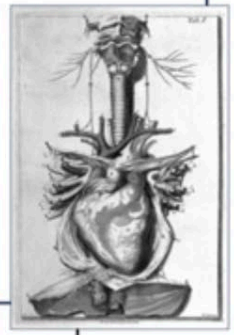
Ancient Rome

Galen's reports of pulmonary gas exchange laid the foundations for modern physiology



Renaissance

Servetus' and Harvey's studies ascertained the structure and function of the cardio-respiratory circulation



Polio epidemic

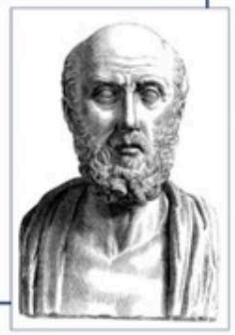
The negative pressure tank ventilator, or "iron lung" was rapidly implemented at scale to support polio patients

1550 | 450 | 129 | 1543 | 1728 | 1939 | 1955 | 2023

BCE | CE

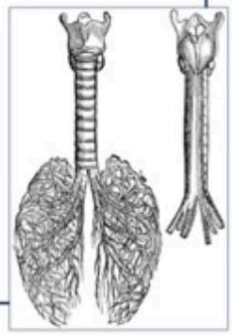
Ancient Greece

The Hippocratic Corpus and Plato provide early descriptions of a cardio-pulmonary system



Renaissance

Vesalius undertook experimentation of positive pressure tracheostomy ventilation to sustain life in an animal model



Polio epidemic

A range of negative pressure ventilators developed in the mid-20th century

21st Century

Positive pressure home ventilation began in the late 20th century. Ventilators are now compact, portable and a range of interfaces are available

D'Cruz R, 2024

1.Jenerasyon

- (1940-1970)
- Mekanik/ pnömotik
- Sadece VC
- I/E oranı sabit
- Hasta tetiklemesi (-)
- PEEP (-)

2. Jenerasyon

- (1970-1980)
- PC/PS eklendi
- Hasta tetiklemesi
- PEEP klinik pratiğe yerleşti
- Temel sensörler
- Alarm sistemleri
- TV ve frekans monitörizasyonu

3. Jenerasyon

- (1980-1990)
- Mikroişlemci (+)
- Dalga formları
- Gelişmiş alarm ve monitörizasyon
- SIMV,APRV,MMV …
- VILI/VALI kavramı

4. Jenerasyon

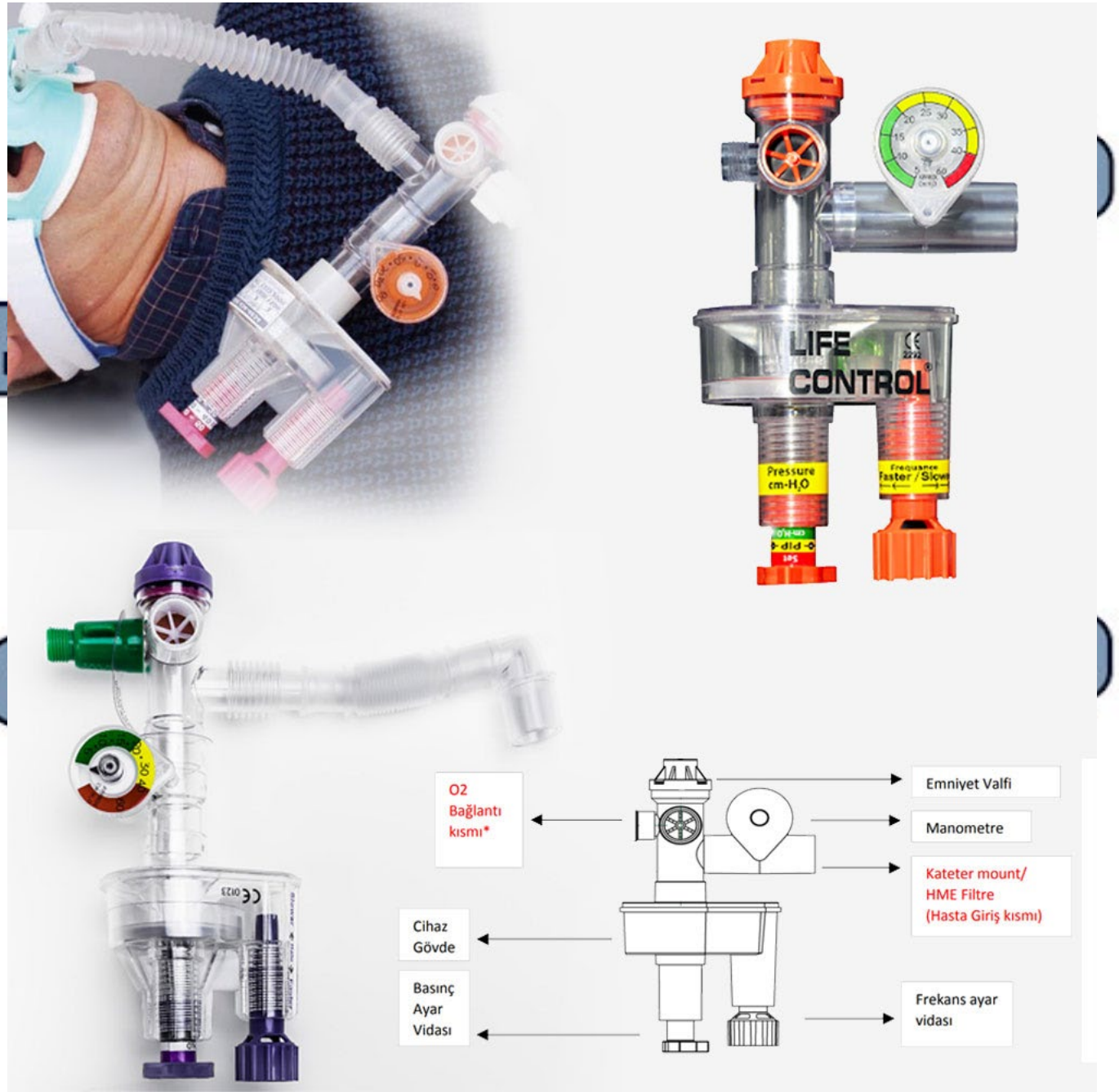
- (1990-Günümüz)
- YB, homecare, NIV, transport
- Çoklu monitörizasyon
- Trend analizi
- ASV, PAV, SmartCare, NAVA …
- PEEP titrasyonu
- Transpulmoner basınç
- FRC ölçümü
- HFOT entegrasyonu

MV çeşitleri

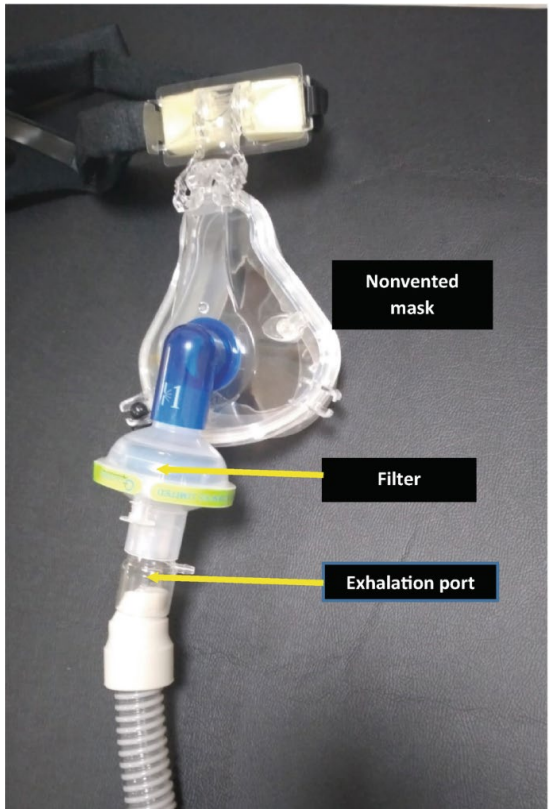
- **Güç kaynağına göre:** pnömotik, kombine (pnömotik + elektrik)
- **Basınç uygulama şekline göre:** negatif basınçlı, pozitif basınçlı, kombine
- **Kullanım amacı ve yerine göre:** yoğun bakım, anestezi, transport, ev tipi, NIMV

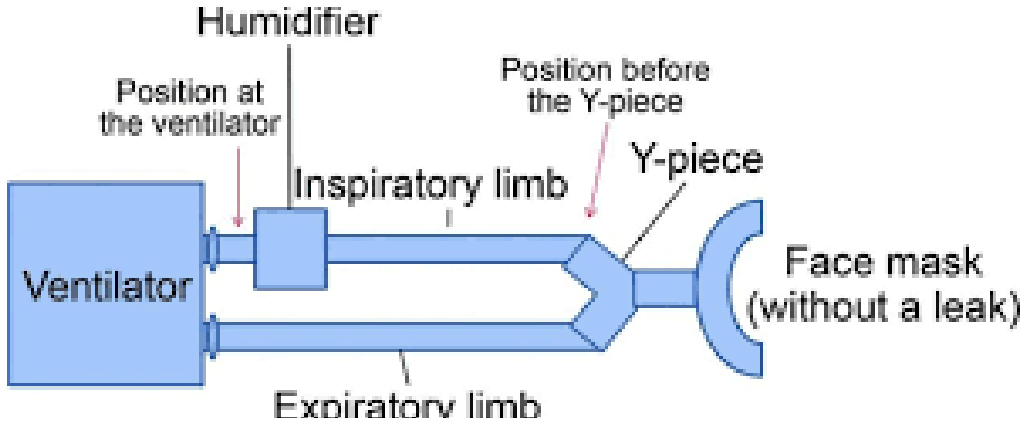
Balon Valv Mask

Transport Ventilators



Non-Invazive Mechanic Ventilators





Kaçak toleransı 60 lt/dk'ya kadar
Otomatik kompanzasyon

ICU Ventilators

Pnömatik Yapı

Gaz Sistemi

- Gaz Girisleri
- Inspiratuvar & Ekspiratuvar Valfler
- Hortumlar

Elektriksel Yapı

Enerji Sistemi

- Güç Kaynağı
- Batarya
- UPS

Elektronik Yapı

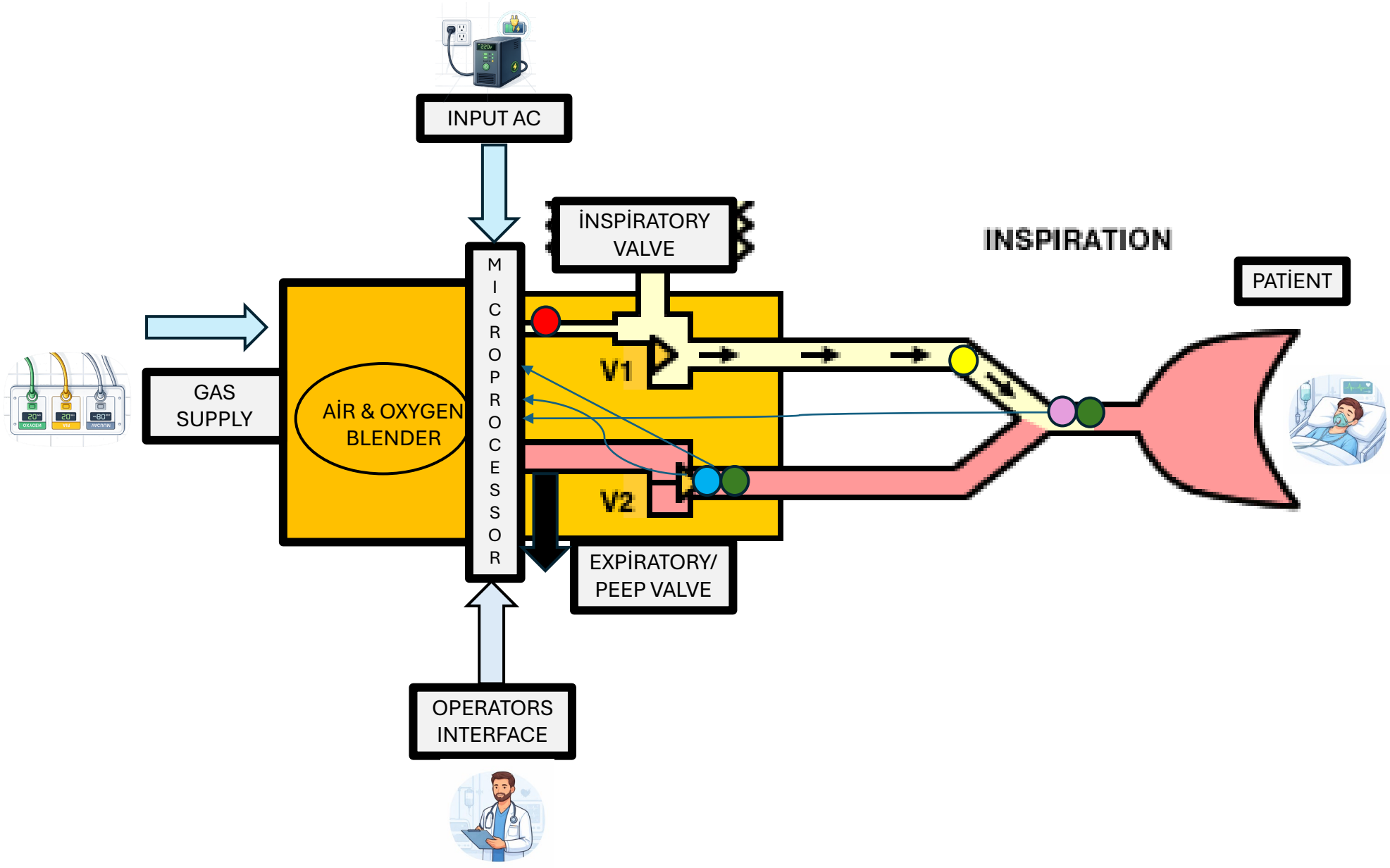
Kontrol Sistemi

- Mikroişlemci
- Sensörler
- Kontrol Karti

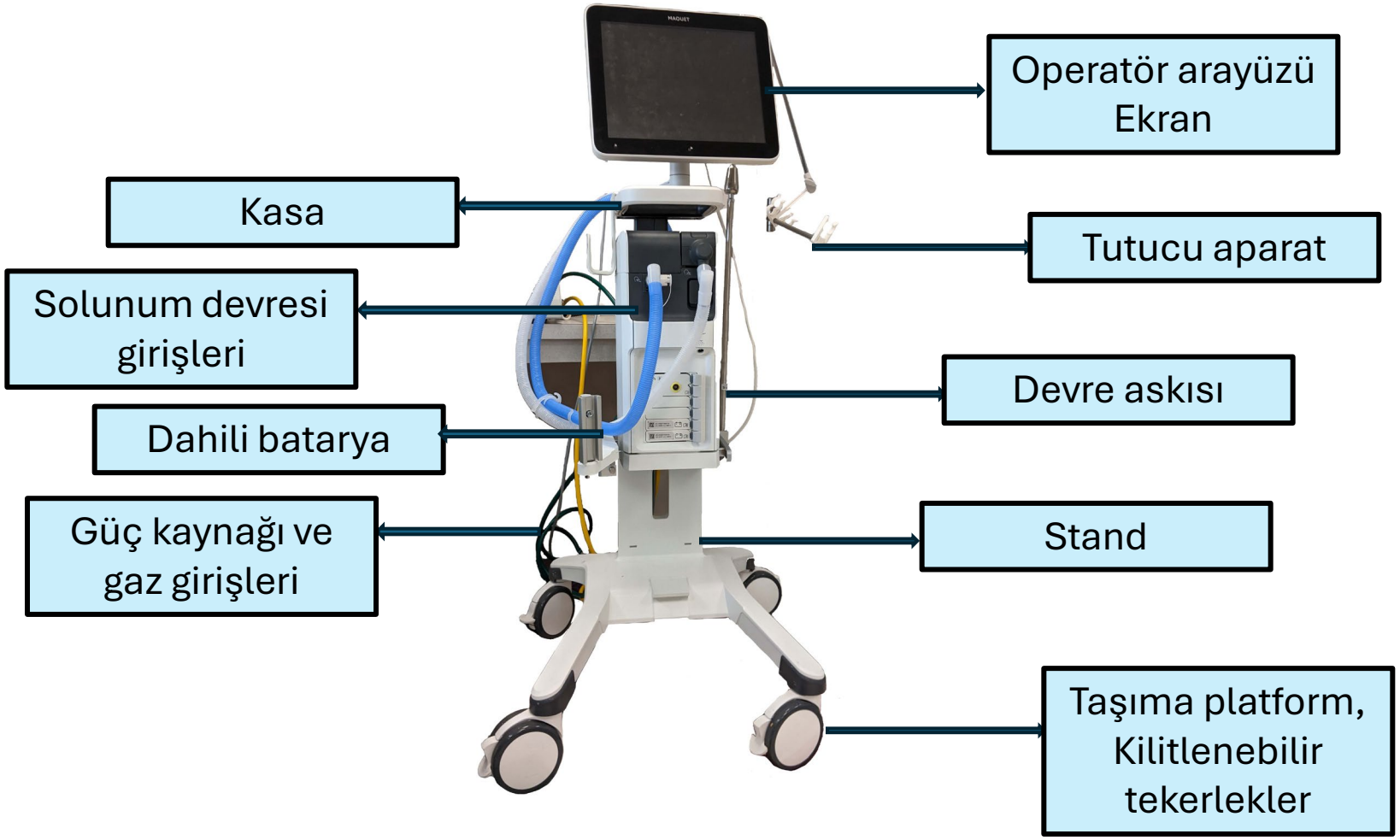
Mekanik Yapı

Fiziksel Yapı

- Şasi & Kasa
- Taşıma Platformu
- Tekerlekler


INPUT AC
İNSPİRATORY VALVE
INSPIRATION
PATİENT
GAS SUPPLY
AİR & OXYGEN BLENDER
MICROPROCESSOR
V1
V2
EXPİRATORY/ PEEP VALVE
OPERATORS INTERFACE

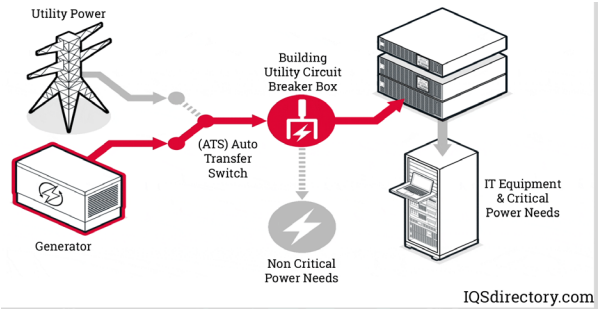
Mekanik yapı



Kasa
→ Çelik,
→ Alüminyum alaşım,
→ Polikarbonat (PC)
→ Akrilonitril Bütadien Stiren (ABS)

Elektrik yapı

- 220 volt 50 Hz şebeke elektriği, AC
- Kesintisiz güç kaynağı (UPS),
- AC→DC
- Batarya, DC
- Mikroişlemci, elektronik devreler, alarm sistemleri, kullanıcı arayüzü…vb için harcanır



Elektronik yapı

- **<u>Mikroişlemci : MSS</u>**

➢Sensörlerden veri toplama

➢Ayarlara uygun ventilasyon algoritmasını çalıştırma

➢Valfleri ve türbinleri kontrol etme

➢Alarm üretme

- **<u>PCB (Printed Circuit Board) elektronik kart :</u>**

➢Elektronik bileşenleri birbirine bağlama

➢Power pin, giriş-çıkış pinleri, sinyal pinleri, kontrol pinleri

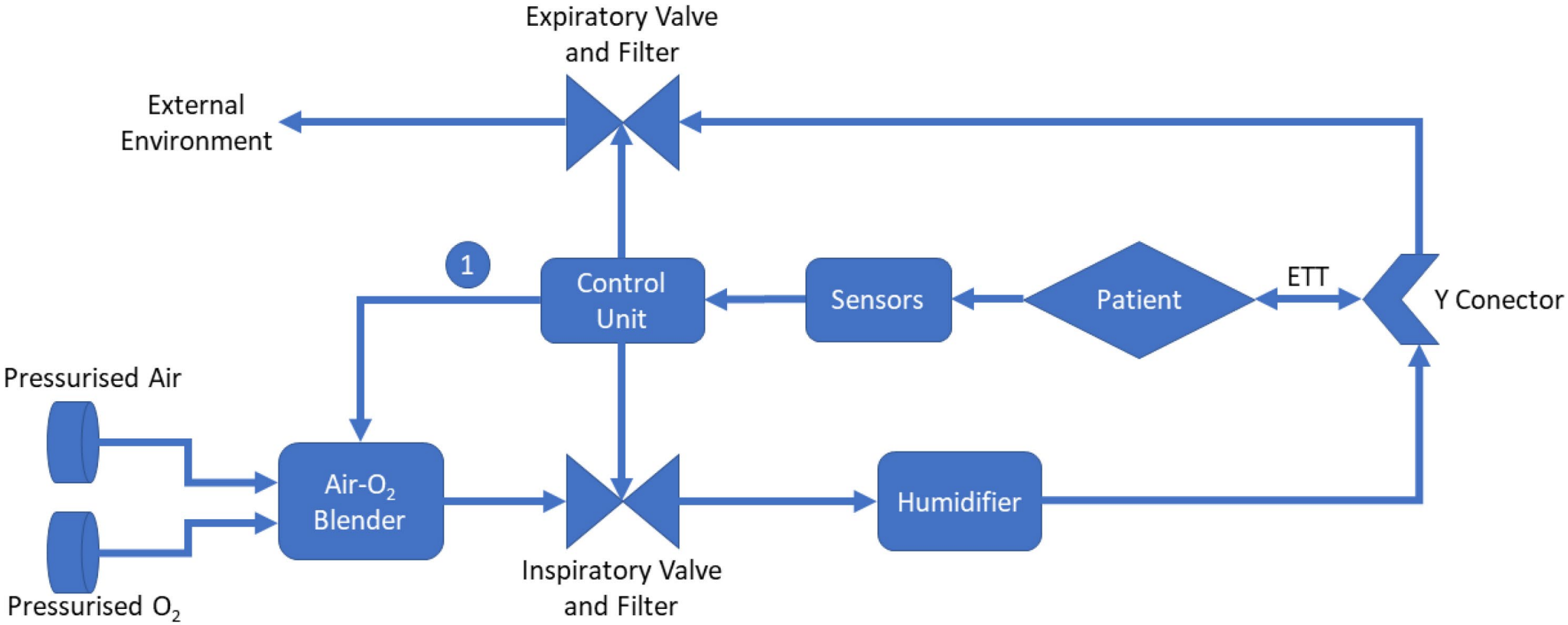
<u>Sensörler : duyu organları</u>

➢O_2, akış, basınç, sıcaklık, $ETCO_2$

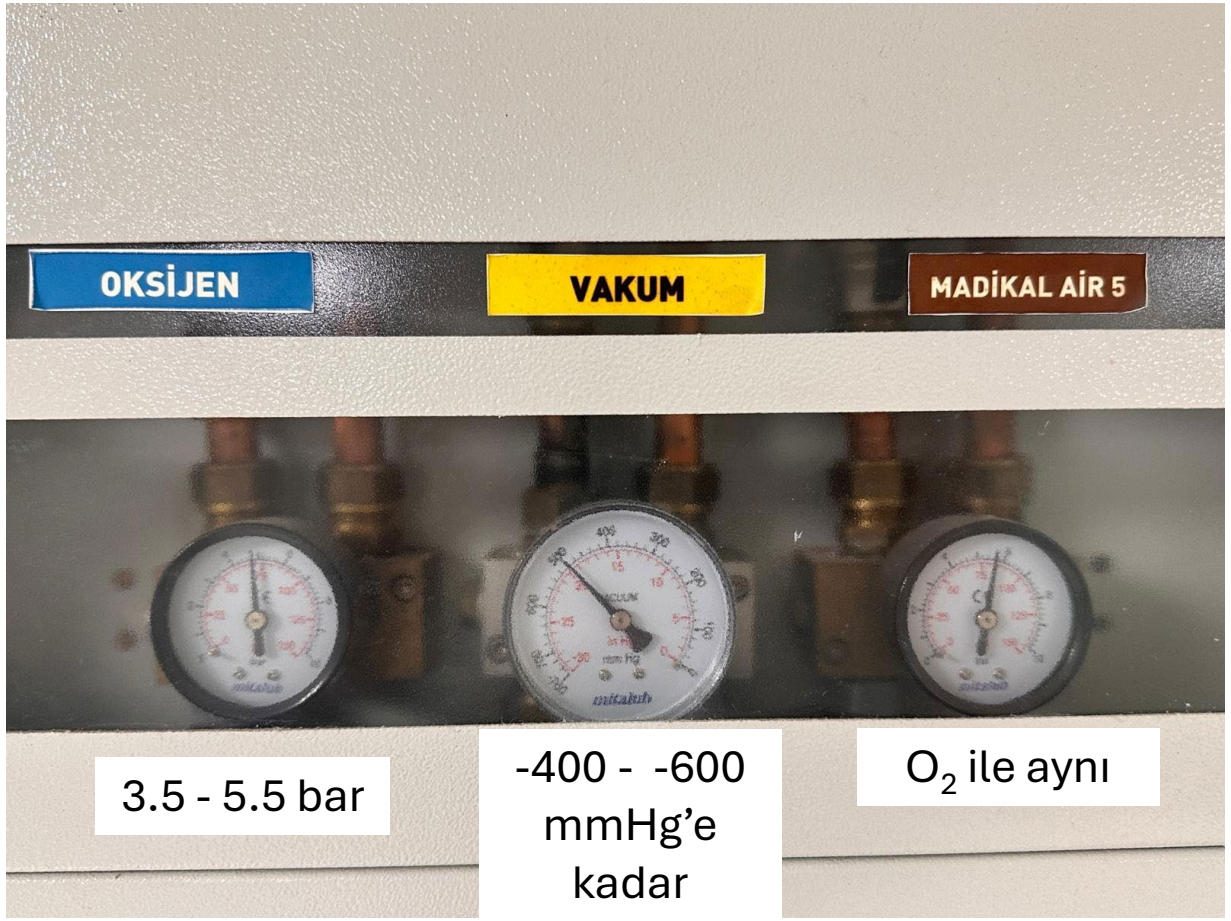
<u>Kontrol devreleri : motor organlar</u>

➢Valfler, türbinler

Pnömatik yapı



Gaz kaynağı



3.5 - 5.5 bar

-400 - -600 mmHg'e kadar

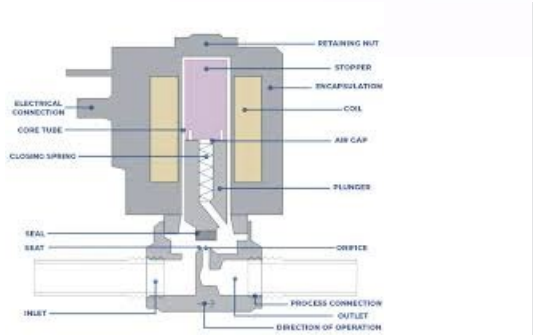
O_2 ile aynı

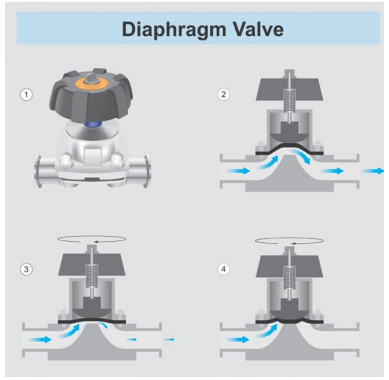
Vakum- Aspirasyon
-100 - -300 mmHg

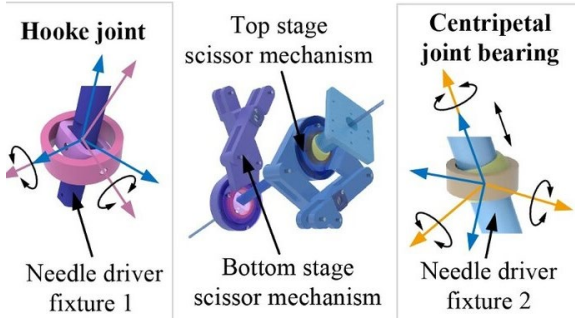
Medikal hava

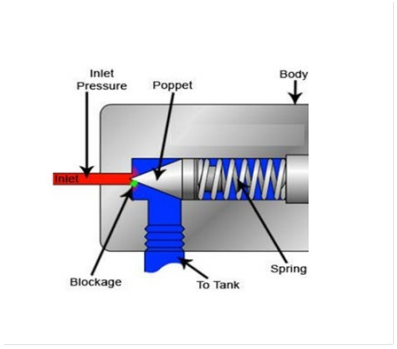
Oksijen

Valfler





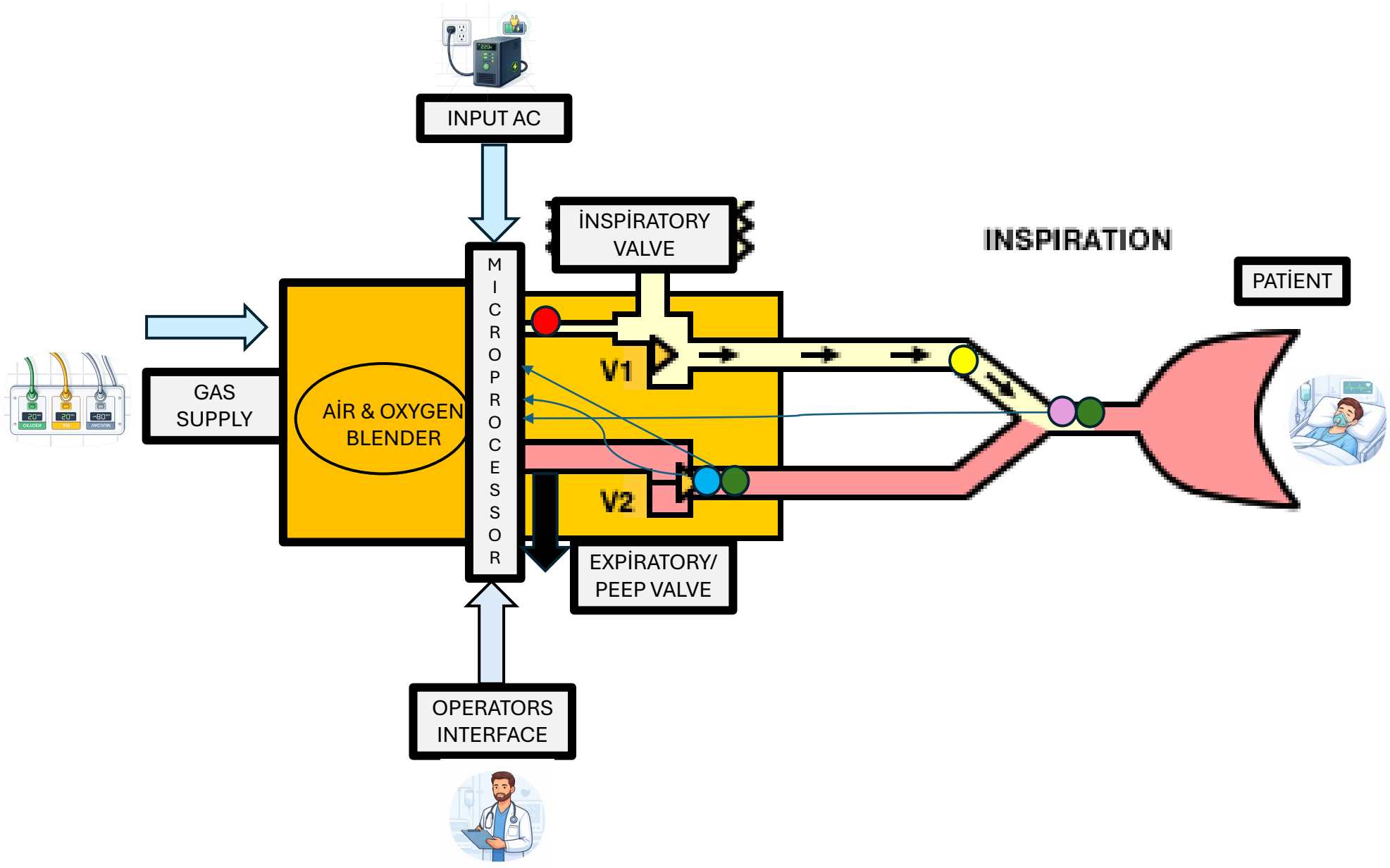




- Mikroişlemci kontrolü gerekir
- İnspirasyon ve ekspirasyon valfi
- PEEP/CPAP ekspirasyon valfi ile sağlanır
- Valfe yakın distal sensörlerden gelen verilerle kontrol edilir
- Ekspiratuvar valfler : mantar, diyafram, makas, solenoid (elektronik)
- İnspiratuvar valfler : solenoid

Sensörler

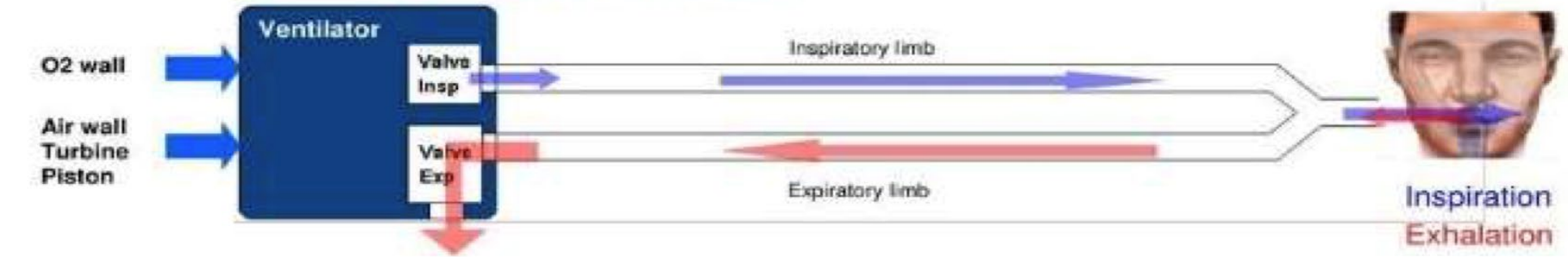
- Cihaz ve hastadan mikroişlemciye feedback
- **Basınç sensörü:** Paw, Pplateu, Ppeak,PEEP
- **Akış sensörü:** İnspiratuvar ve ekspiratuvar akım ölçülür,
  TV ve MV hesaplanır
- **O2 sensörü:** FiO_2 ölçülür, gaz karışımı doğrulanır
- **Sıcaklık**
- **$ETCO_2$**


INPUT AC
İNSPİRATORY VALVE
INSPIRATION
PATİENT
GAS SUPPLY
AİR & OXYGEN BLENDER
MICROPROCESSOR
V1
V2
EXPİRATORY/ PEEP VALVE
OPERATORS INTERFACE

Ventilators & patient circuit type

Different technologies used in mechanical ventilation (IV & NIV)

Dual limb system with proportional expiratory valve



Single limb system with proximal expiratory valve

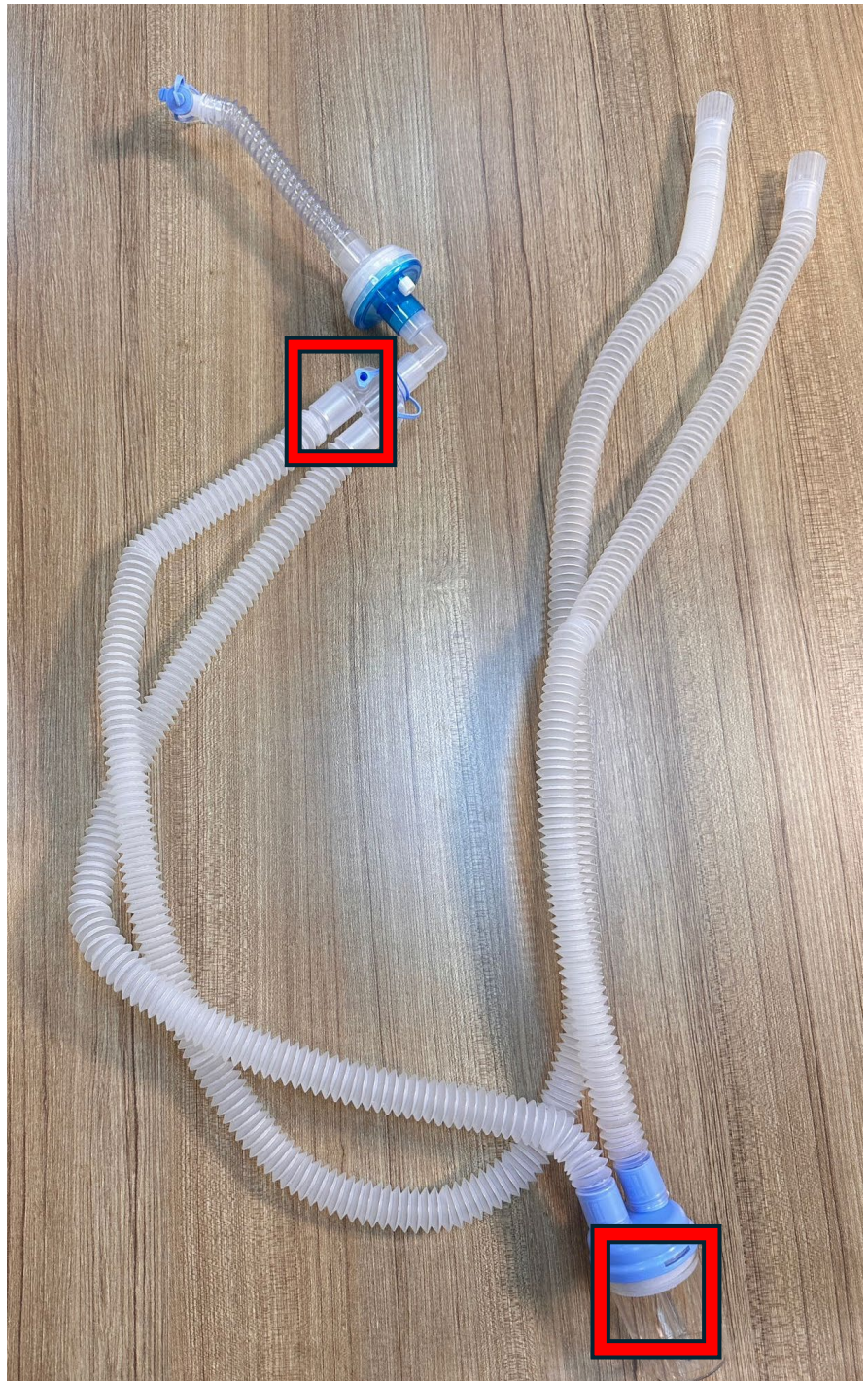
Single limb system with intentional expiratory leak

Devreler

- Propilen, Polietilen, PVC
- Hafif, basit oluklu yapı

  (kink direnci & esneklik & kollapsın önlenmesi)

  ↓direnç, ↓kompliyans
- Gaz geçirmeyen
- Disposable (steril ambalaj)
- Biologically inert

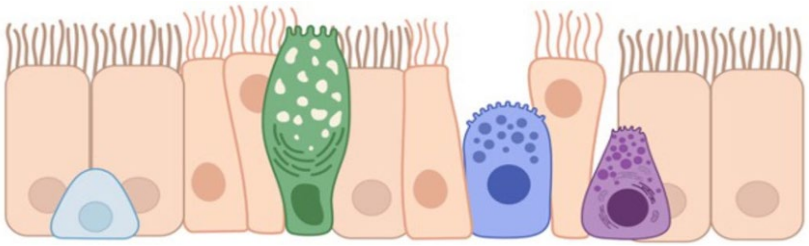


Devreler

- İç çap (ISO): erişkin → 22 mm
  pediatrik → 15 mm
  neonatal → 10-12 mm
- Konnektörler de 22 mm ile uyumlu olmalı

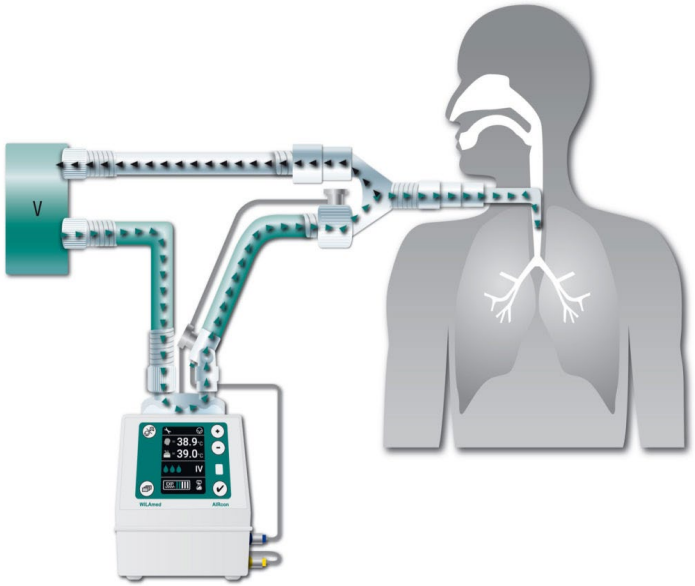
- Her kolun uzunluğu: erişkin → 1.5-1.8 m
- Çift kolun toplam devre hacmi: 1100-1400 ml
- İnspiratuvar kolda yaklaşık: 550-700 ml ölü boşluk

Humidifikasyon



Psödostratifiye siliyalı solunum epiteli

Haitham S, 2014



Hidrofobik membran

tylene)

fluoride)

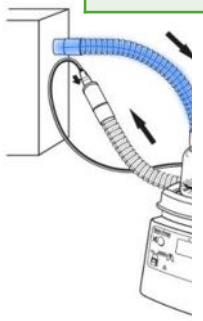
nponent

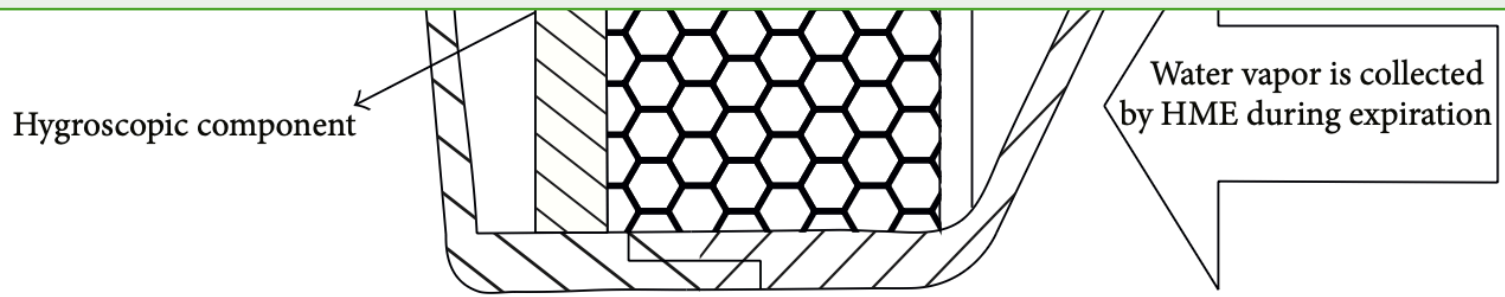
Isı

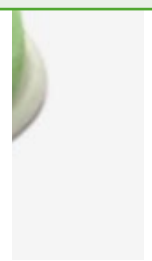
ma (+)

HH ek direnç -	HME/HMEF direnç ve ölü boşluk↑
➢ VIP riski? ➢ Koyu visköz sekresyonu olan hastalar ➢ Zor ventile edilen hasta (ARDS, otoPEEP olan ağır bronkospazmı ve hiperkapnisi olan hastalar) ➢ Hipotermik hasta	➢ Yoğun bakımda erken dönem / kısa süreli MV ➢ Görece stabil ventilasyon zor olmayan hastalar ➢ Sekresyonu az olan hastalar

AARC Clinical Practice Guideline,2012
Biomd research Int 2014
Chiumello 2014
Lellouche et al 2004

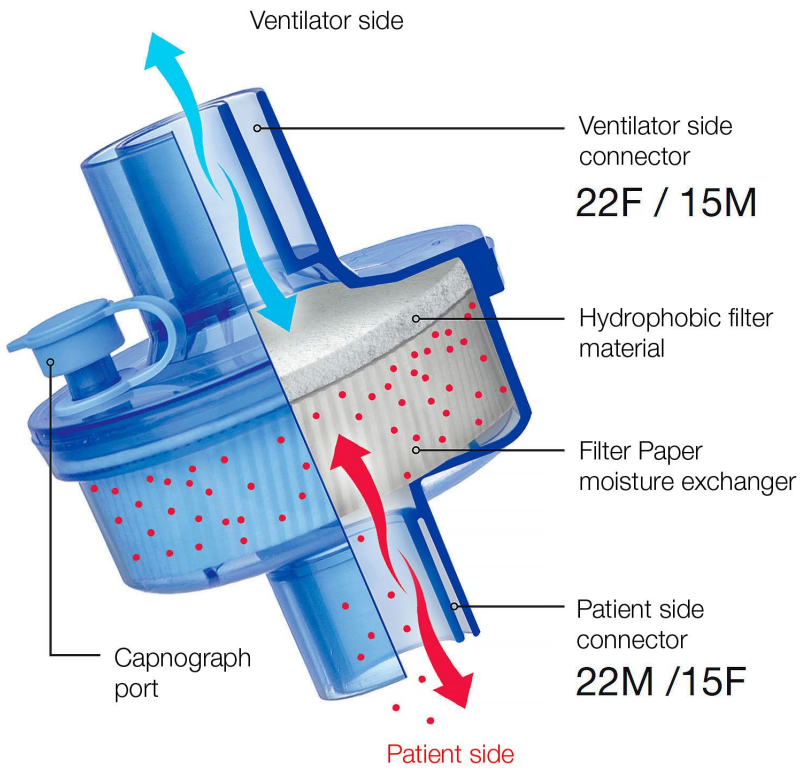






Humidifyer

Bakteri/Virüs filtresi

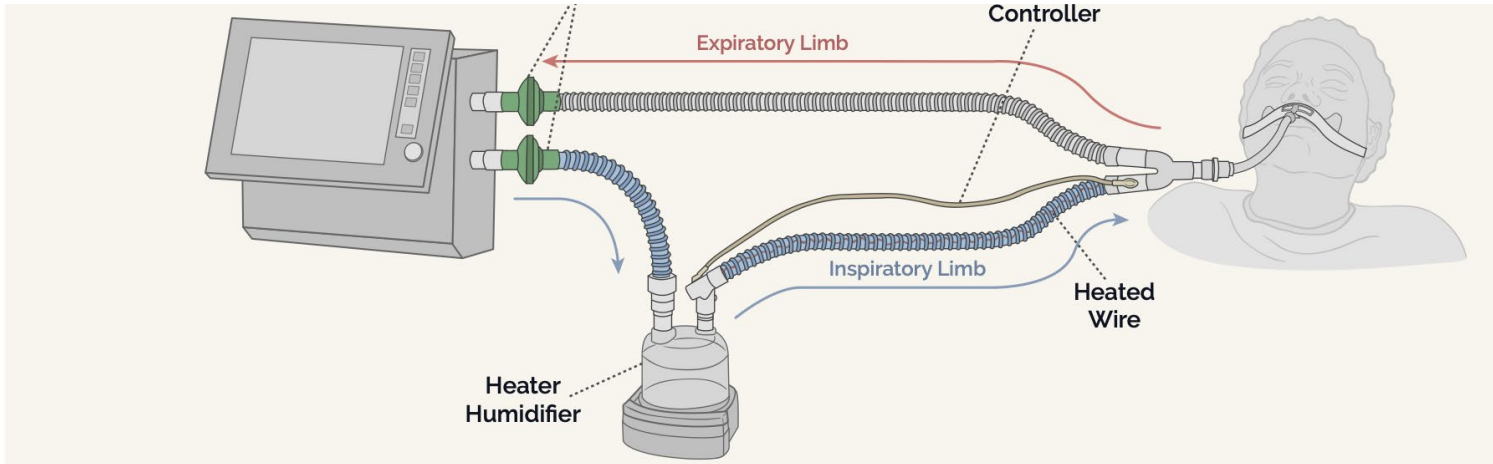


- BVF/ Breathing filter / HMEF
- Cam, polipropilen mikrofiber
- Mekanik ve elektrostatik filtrasyon
- %99.99 BFE, VFE

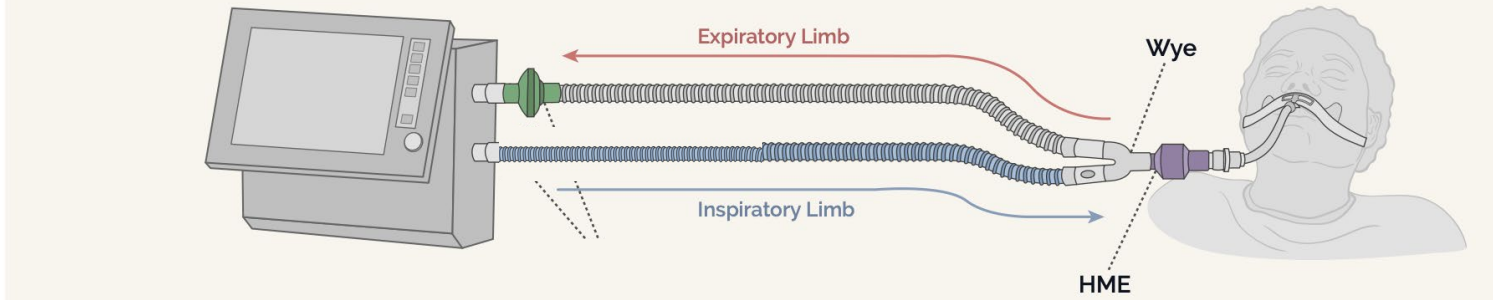
Filtreler

- Ölü boşluk ve havayolu direnci
- 24-48 saatte bir değiştirilmeli

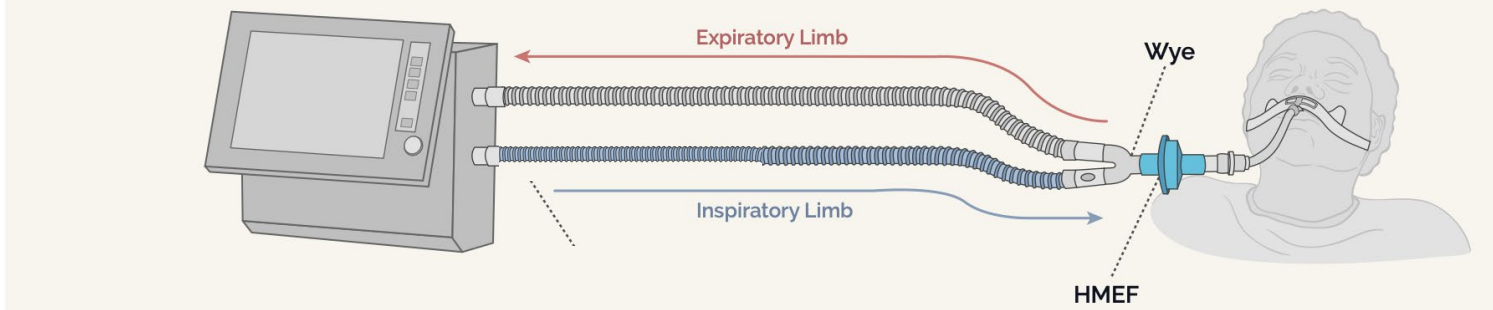
- HME/HMEF→ Y parçası ile hasta arasına
- BVF → inspiratuvar kol (opsiyonel) ve ekspiratuvar kol (ortamı ve çalışanları korur) -MV bağlantı yerine



Heat Moisture Exchanger (HME)



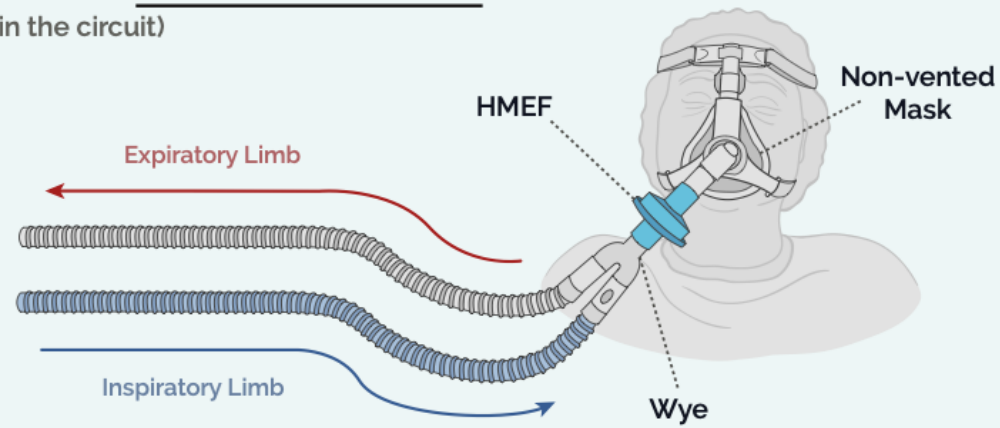
Heat Moisture Exchange Filter (HMEF)



Always check manufacturer's recommendations to determine if your device, circuit, and mask combination requires an additional anti-asphyxia valve (not shown) 2021

Dual Limb Circuit + Non-Vented Mask

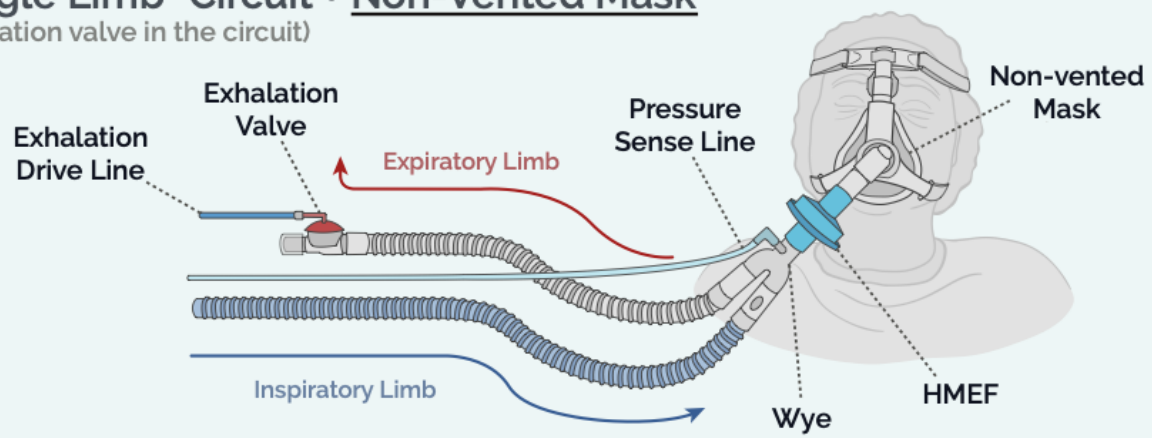
(Exhalation valve in the circuit)



- Because this setup has an **expiratory valve** at or in the ventilator (not shown), a **non-vented mask** must be used for CPAP/NIPPV
- See Figure "Ventilator Circuit Setup" for alternative humidification & filter setups. An HMEF is shown here but may not be the optimal setup depending on local resources.
- Of note, the addition of filters between the circuit Wye and the patient introduce dead space.

"Single Limb" Circuit + Non-Vented Mask

(Exhalation valve in the circuit)

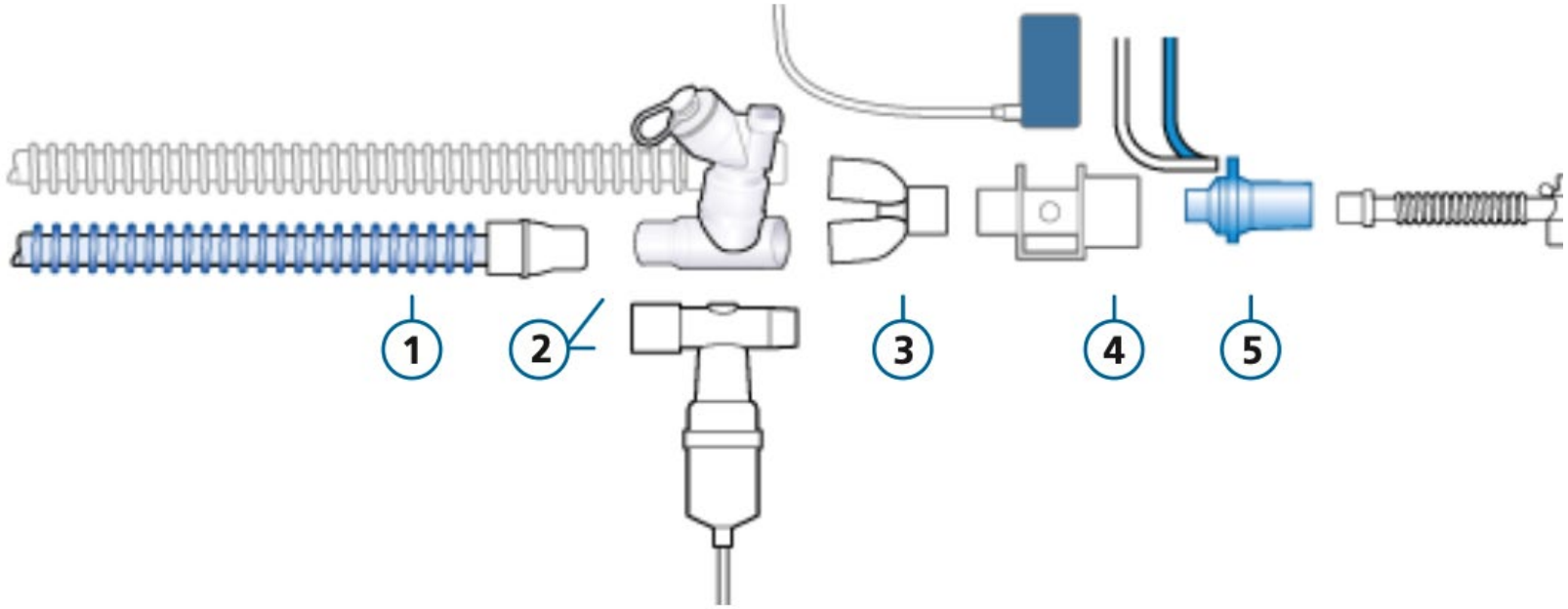


- The term 'single limb' circuit is a commonly used misnomer when referring to the type of circuit shown here. The setup shown has a short expiratory limb and expiratory valve and functions similarly to a dual limb circuit.
- Because this setup has an **expiratory valve**, a **non-vented mask** must be used for CPAP/NIPPV
- See Figure "Ventilator Circuit Setup" for alternative humidification & filter setups.

Nebulize tedaviler

Using a nebulizer with a DUAL LIMB breathing circuit set (with humidifier)

AEROGEN and PNEUMATIC: Connection to inspiratory limb before the Y-piece

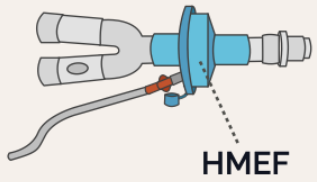


İnspiratuvar kol üzerinde Y parçasına 15 cm lik mesafede

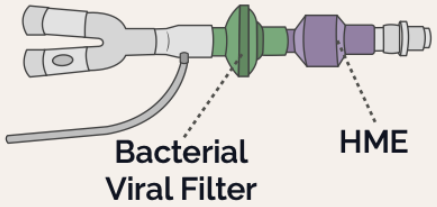
$ETCO_2$ sensörü

END TIDAL CO2 PLACEMENT

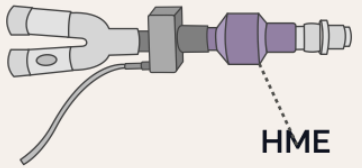
Sidestream CO2
Sampling HMEF with integrated sampling port



Sidestream CO2
Sampling HME and Bacterial Viral Filter

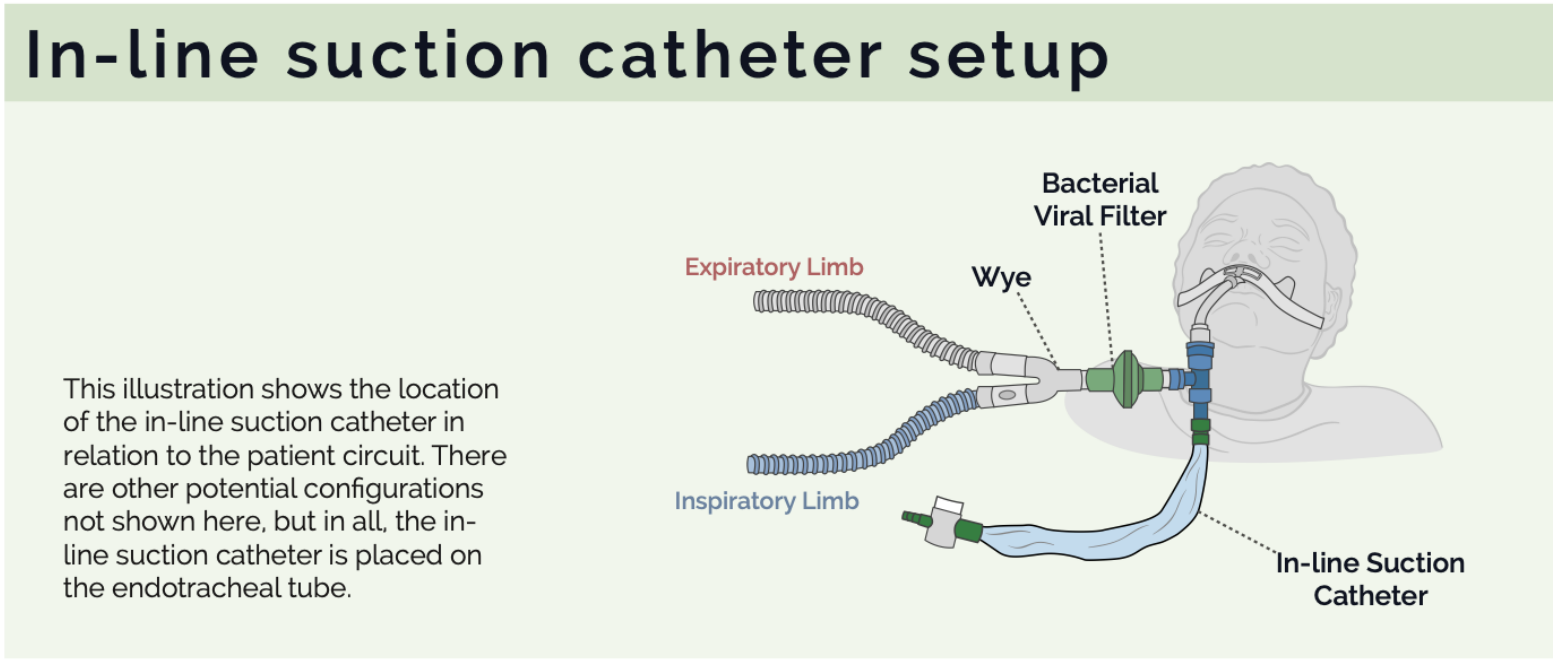


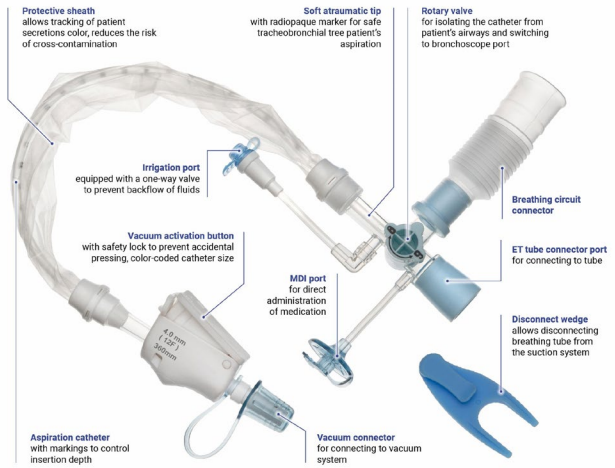
Mainstream CO2
Monitoring HME



Deadspace and resistance are increased by the addition of any filters or other adapters, including end tidal CO2. Read manufacturers'' specifications to quantify potential impact on ventilator strategy.

Kapalı aspirasyon sistemi





ETT ile solunum devresi arasına

Kateter mount

Hastayı MV'ye bağlamadan önce

- ☑ UPS kontrolü
- ☑ Oksijen ve medikal hava bağlantıları ve basınç kontrolü
- ☑ Ventilatör açılışı ve self-testin tamamlanması
- ☑ İnspiratuvar ve ekspiratuvar solunum devresinin takılması
- ☑ Ekspiratuvar valfin yerleştirilmesi (cihaz dışı ise)
- ☑ Filtrelerin takılması (BV filtre, HME / HMEF, HH)
- ☑ Sensörlerin kalibrasyonu (flow, basınç ve O_2 sensörleri)
- ☑ Devre kaçak testinin yapılması
- ☑ Alarm limitlerinin ayarlanması
- ☑ Başlangıç ventilatör ayarlarının yapılması (mod, VT, RR, FiO_2, PEEP, trigger)
- ☑ Uygun hasta arayüzünü ve bağlantılarını (kateter mount) hazırlanması
- ☑ Kullanılacaksa kapalı aspirasyon sistemi, $ETCO_2$ bağlantısı

UASK 2026

Uluslararası Katılımlı

AKCİĞER SAĞLIĞI KONGRESİ

25-28 MART 2026

Sueno Deluxe Hotel, Belek/Antalya

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