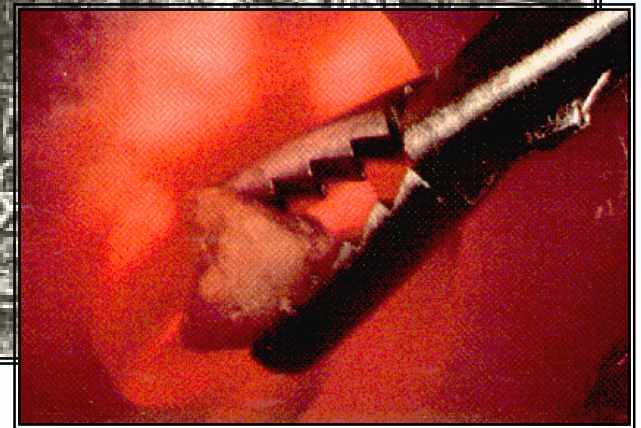
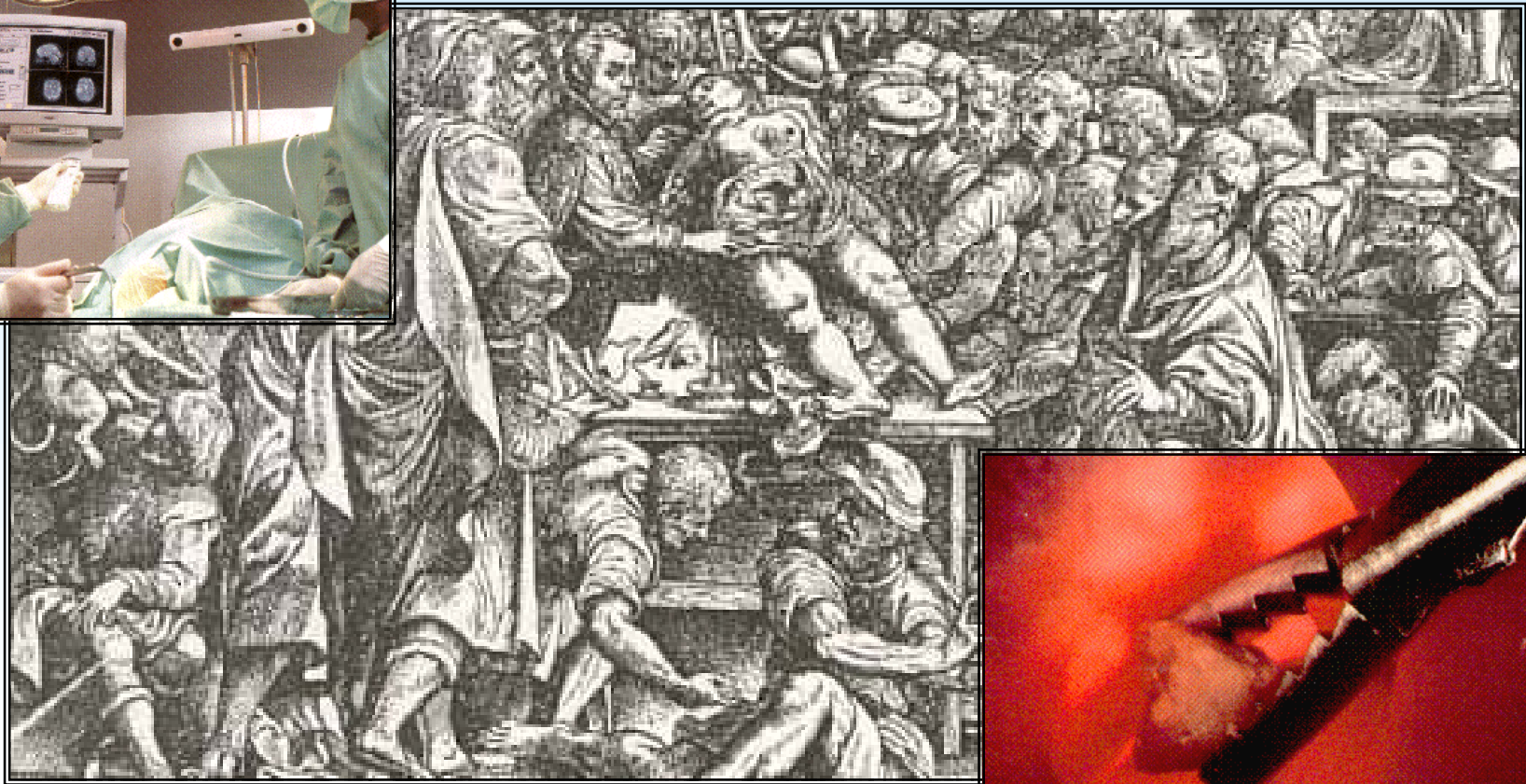


# THE OPERATING DEPARTMENT



## Historical Remarks

- Surgery may alleviate pain, restore or maintain the normal function of the body and eliminate a threat to life. The emphasis on treatment should not be allowed to create a false image that the operation procedure is the essence of the discipline, which compasses preoperative care, intra-operative judgement and management, and postoperative care.
- For thousands of years surgery practices were simple mechanical endeavours. The results depended on the plastic skills of the operator and the then unknown ability of the body to heal. A more profound understanding of normal body functions was gained only in the past half-century. Before the nineteenth century surgery was almost restricted to some procedures that could be performed on the non-anaesthetized patient, such as amputation, trepanning of the skull, incision of abscess, and operation of cataract.

## Clinical Surgery becomes a Science

- Although the introduction of anesthetics had greatly extended the scope of surgery, as far as to the last quarter of the nineteenth century the results of the common operations were alarming. The average level of competence in the medical profession remained depressingly low until the beginning of the twentieth century. Up to the second quarter of our century clinical surgery was not a science. It was a profession, or perhaps a kind of art, the quality of performance depending on the ability, skill and training of the surgeon.
- Surgical advances have been largely dependent on the basic scientific research, experimental surgery and para-surgical innovation. Most of them have taken place in terms of pre-operative and post-operative care. However, the great amount of hardware and electronics which have been introduced in the operation room have sometimes given rise to the erroneous belief that increased technology substitutes for good procedures.

## Operation frequency

- In a well planned and run hospital bed occupancy would be high, waiting lists short and operation sessions fully used.
- To determine the operation frequency including emergencies in larger hospitals, a thumb rule, 0.1 operations per bed and day, can be used.
- However, the number of operation rooms in a hospital could be more exactly determined, when it is related to the number of surgical and equivalent beds, the percentage rate of bed occupancy, the average length of stay for patients in surgical and equivalent clinics, the length of the daily operation session, and to the length of the hygienic interval.

## **Basic procedures that encircle the act of surgery**

- Reception and identification of patient.
- Preoperative supervision of patient.
- Depilation or shaving of patient.
- Transfer of patient to operation table.
- Administration of anesthesia.
- Intubation.

## Patient movements in the course of surgical operations

- Positioning.
- Preparation of the operative area and surrounding skin.
- Draping of the patient.
- The act of surgery, operation, which may involve blood transfusion, parenteral fluid administration, and X-ray administration.
- Wound sewn up and dressed.
- Drapes removed and bagged.
- Extubation.
- Transfer of patient from operation table to trolley and to the anaesthetic recovery area.
- Post-operative supervision of patient.

## Supporting procedures

- Staff changing to operation room garments and shoes.
- Putting on cap.
- Masking.
- Aseptic washing of hands.
- Gowning.
- Putting on gloves.
- Putting on apron.
- Laying out, checking and rechecking the number of instruments and dressings to be use during the operation.

## Administrative and clerical procedures

- Preparation of operation lists, duty schedules and rota.
- Requisition of patient.
- Notification to wards of time for patient transport to and from the surgical department.
- Distribution of messages.
- Staff paging.
- Requisition of records, equipment and material.
- Contacts with other departments, laboratories, workshops and suppliers.
- Preparation of operation records.
- Preparation of operation room records.
- Filing.
- Statistical interpretation of operation room records.



## Housekeeping procedures

- Collection of used instruments.
- Collection of used materials, and soiled surgical instruments, dressings and underlay.
- Cleaning of operation rooms and other areas in the surgical department.
- Disposal or incineration of refuse.
- Storekeeping.
- Repairs.

# Operating Department Areas

- In order to have all these procedures performed smoothly, an appropriate designing of the department and the optimal use of any available architectural means is necessary. The Operating Department includes following areas:
  - ◆ *Staff areas: Entrances, Cloak rooms, Changing rooms, Lounge-refreshment room, Offices, on-call rooms.*
  - ◆ *Patient areas: Holding area, Immediate pre-operative ward, Transfer areas.*
  - ◆ *Procedure areas: Anaesthetic room, Scrubbing and Gowning room, Several Operation rooms (General, Traumatological, Orthopaedic & Plaster, Eye, ENT, Cardiovascular, Endoscopy).*
- Departmental space planning should ensure the avoidance of unnecessary movement and obstruction. It must provide for easy, simultaneous circulation of various categories of staff and supplies.

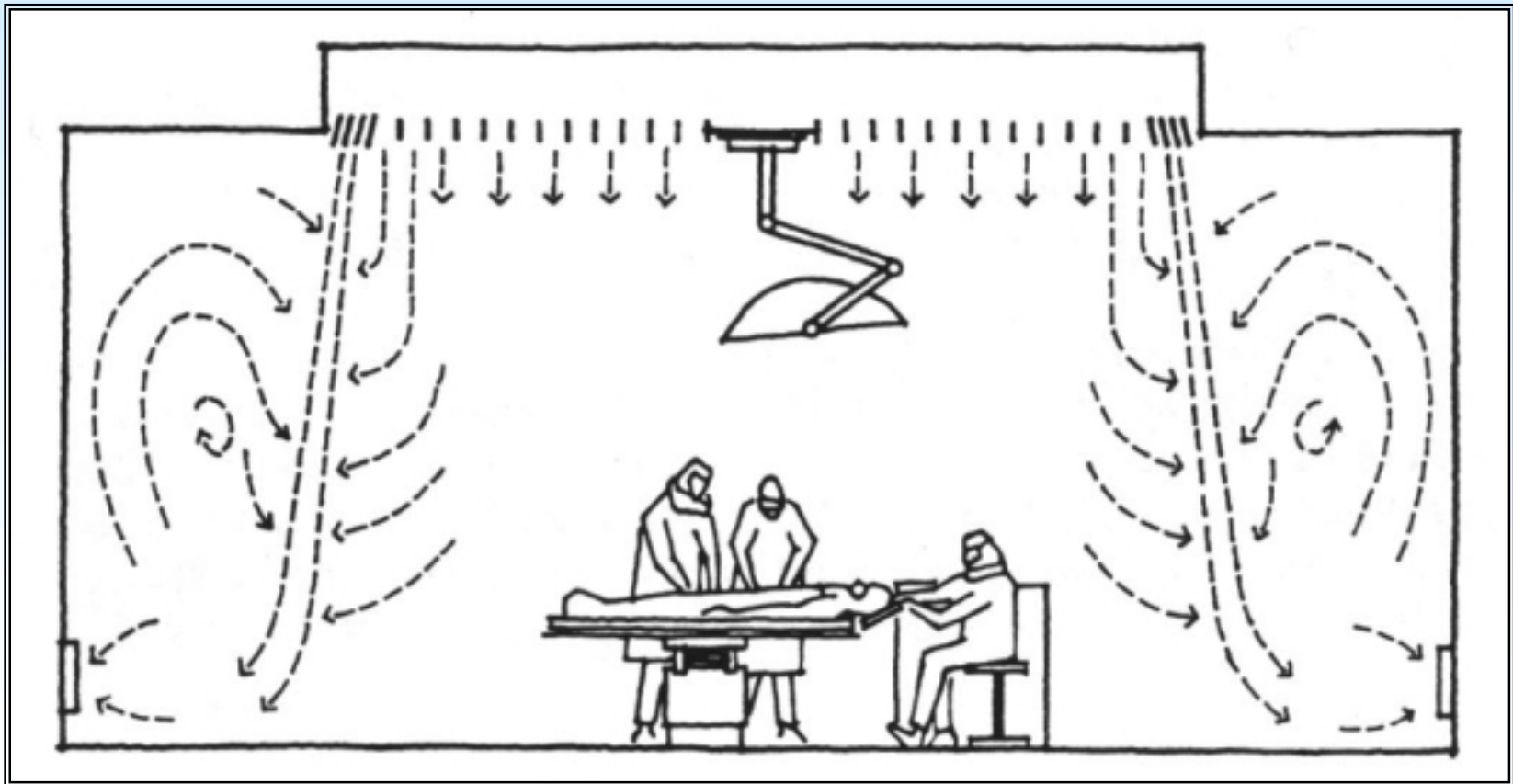
## The five surgical department cleanliness zones

- The *general zone* corresponds to usual hospital cleanliness standard.
- The *clean zone* provides for the surgical department reception ward, anaesthetic rooms, delivery rooms, endoscopy rooms, stores for blood, medicine, parenteral solutions etc., the sterile service area, the general post-anaesthetic area, X-ray apparatus stores.
- The *super clean* zone accommodates scrub-up and gowning areas, operation rooms, operation rooms stores, sterile linen stores, and thoracic post-anesthesia rooms.
- The *ultra clean* zone is determined by a circle with a 1 m diameter around the wound.
- The *aseptic zone* is limited to the area of incision.

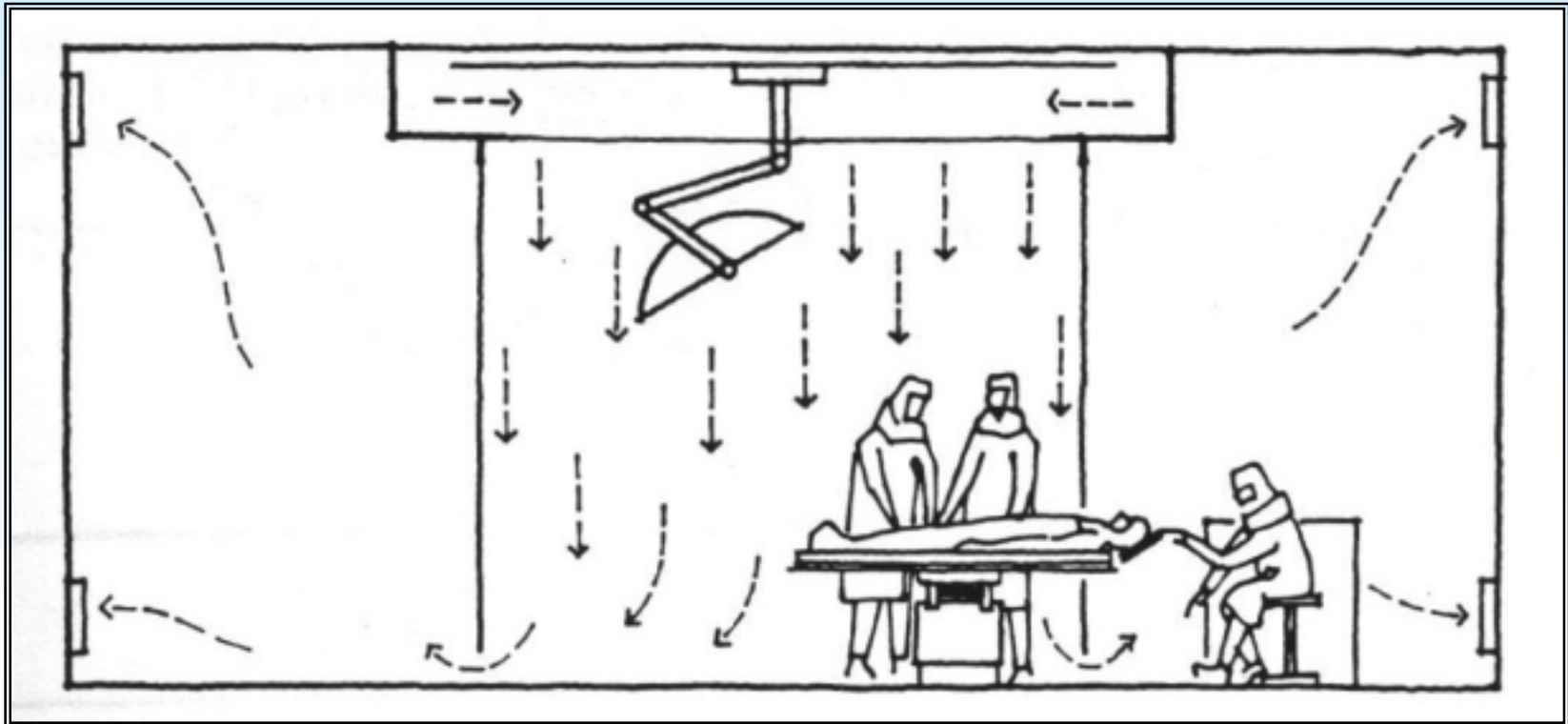
# Operating Room Installation Engineering

- Besides the *architectural means* used to provide the above zoning, ventilation of the operating department, and the use of clean air isolators and enclosures are some of the *mechanical engineering means* necessary to provide for strong reducing or eliminating airborne microorganisms, during surgical operations.
- Air distribution is combined to the use of filters, that hinder the outside pathogenic particles over the 1  $\mu\text{m}$  range to enter the operation rooms.
- Although the amount of filtration needed is probably much less than generally assumed, since the infective particles have a size of 10 - 40  $\mu\text{m}$ , HEPA filters efficient for submicron filtration are frequently used.
- However, it is the attitude of the staff to the hospital hygiene generally and asepsis particularly, which determines the results of the aspired aseptic techniques within the surgical departments.

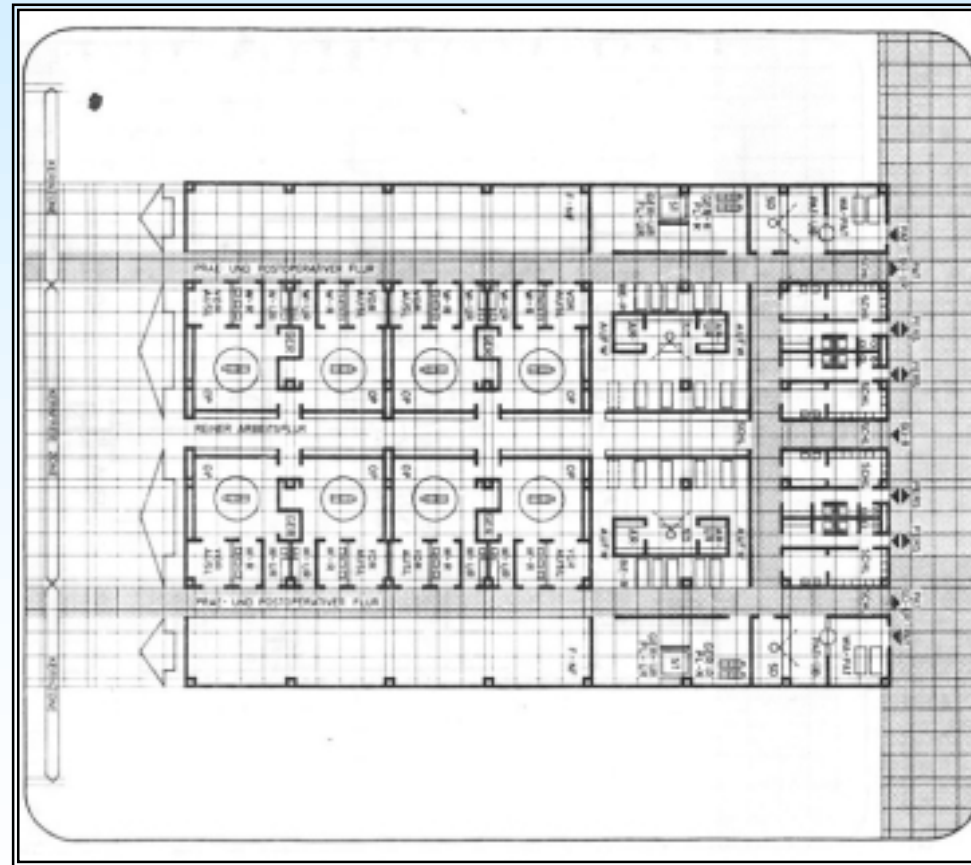
**The Allander air-curtaining system: Thin air-seal streams limit the sensitive area (80 times/hour) from the room outside (15-20 times/hour)**



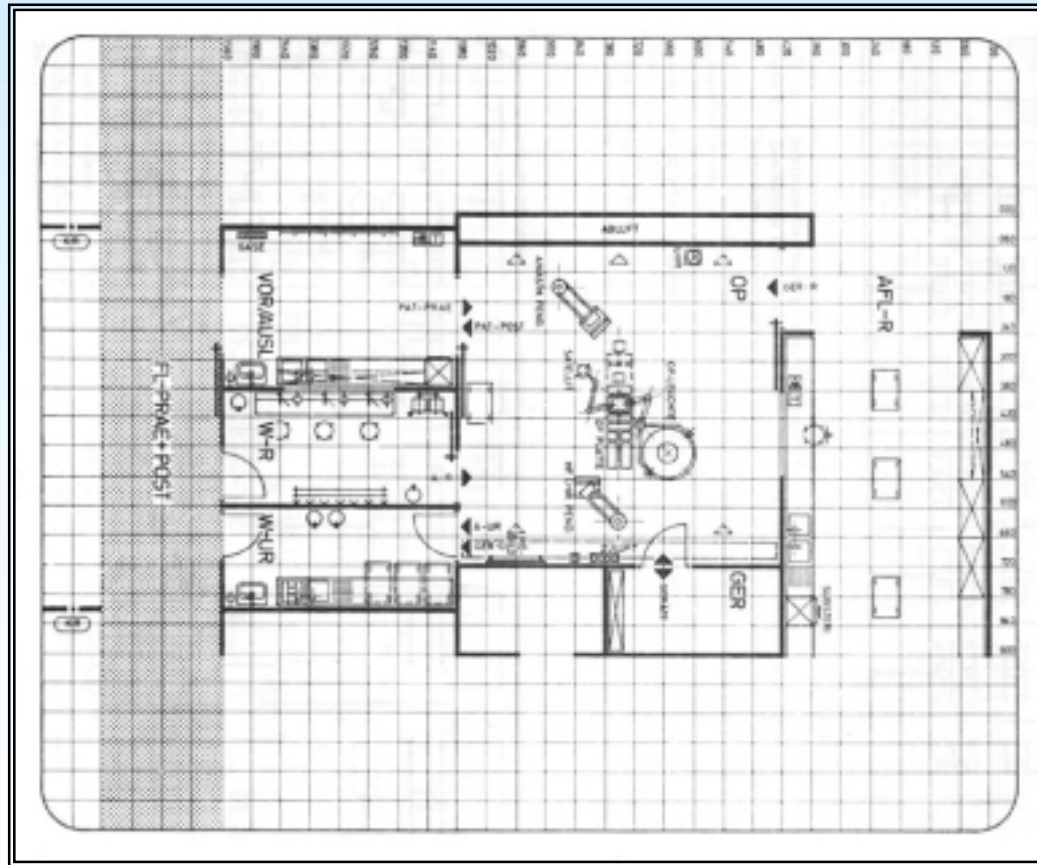
## Vertical unidirectional air-flow (laminar flow) combined to the Charnley enclosure



# Typical Surgical Department

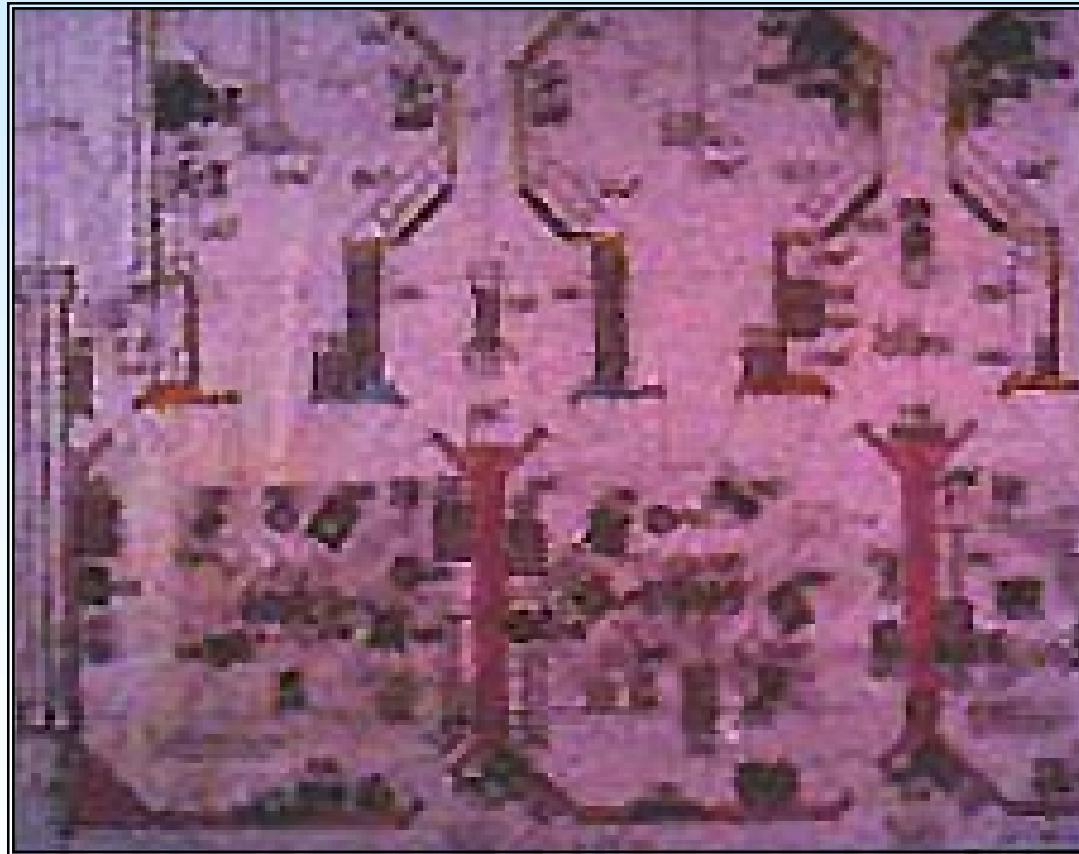


# Typical Operation Room Layout

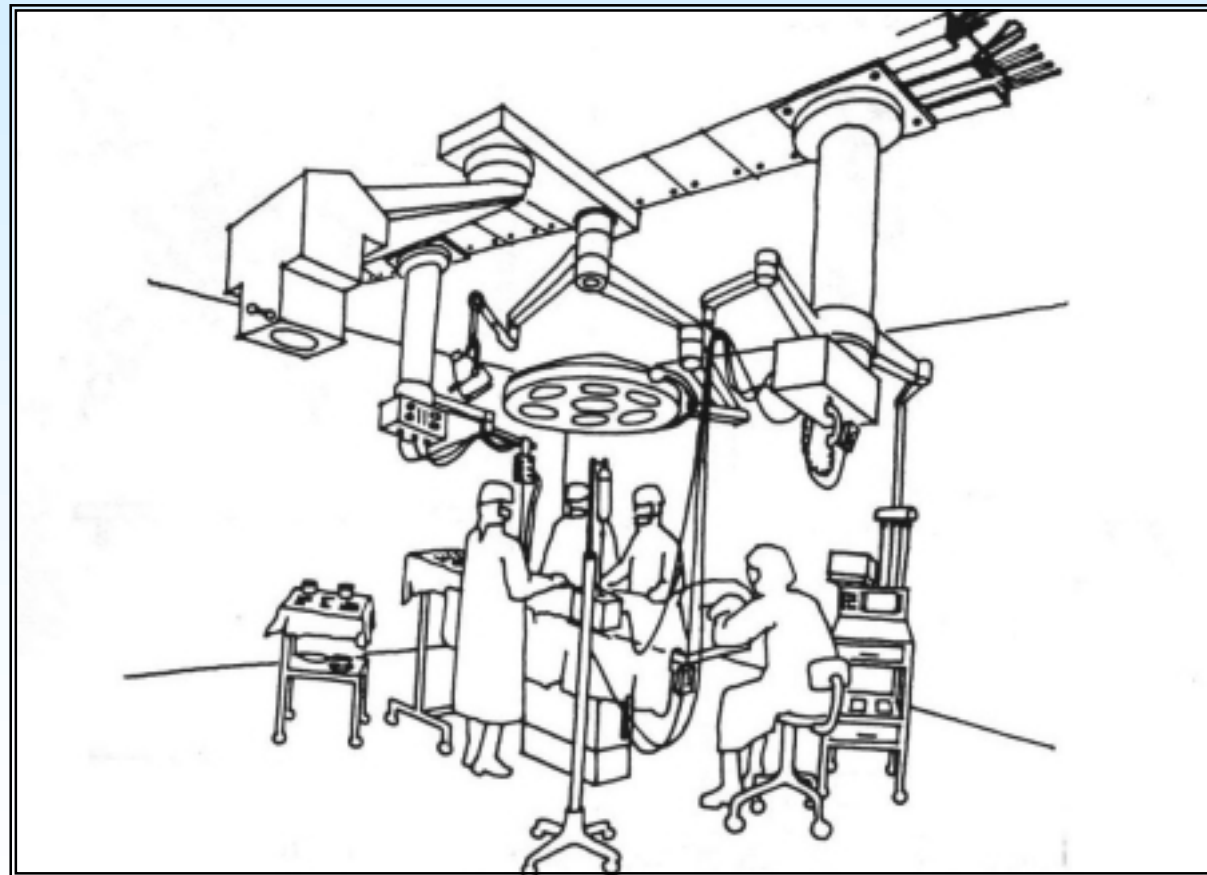




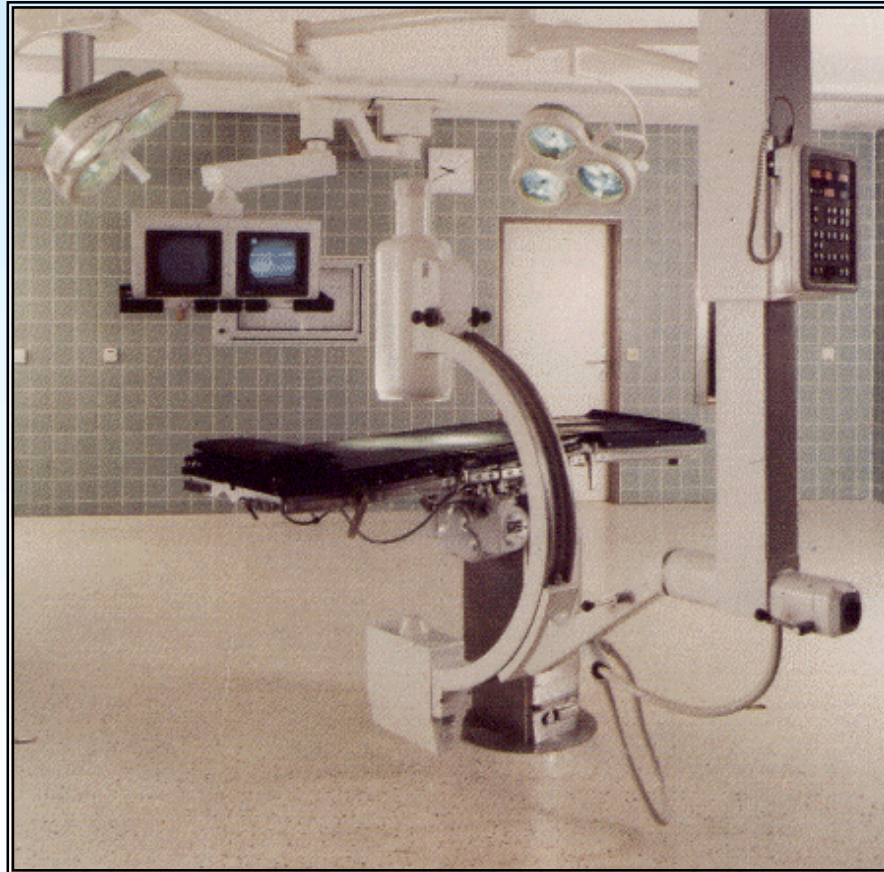
## Surgical Department (ΠΕΠΑΓΝΗ)



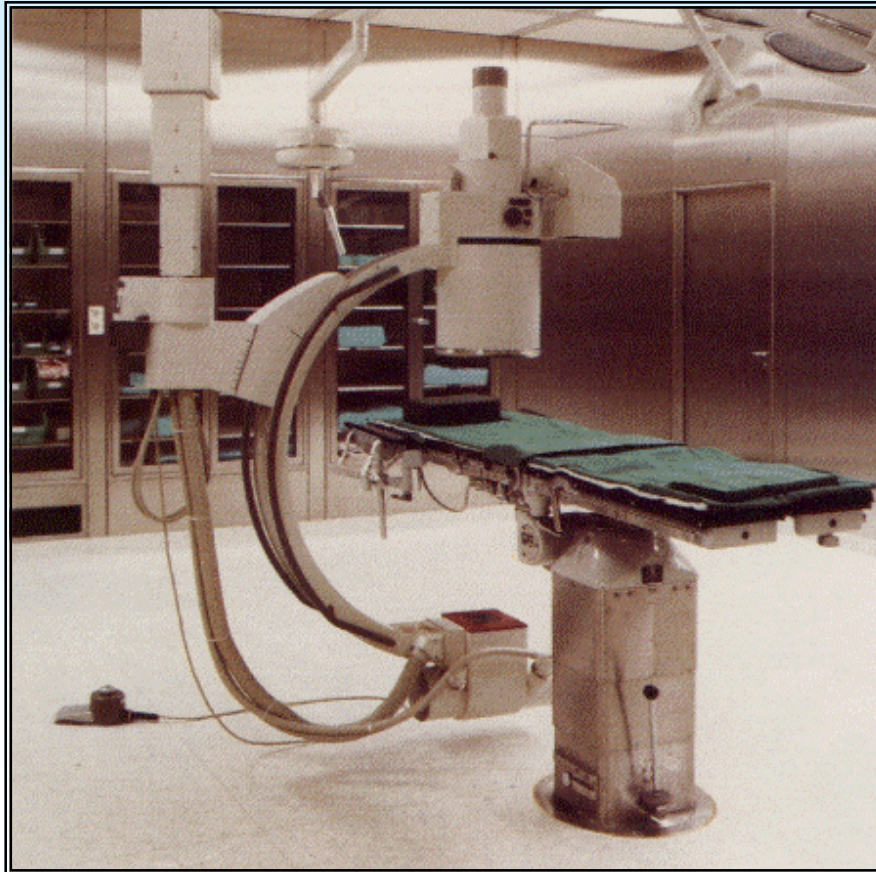
# Typical Operation Room



## Operation Room: Traditional finishing



## Operation Room: Stainless steel finishing



# Typical Operation Room



# Operation lamps

Following requirements should be fulfilled:

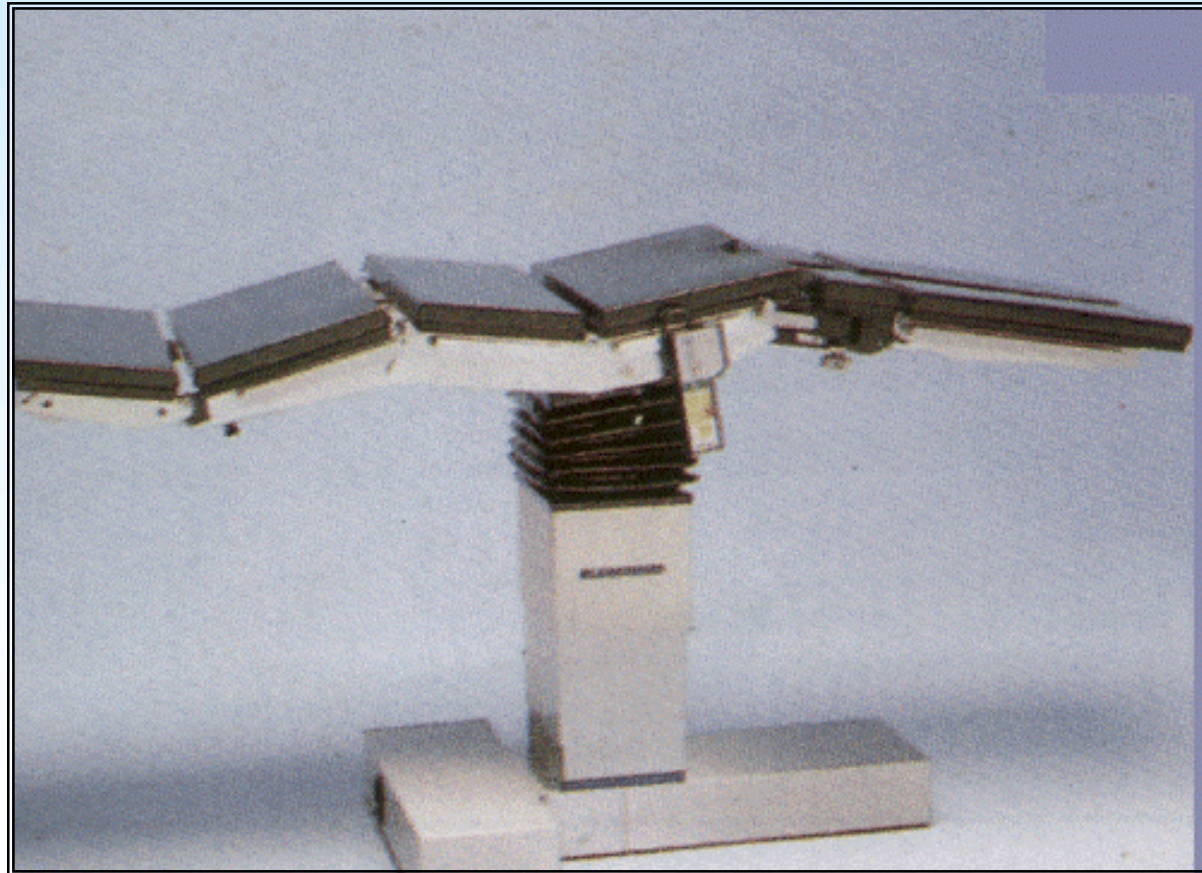
- ◆ *The intensity of the light 40 000 -100 000 lux at the working plane.*
- ◆ *The fitting should be directionally flexible/.*
- ◆ *The area of the lit field should be variable.*
- ◆ *The control should be accurate and quick.*
- ◆ *The color temperature should be at least 5000 °K.*
- ◆ *The index of color reproduction (filter-effect)  $R_i$  (DIN 6169) should be 70%.*
- ◆ *Heat radiation should be as small as possible.*
- ◆ *Outer surface of luminaries temperature  $< 58$  °C.*
- ◆ *Secondary (satellite) lamp should be available in some O.R.*



## Operation table: Properties

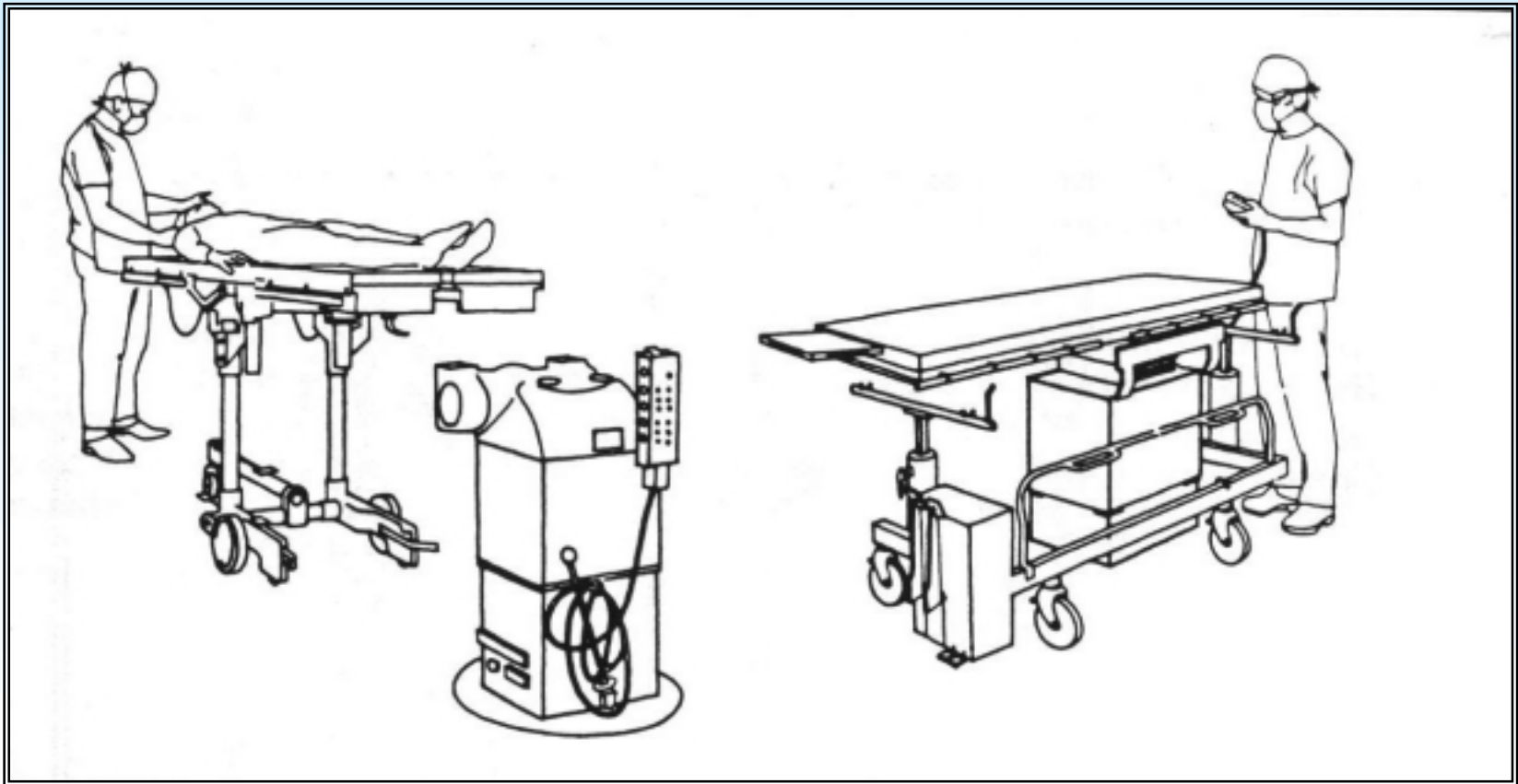
- The main item of the operation room furniture is the operation table.
- There are manually-hydraulic adjustable and electric-hydraulic powered tables.
- All operation tables should allow convenient insertion of X-ray cassettes.
- There are operation table tops that can be detached from their permanently fixed pedestals, and can be fitted on a wheeled trolley for transfer of the patient, between the anaesthetic room and the operation room and vice versa.
- Operation table-tops must be radio-lucent.

# Operation table

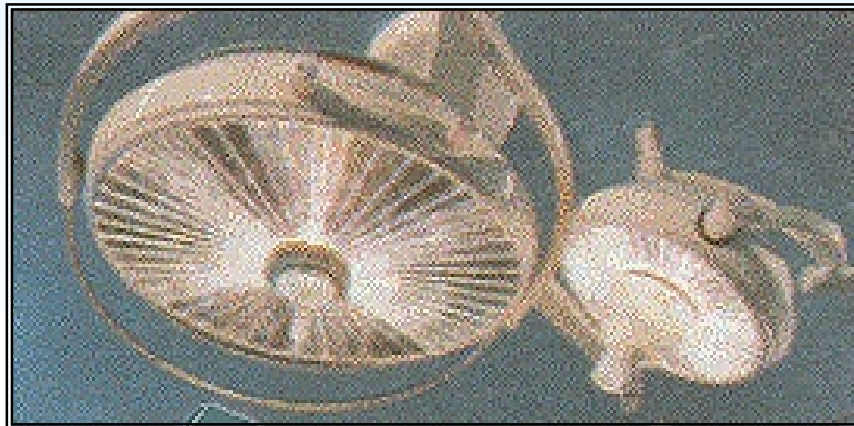




## Two different types of detachable table-top operating tables: Maquet (l) KIFA H (r)



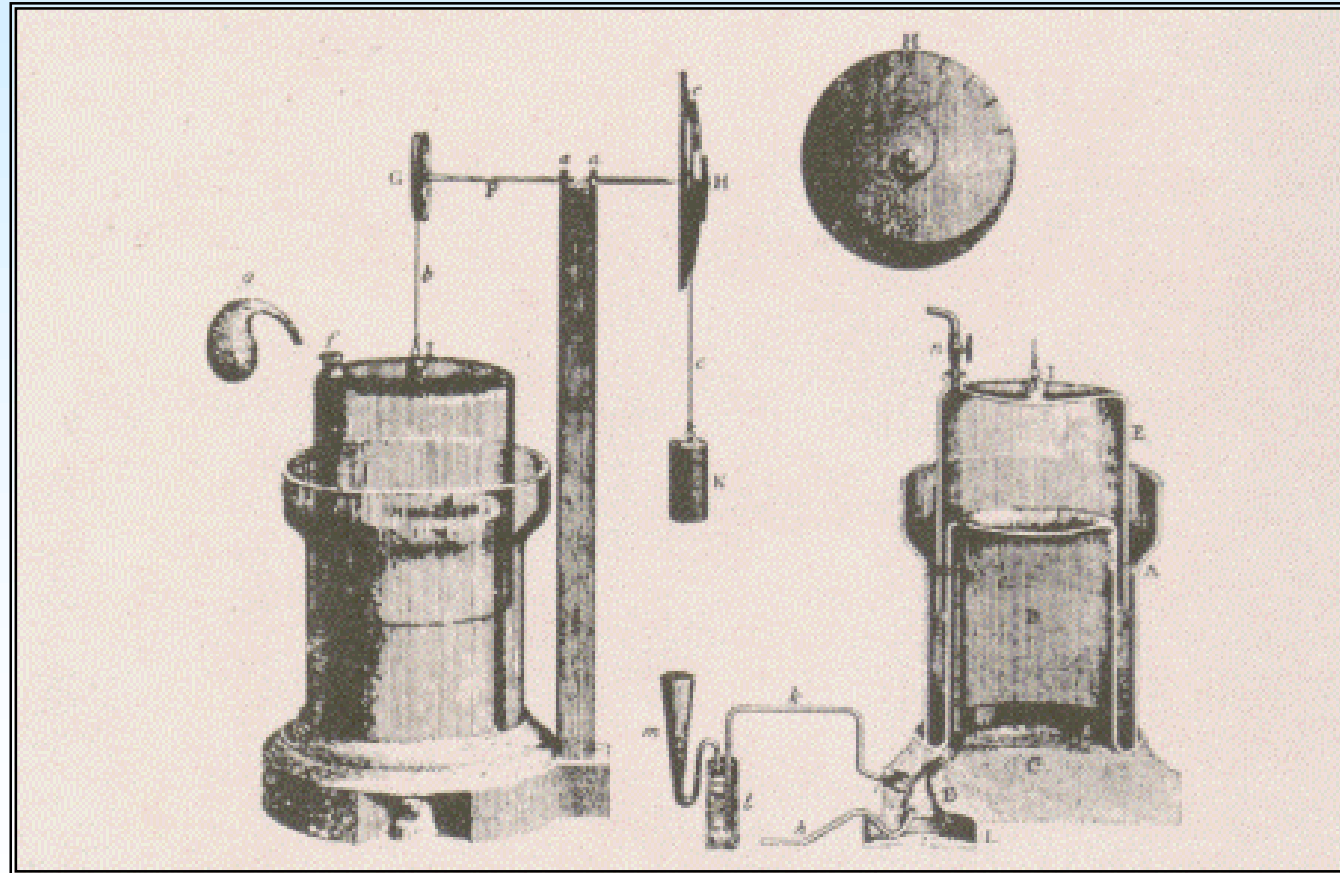
## **A Castle operation lamp and a multi-satellite Pilling operation lamp**



# Anesthesia



## The first Anesthesia Machines (Boyle Vaporizer)



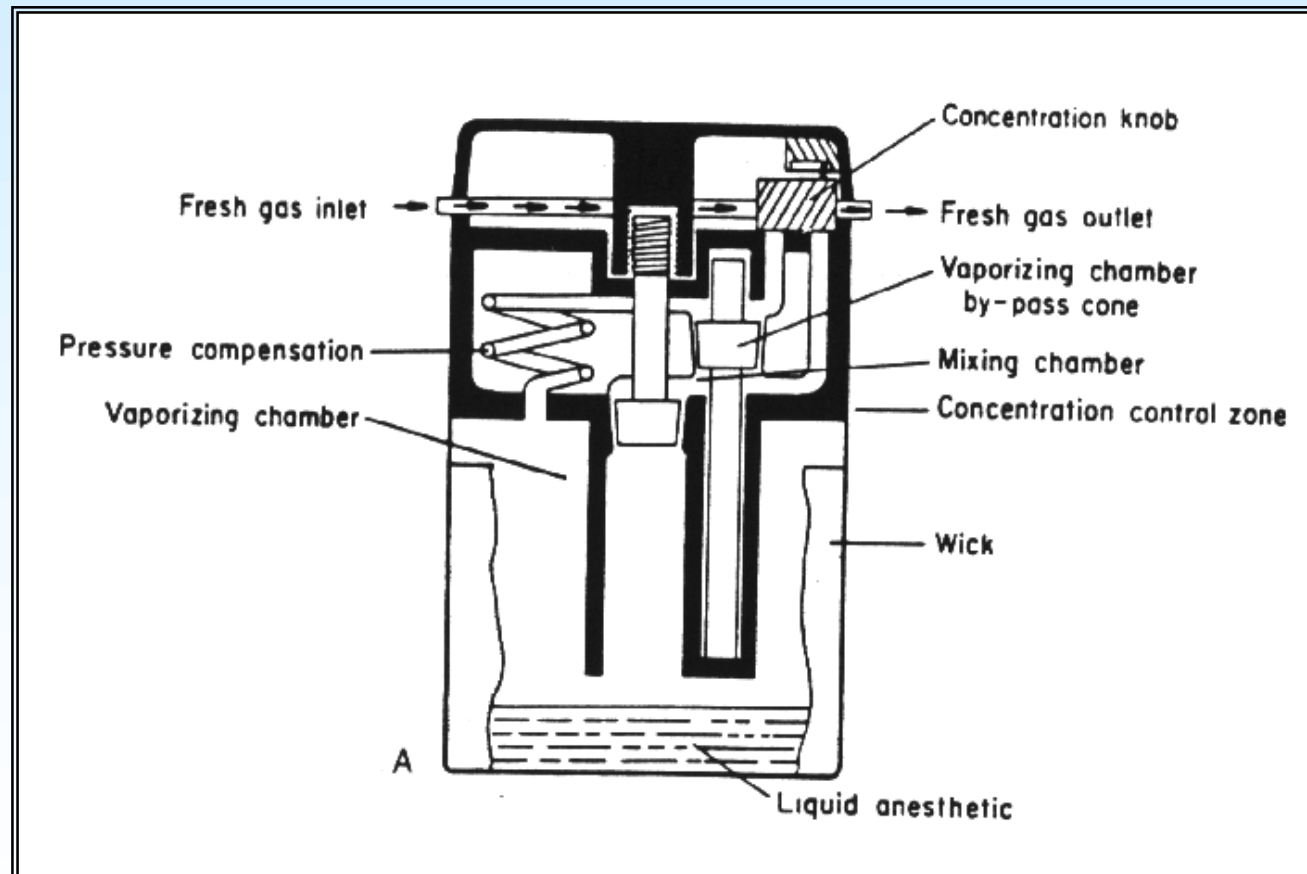
## Medical Gases Supply and Anesthesia machine

- In operation rooms outlets for oxygen, nitrous oxide, compressed air and vacuum (suction pipes) are laid in telescopic tubes, which must not extend downwards lower than 2 m above the floor and are frequently backed-up with wall-mounted outlets.
- Anesthesia machines are vital to the practice of anesthesia. Current anesthesia systems are being developed with a number of alarm systems (manometers, O<sub>2</sub> flow, pO<sub>2</sub> & pN<sub>2</sub>O in breathing circuit, IR-spectrometer or mass-spectrometer anesthesia agent detectors etc.) and attachments.
- The physical characteristics of liquid/vapours and gases, as well as, temperature are especially important in flown-meter and vaporizer design.

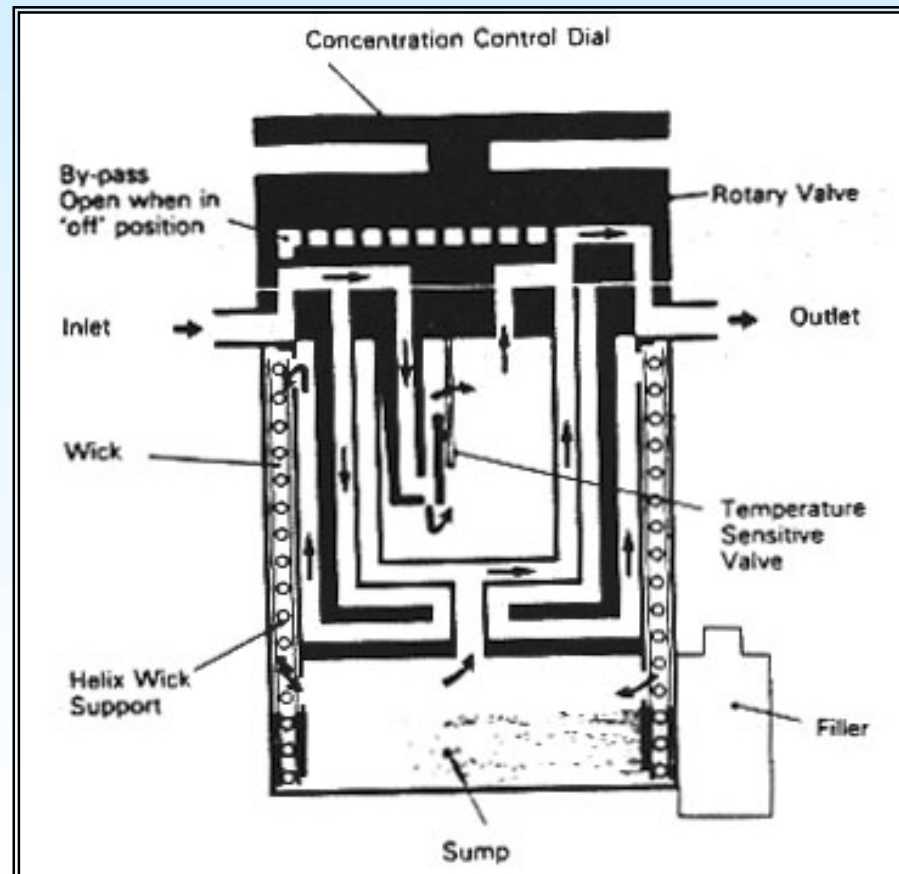
# Anesthesia machines



# Draeger Vaporizer

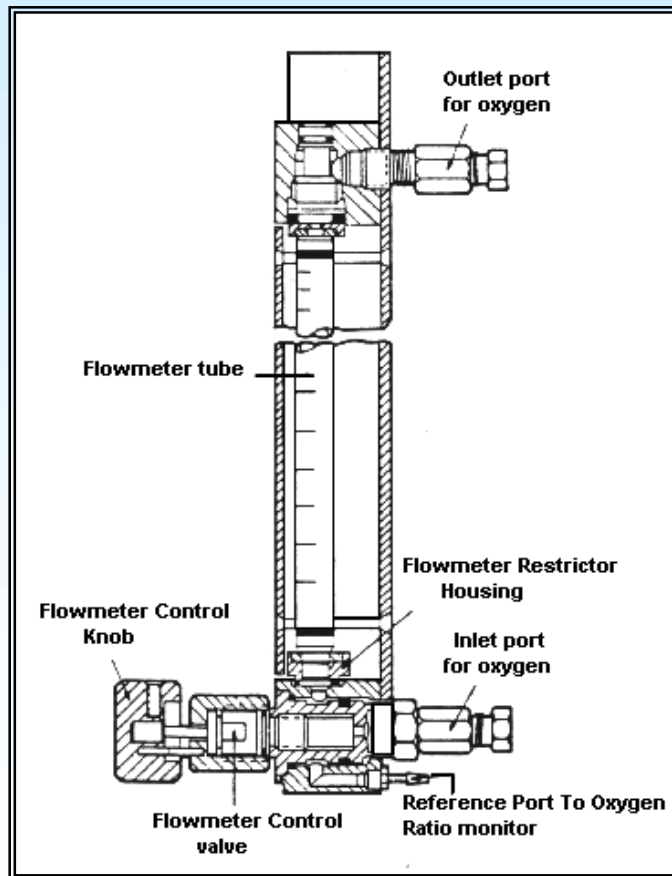


# Ohmeda Vaporizer

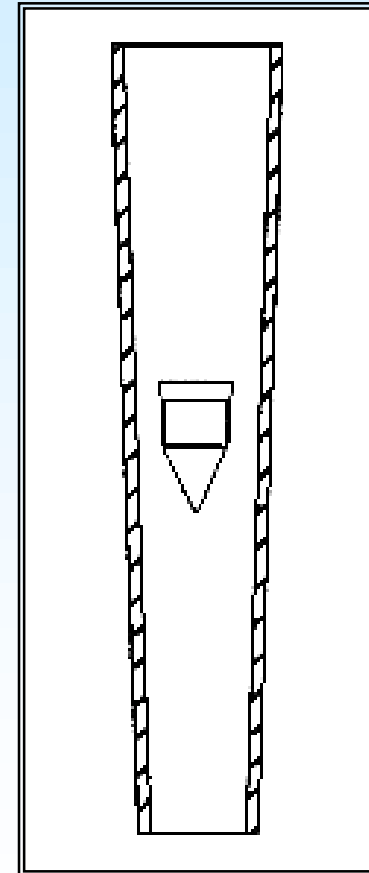
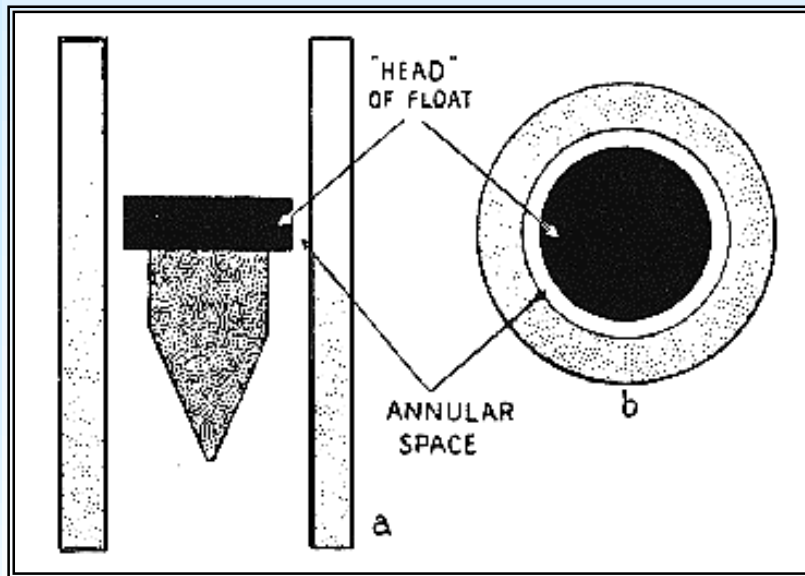




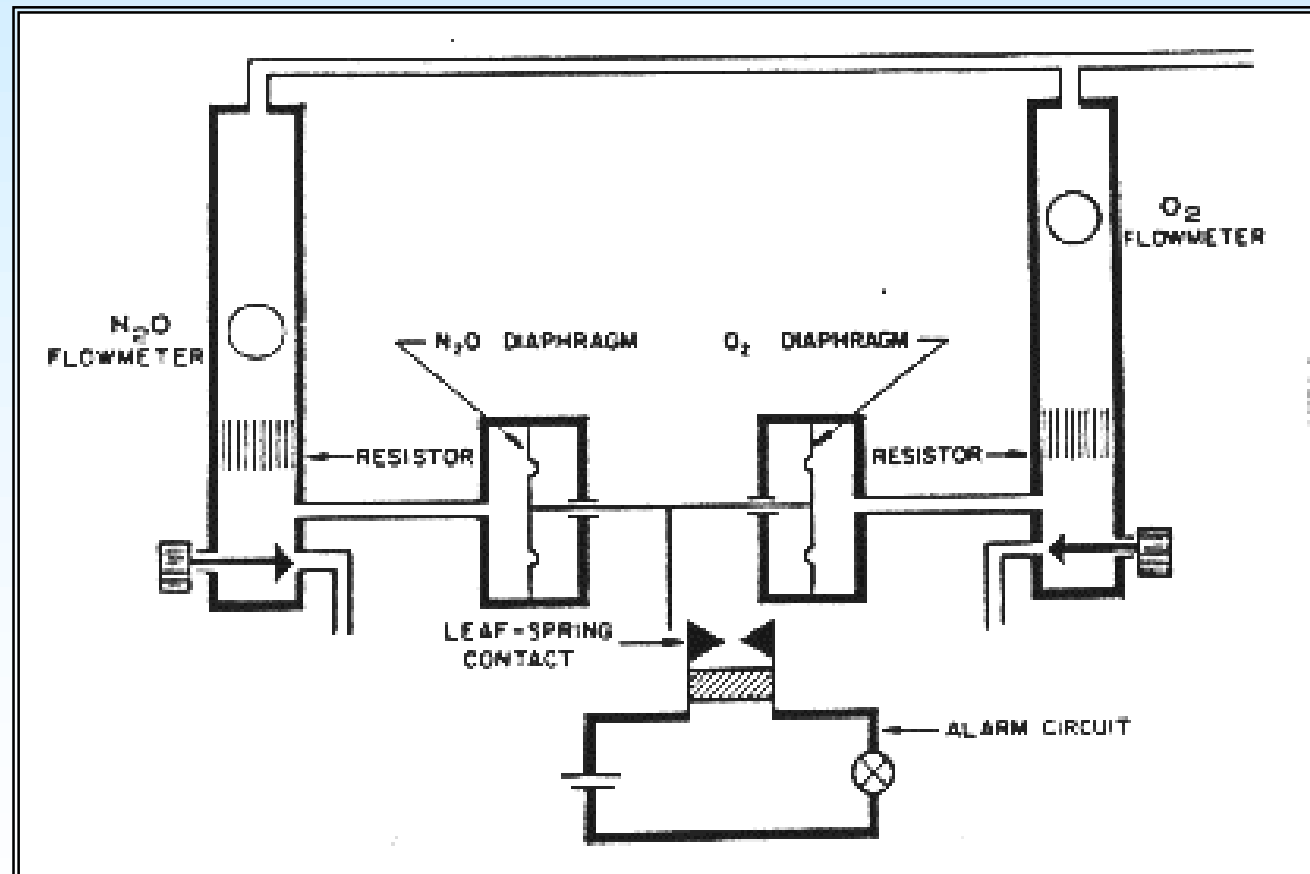
# Flowmeter



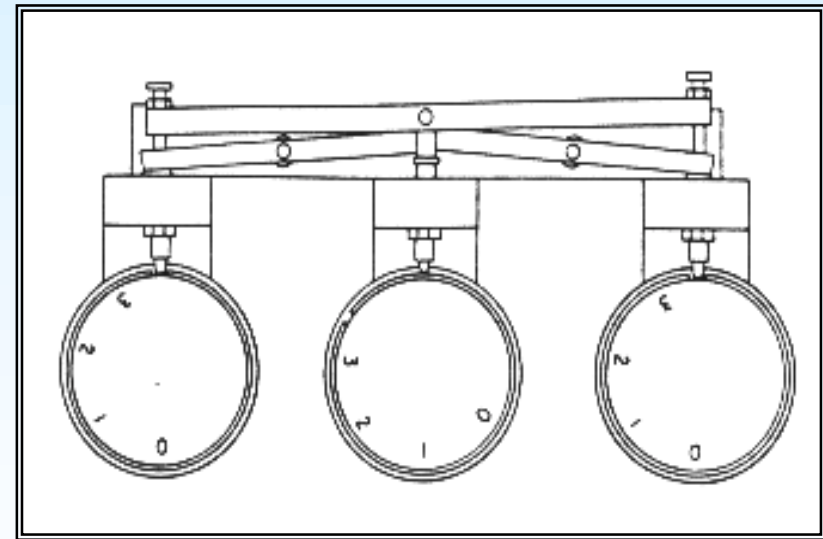
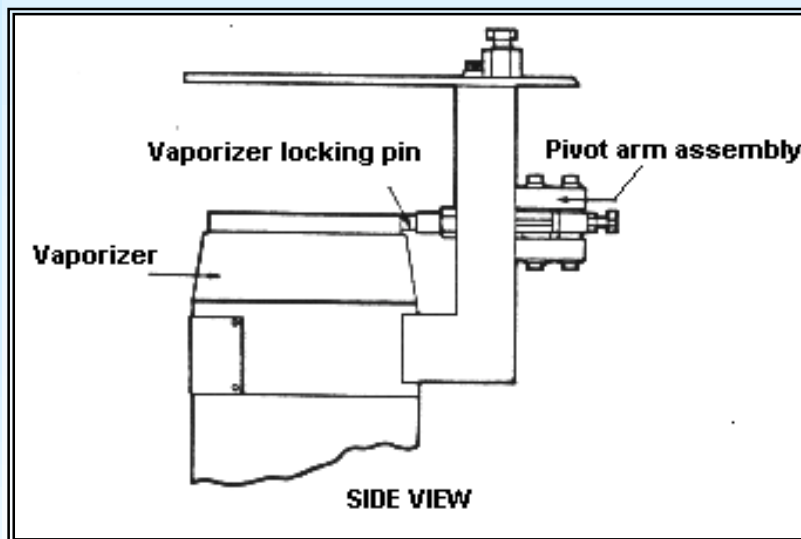
## Flown-meter details



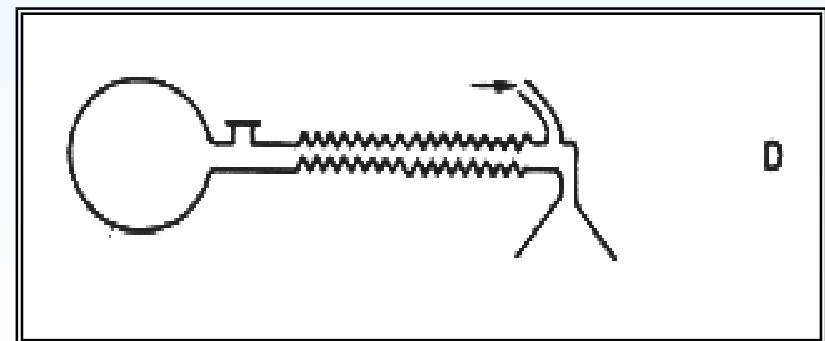
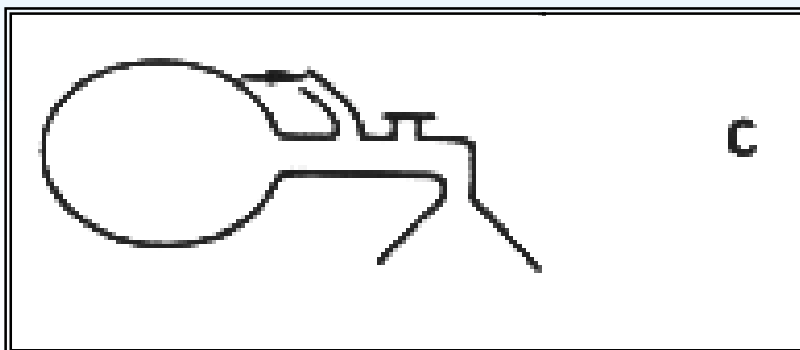
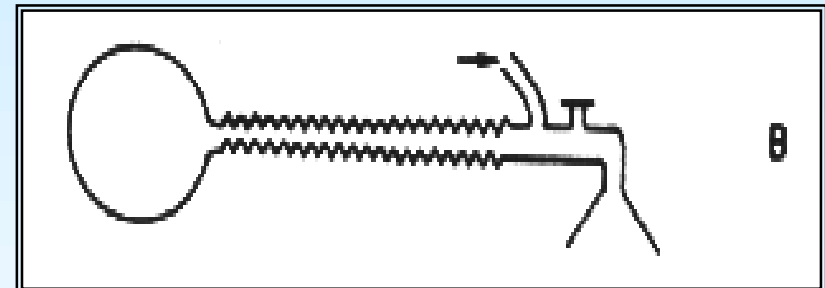
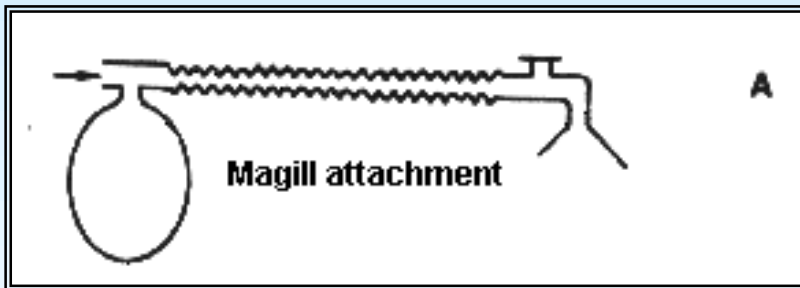
## O<sub>2</sub> flow alarm systems



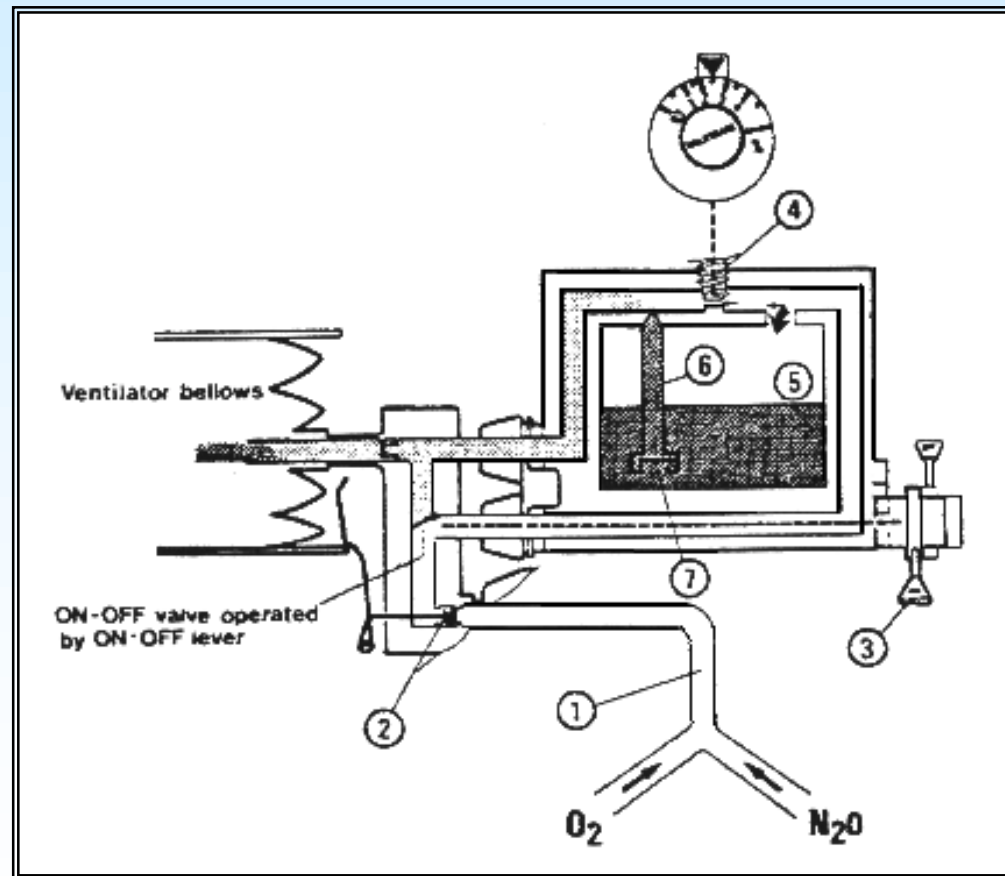
# Mutual locking system of different Vaporizers on an Anesthesia Machine



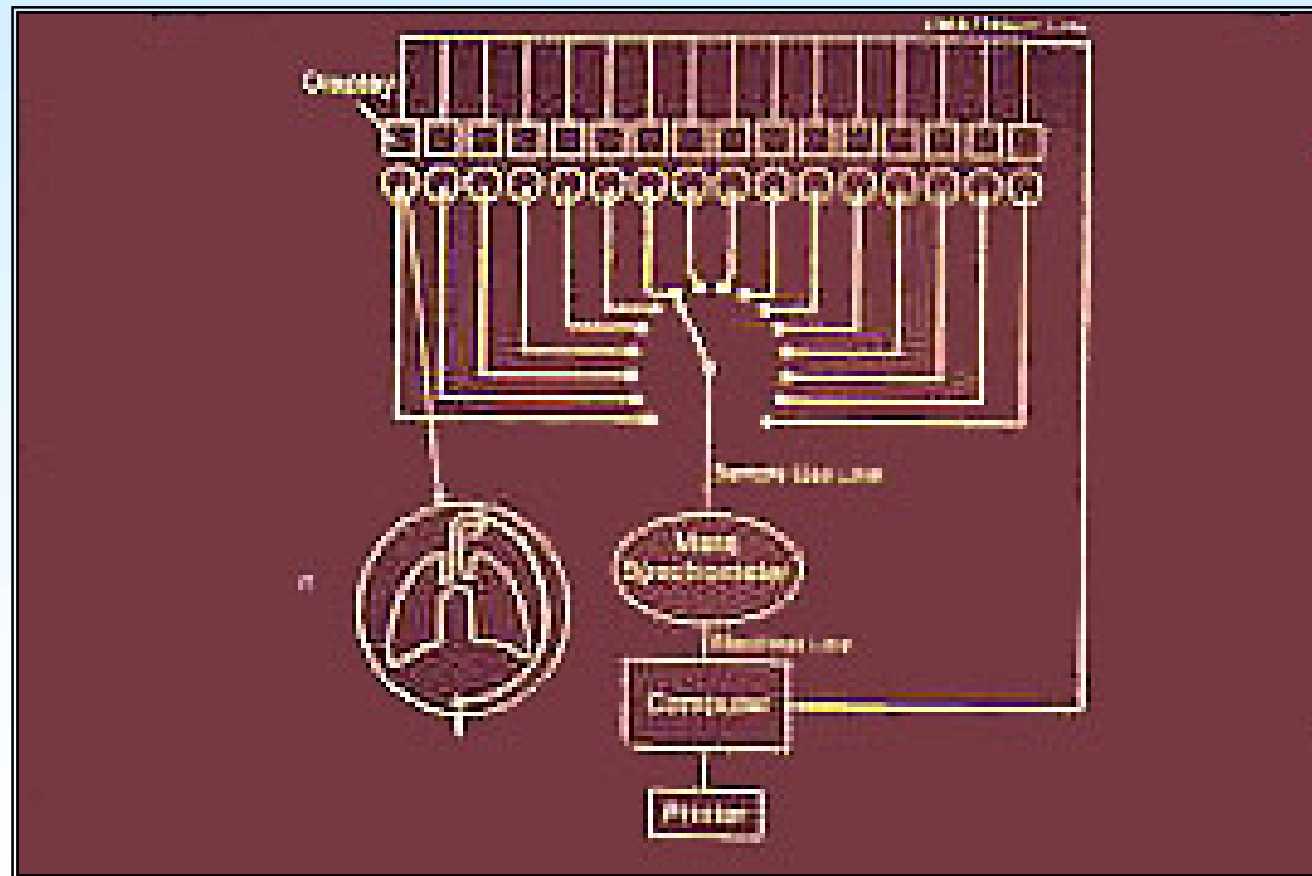
# Respiration Circuit Classification System according to Mappleson



# Anesthesia Machine without Vaporizer

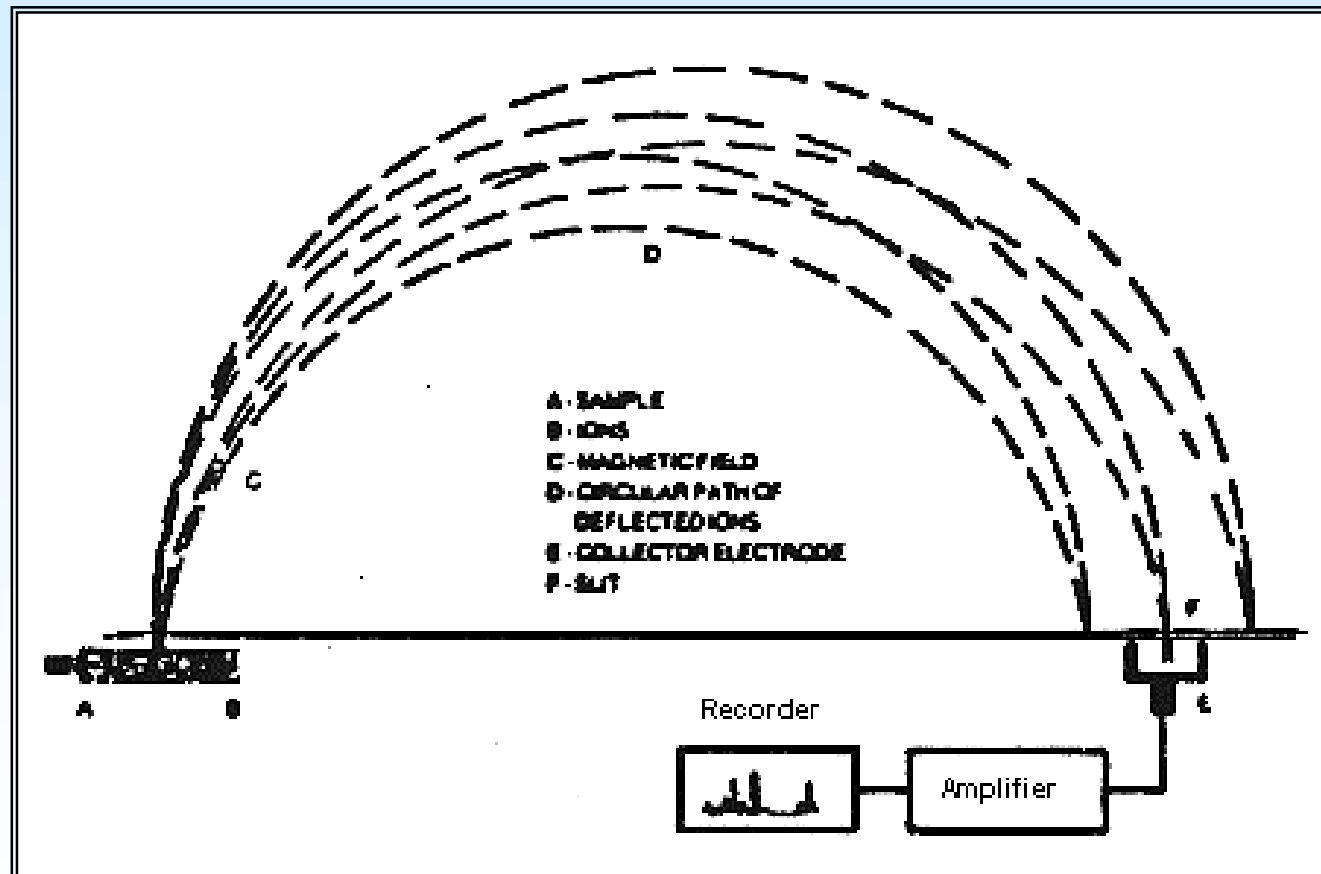


# Central Patient Gas Monitoring System

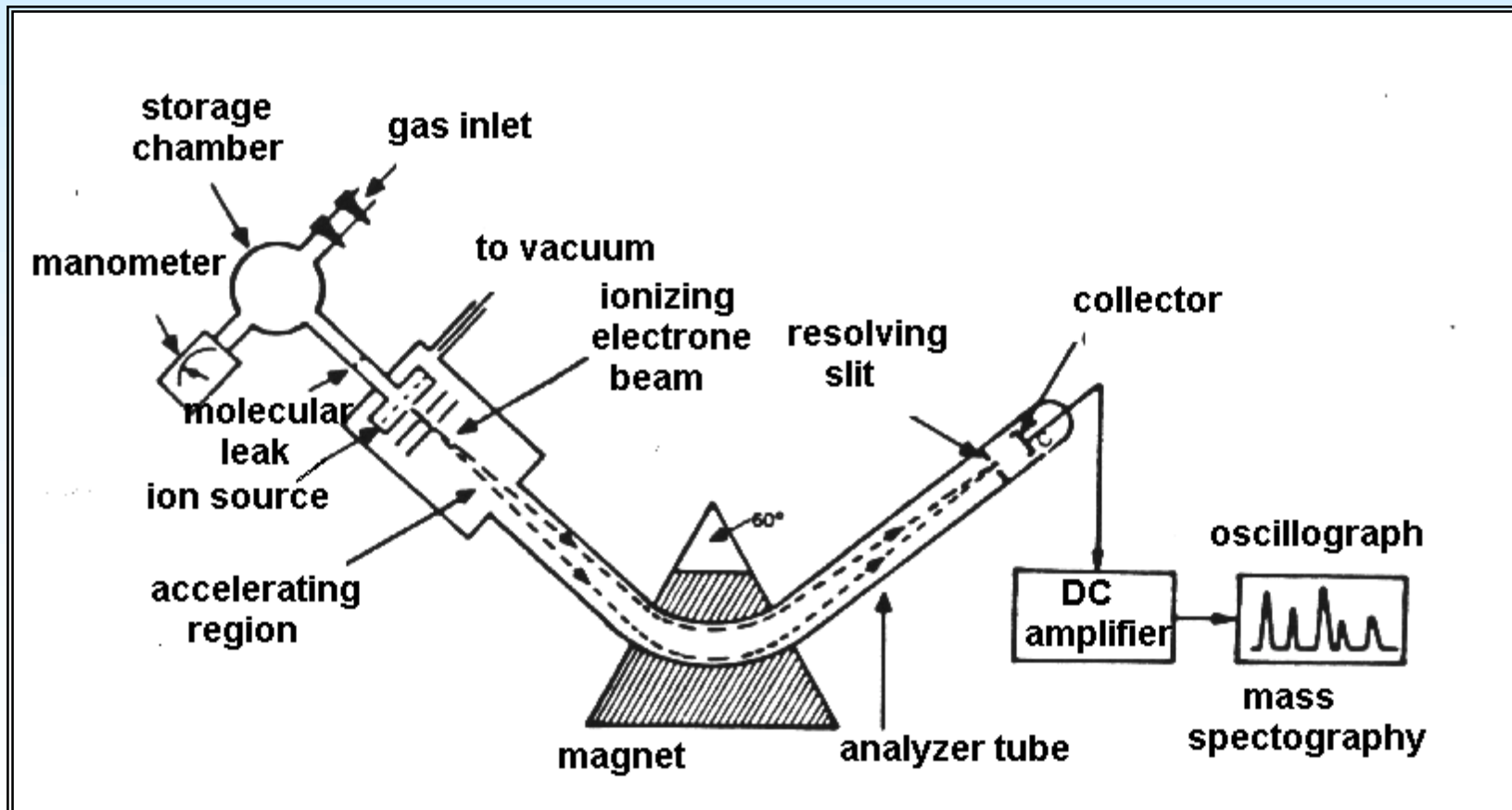




# Mass Spectrometer: Operation Principle



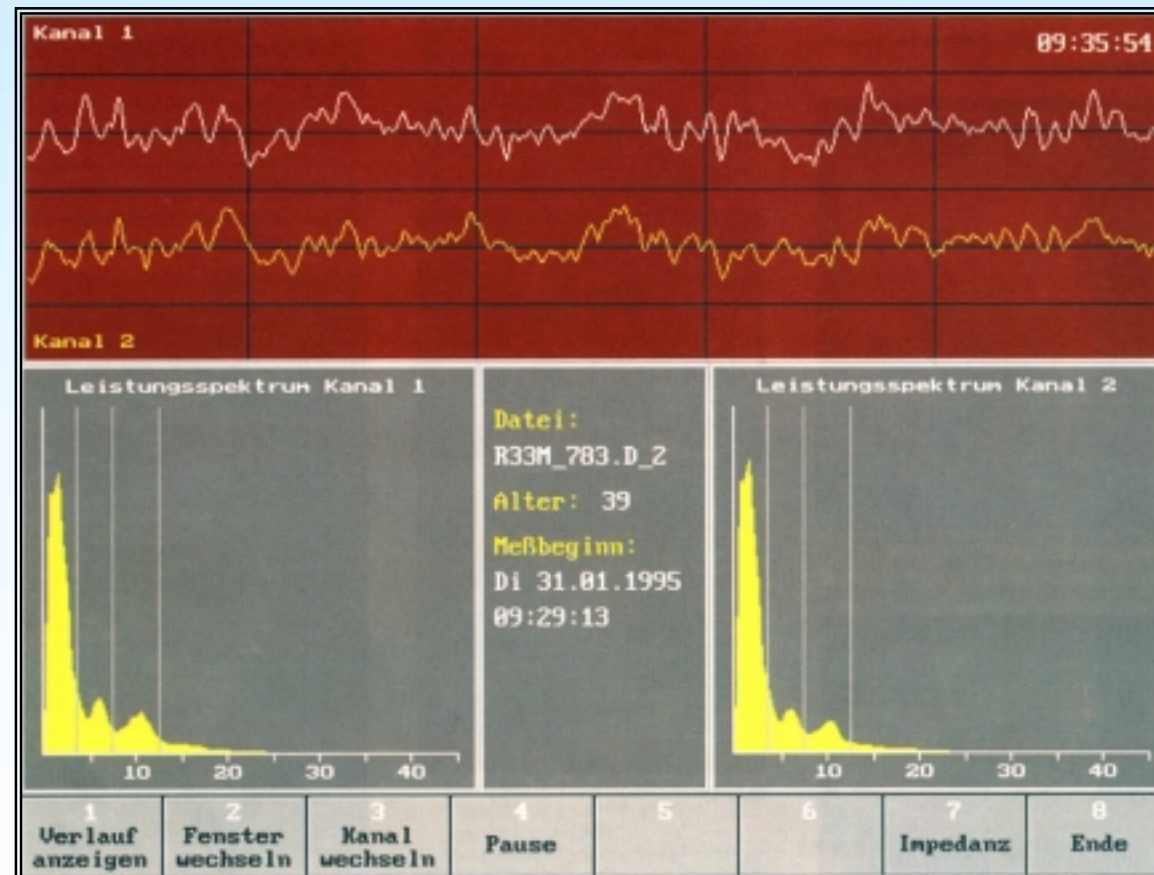
# Mass Spectrometer: Block Diagram



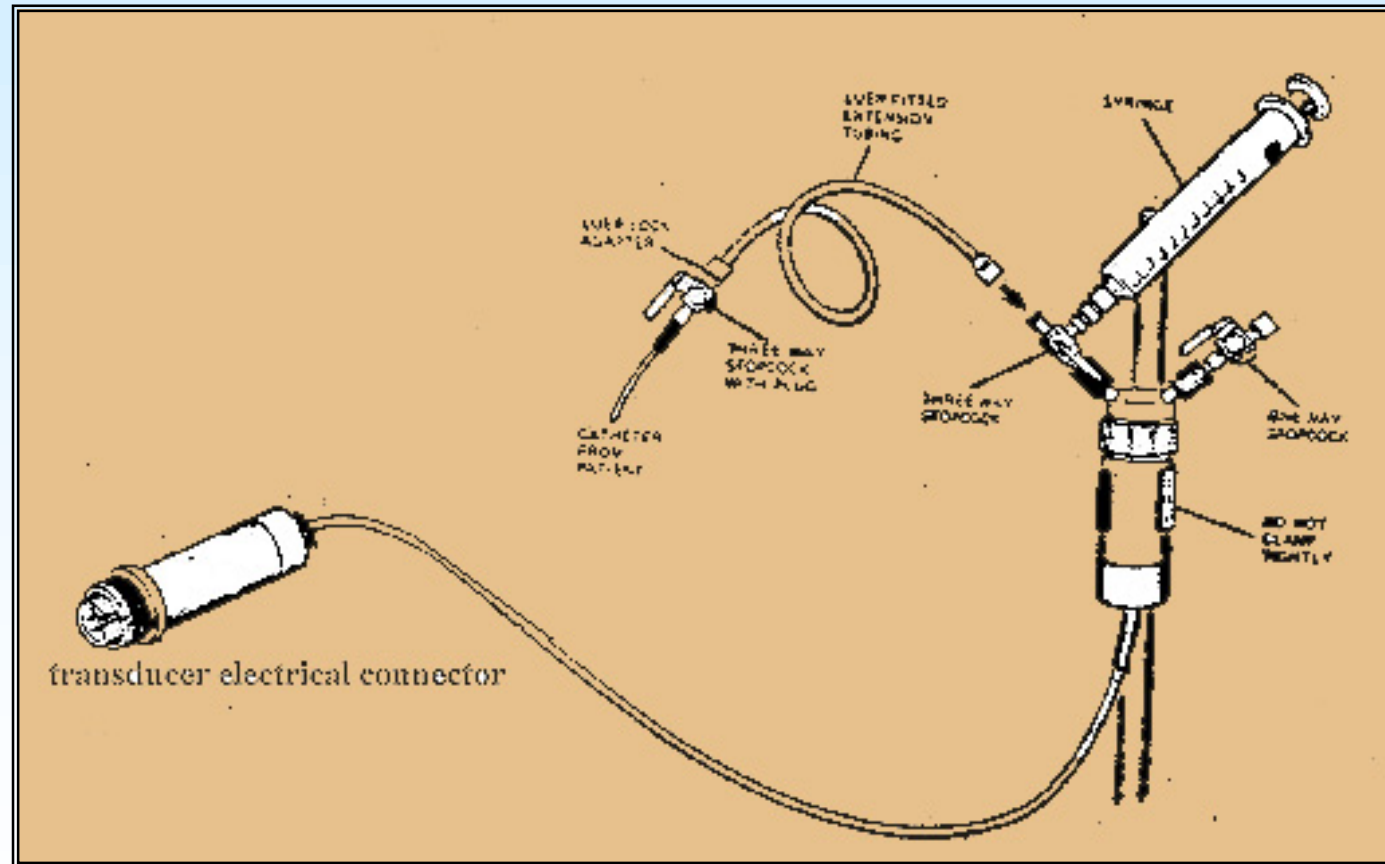
## Chemical pollution in the operating room

- Chemical pollution of operating room air has received increasing attention and a safe exposure limit or a level above which anesthetics begin to exert a toxic effect cannot be determined.
- If non re-circulating air exchange rates in a regular operation room are not greater than 12 times per hour, a waste-gas disposal system (scavenger) should be installed.

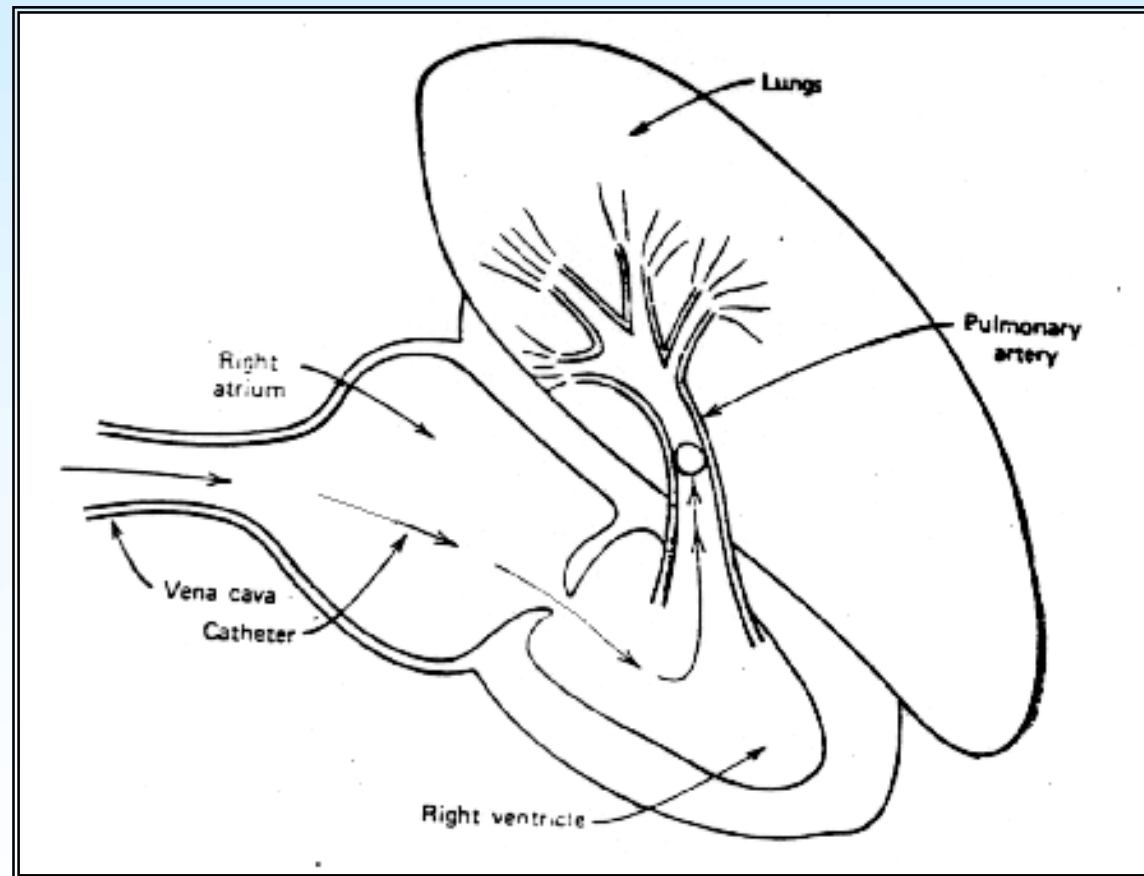
# Anesthesia Depth



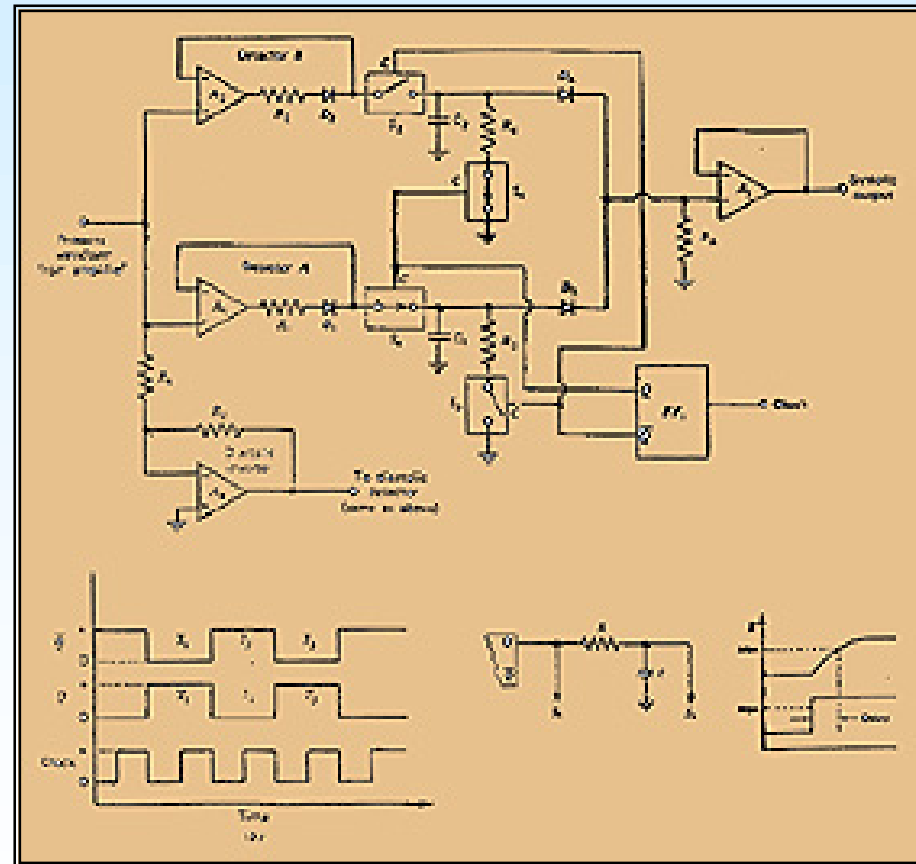
# Invasive Arterial Pressure Measurement System



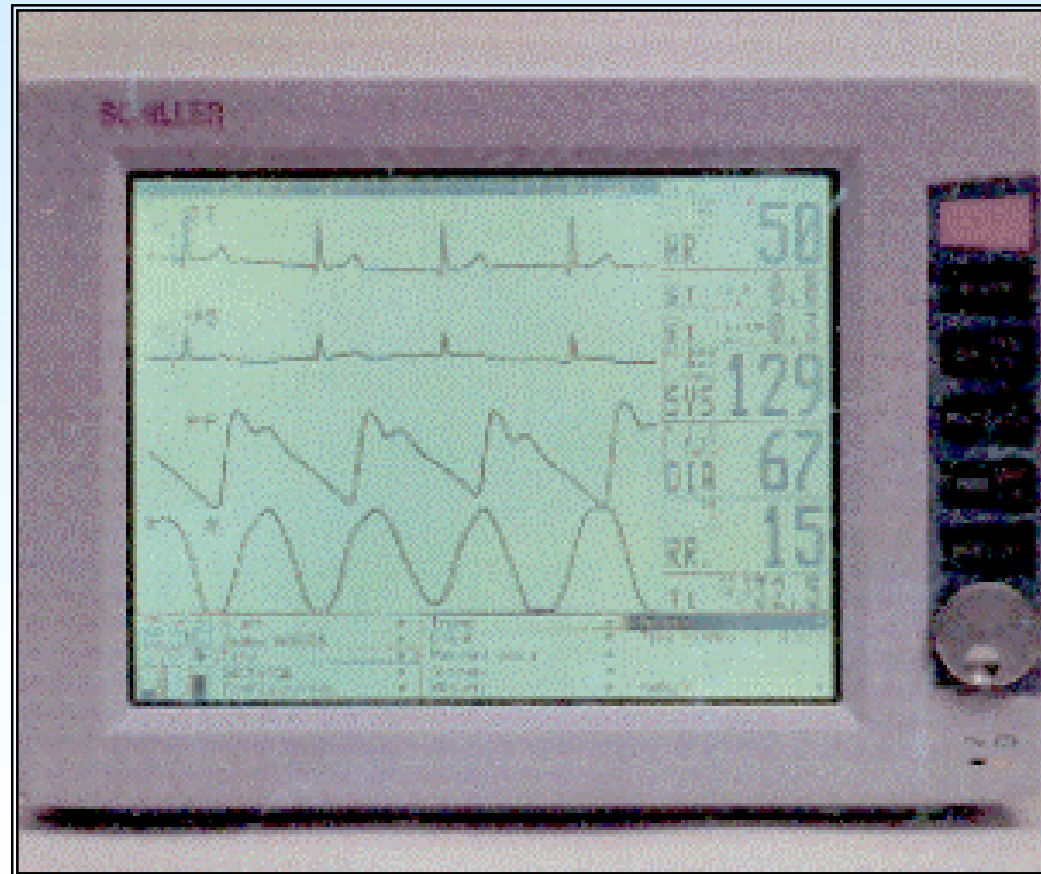
# Invasive Arterial Pressure Measurement in Vena Cava, Right Atrium and Right Ventricle



# Block Diagram of an Invasive Arterial Pressure Measurement System

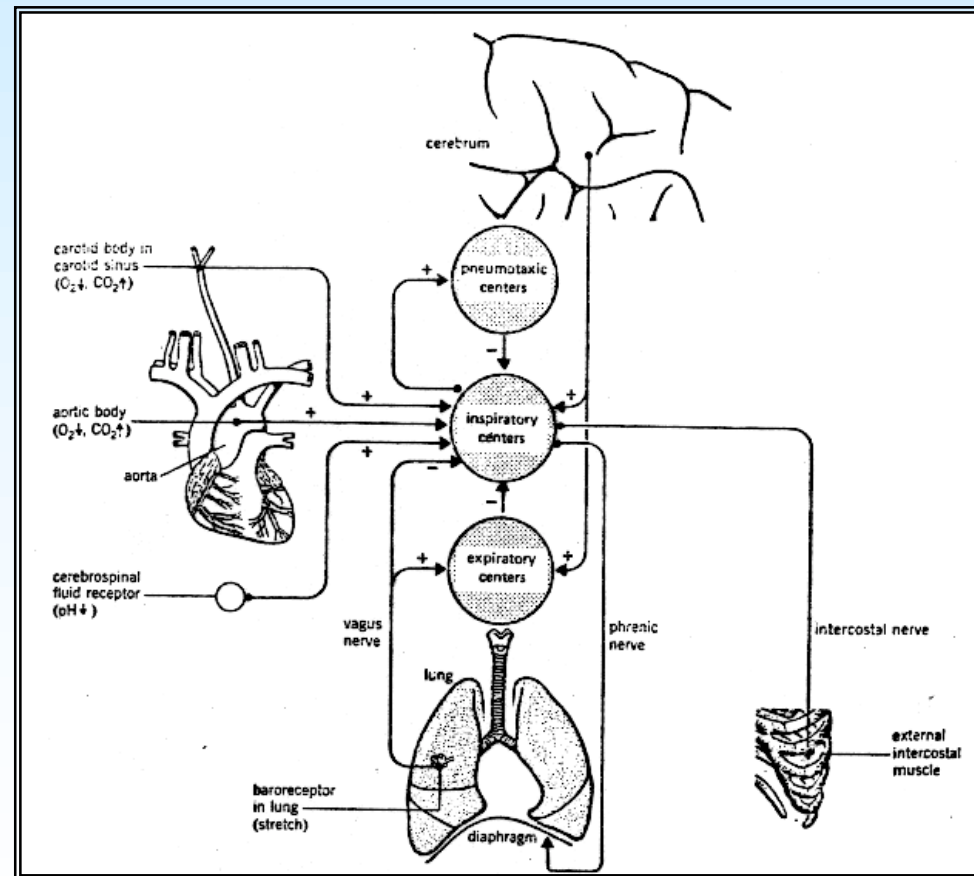


# OR Monitor

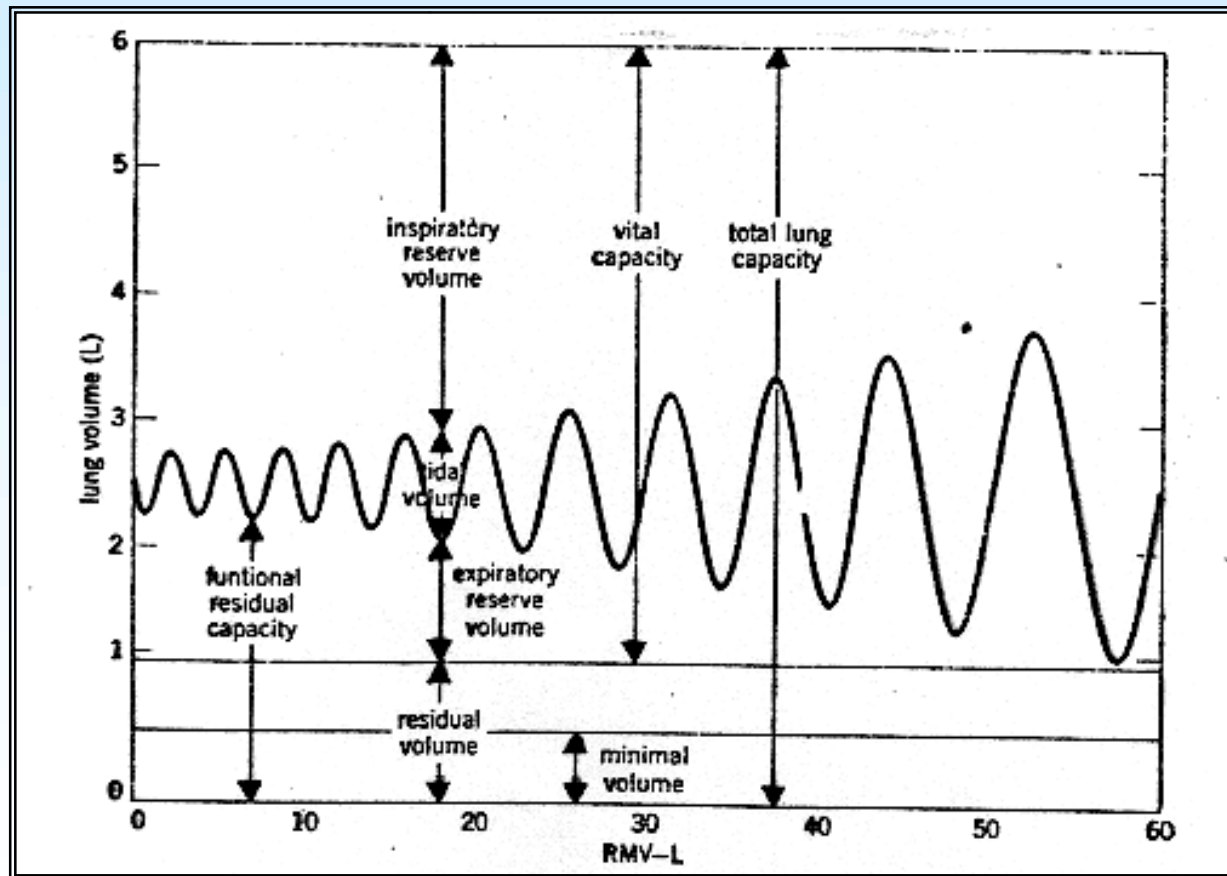




# Respiration Physiology



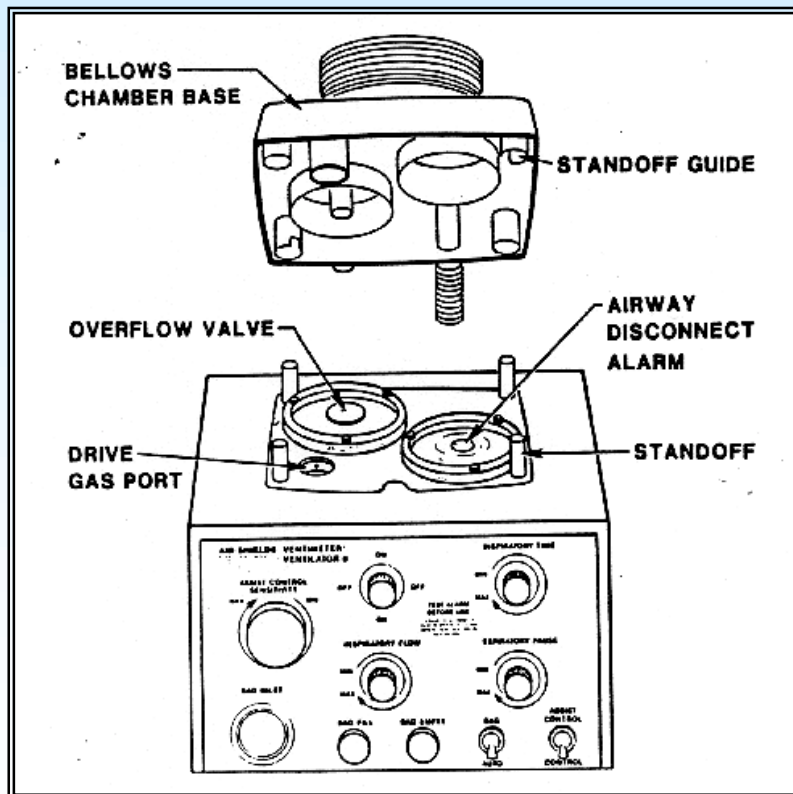
# Respiration Volumes



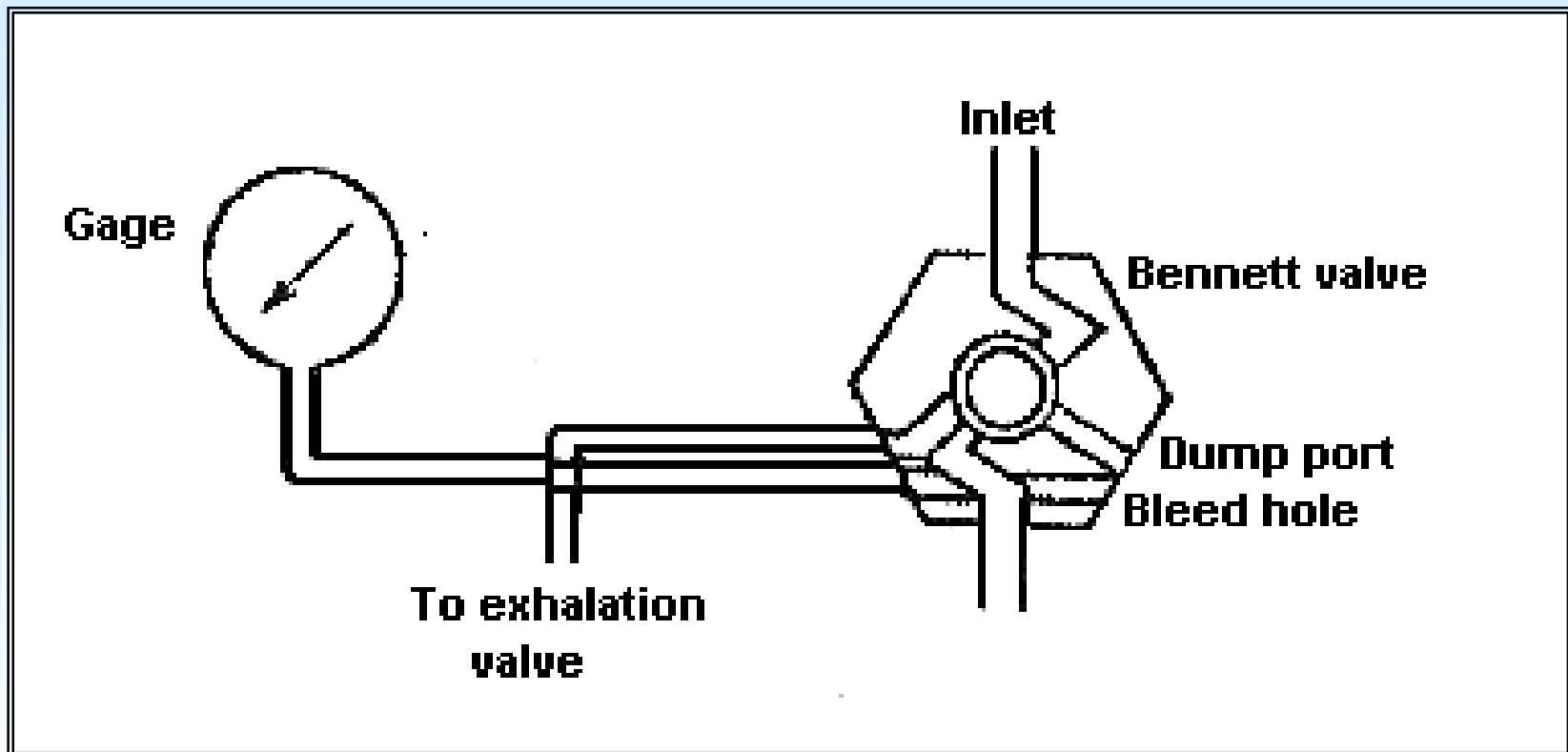
# Ventilators

- Ventilators for anesthesia have become an integral component of the modern anesthesia machine and allow ventilation, arterial carbon dioxide control and compensation of changes in lung compliance, during operation.
- Ventilators can be divided into pressure-limited and volume-limited.

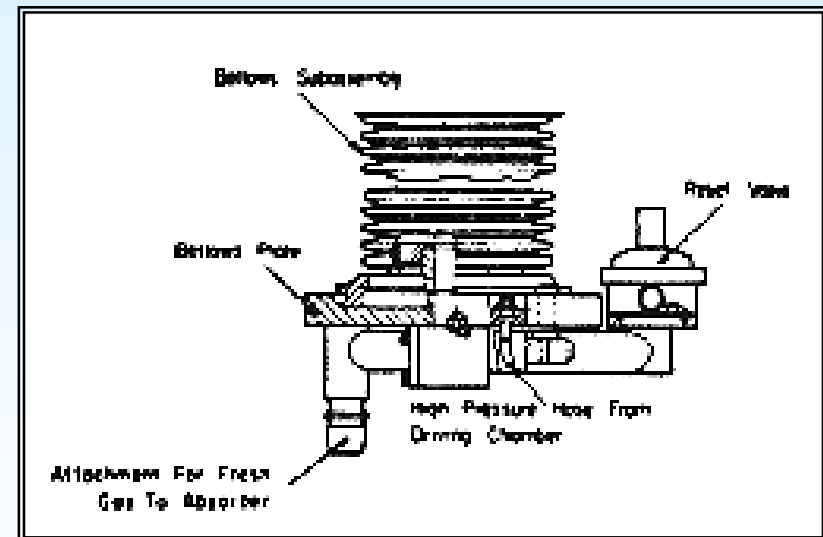
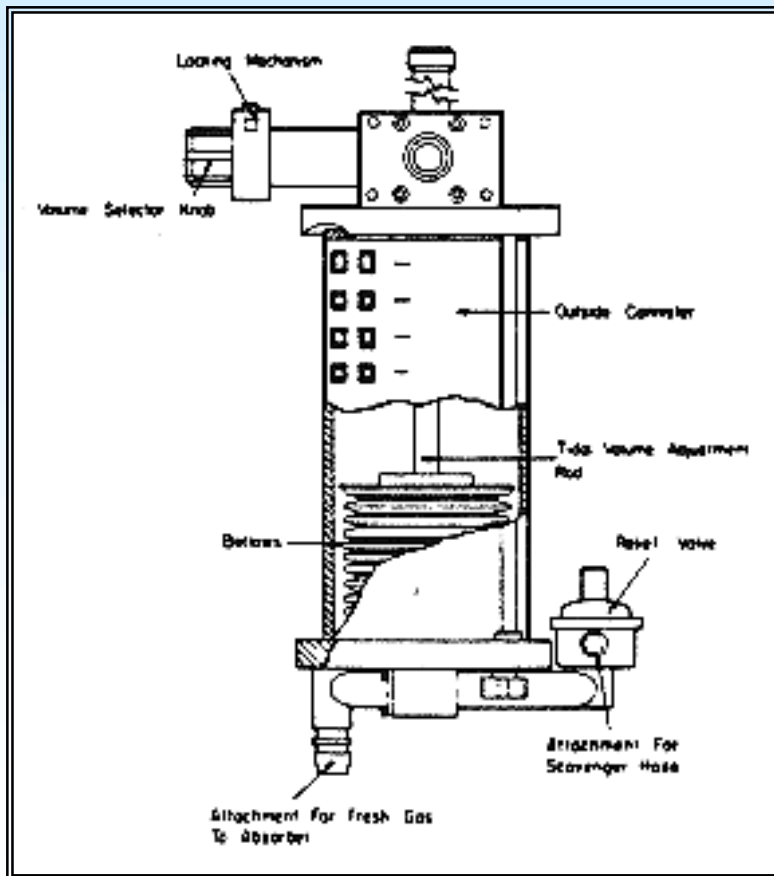
# Typical Ventilator Structure



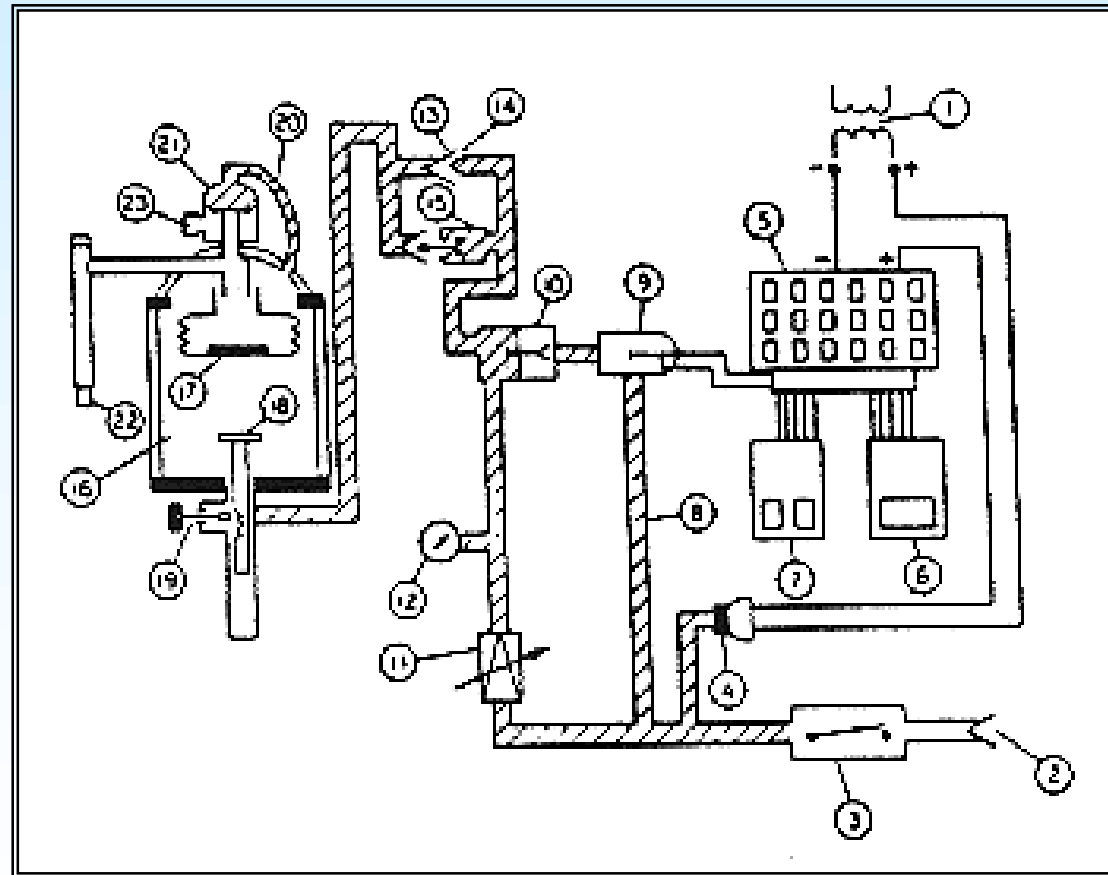
# Benett Valve



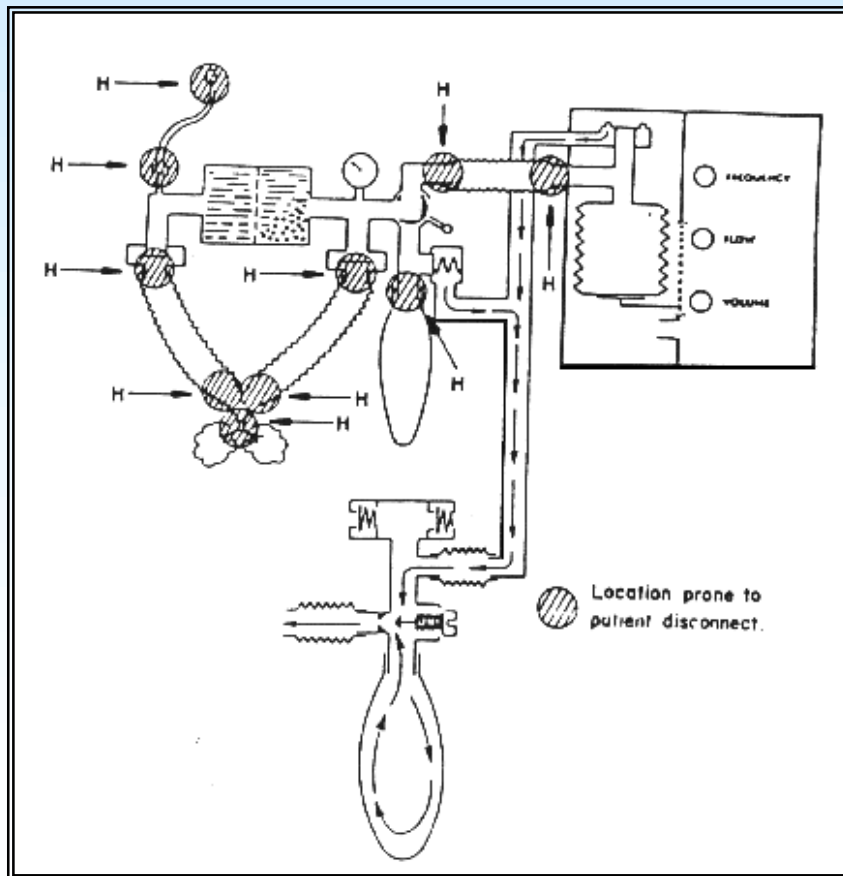
# Ventilator Spirometer Bellows



# Ventilator - Anesthesia Machine Connection



# Frequent Leaking Points

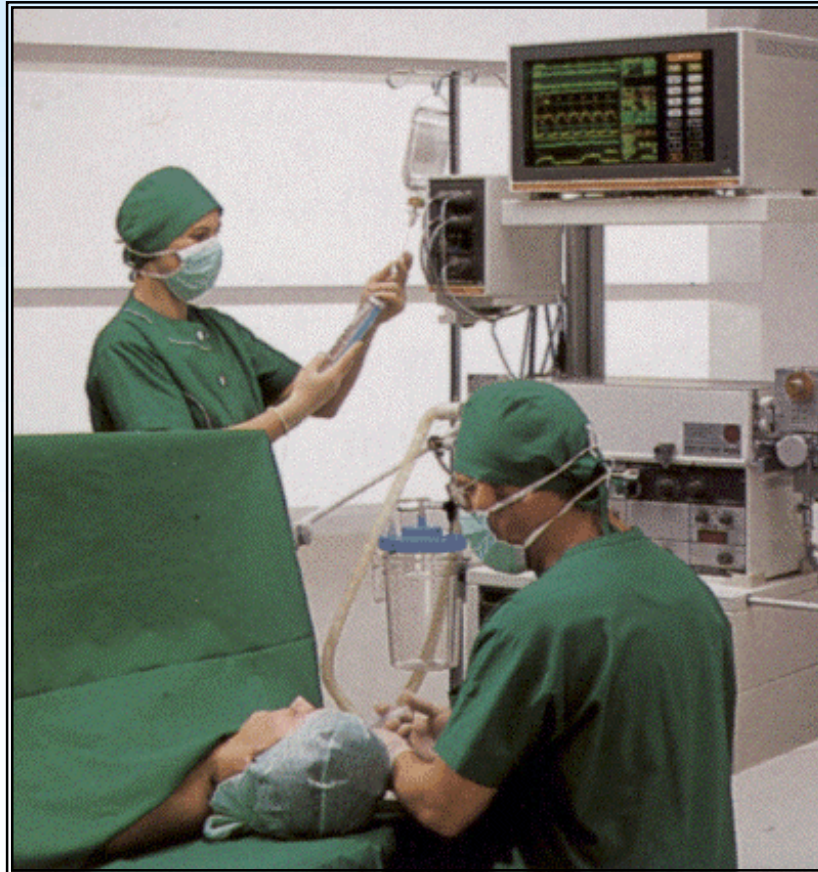




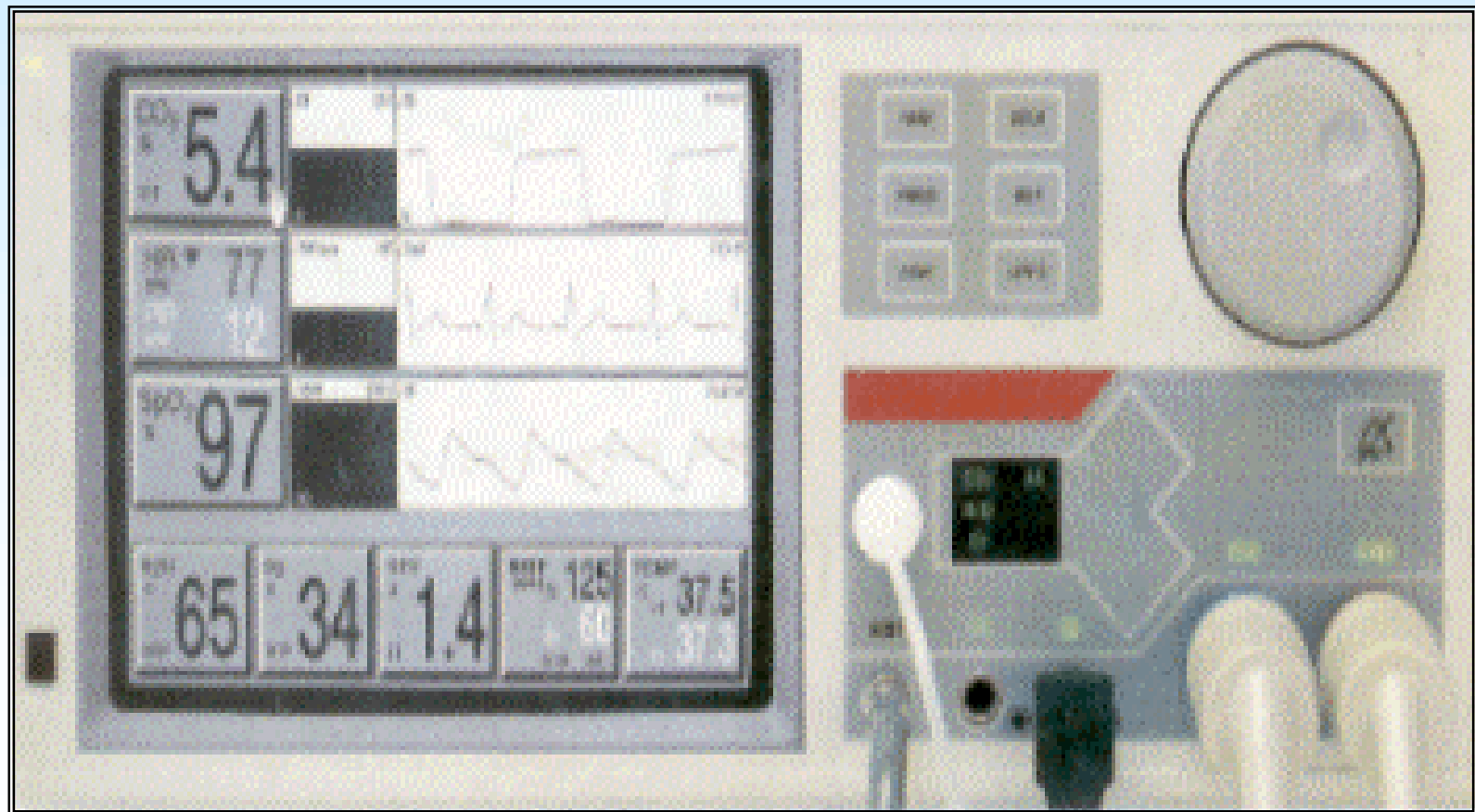
## Monitoring Equipment

- Operation Room Monitors include ECG, temperature, arterial pressure, EEG-related anesthesia depth, respiration rate and patient circuit gas monitoring monitoring, combined in one or distributed to more than one devices.
- These monitors can be ceiling suspended and/or mounted on the anesthesia machine.

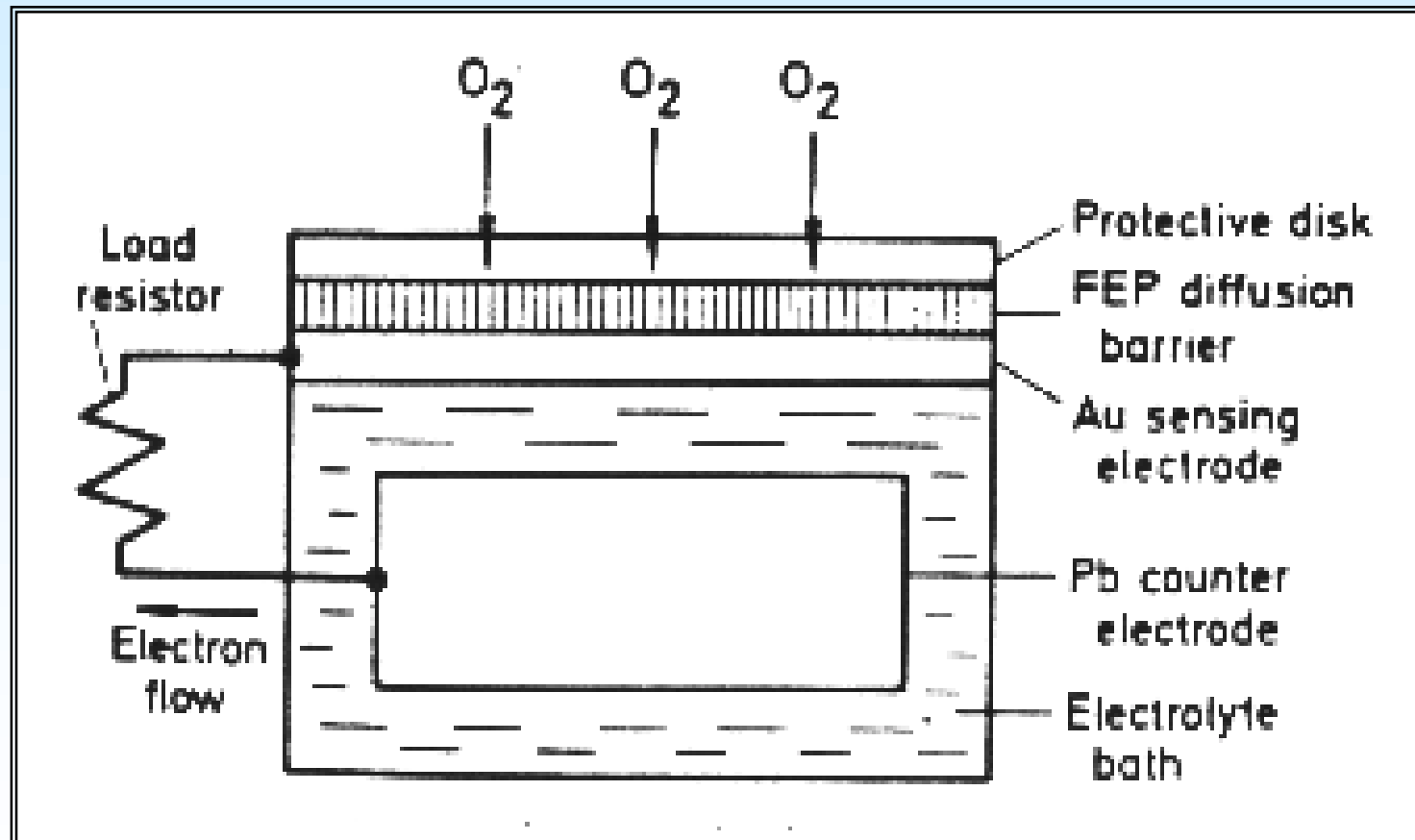
# OR Monitor



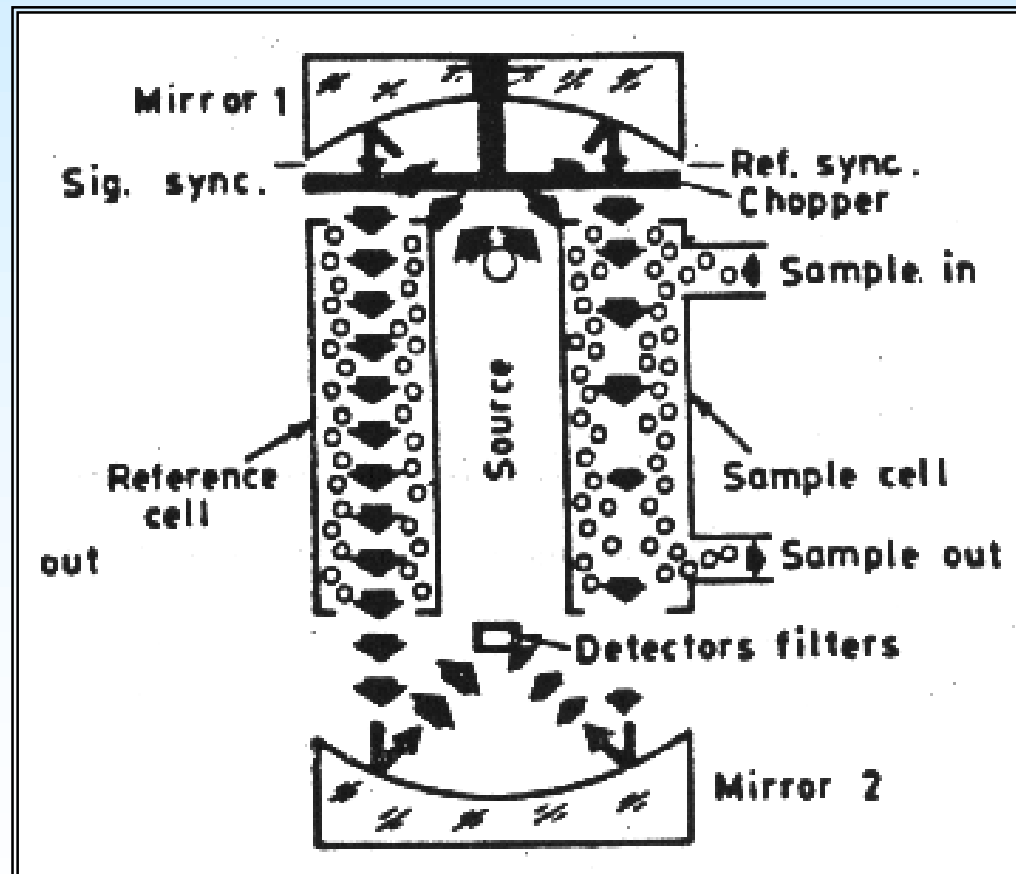
# OR Monitor + Capnography



## Typical Oxygen Electrode



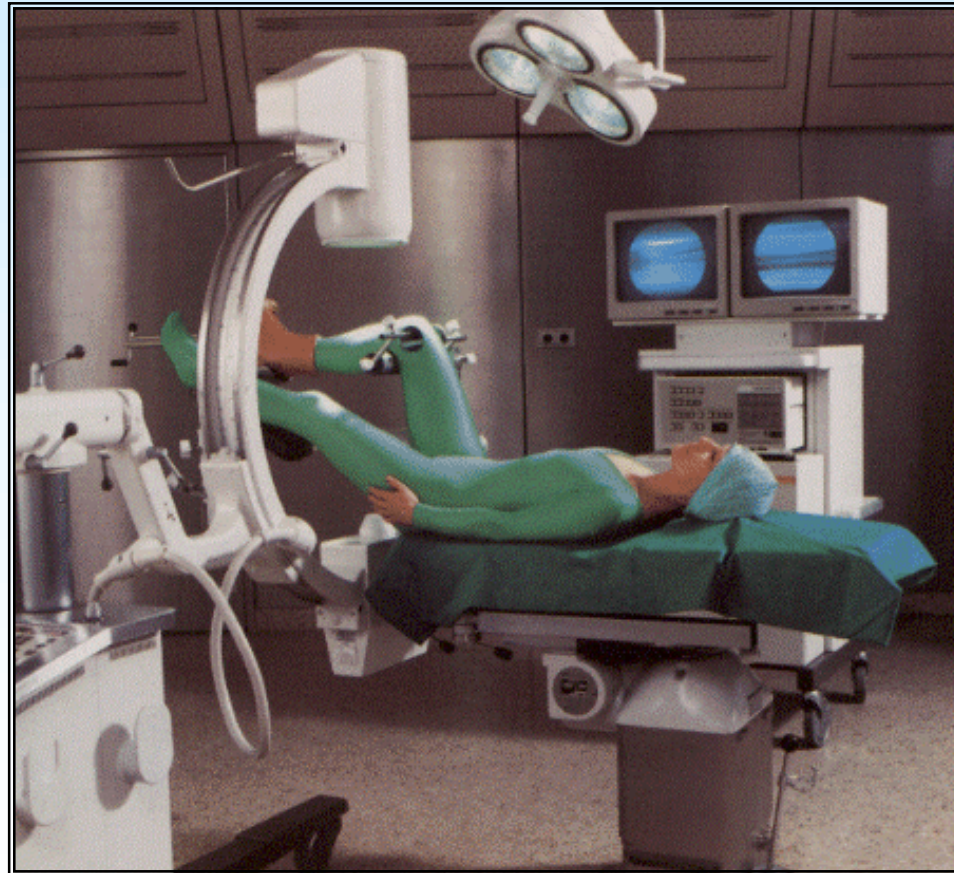
# IR absorption CO<sub>2</sub> detector



## Radiology Equipment

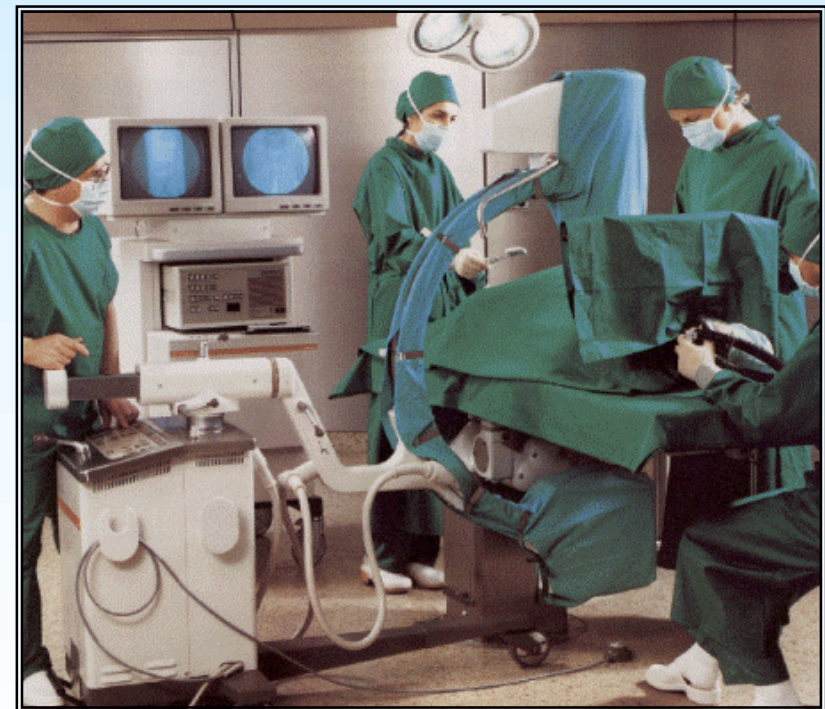
- A significant number of surgical procedures require intra-operative radiological assistance, as performed in a hospital with general surgery, orthopedic, cardiac surgery, intra-operative angiography, and urology services.
- Questions commonly arise about the number of ceiling-mounted and mobile X-ray equipment, the appropriateness of cassette-film machines or mobile C-arm fluoroscopy units, film-processing, electronic image storage and display, radiation protection in operating room etc.
- To organize, arrange, and equip a surgical suite and to educate the surgeons, radiologist, OR-personnel, and technicians about operation room X-ray is always a challenging task, that should be performed individually in each Operating Department.

# Radiological Equipment in OR





## Ceiling-mounted and mobile X-ray equipment

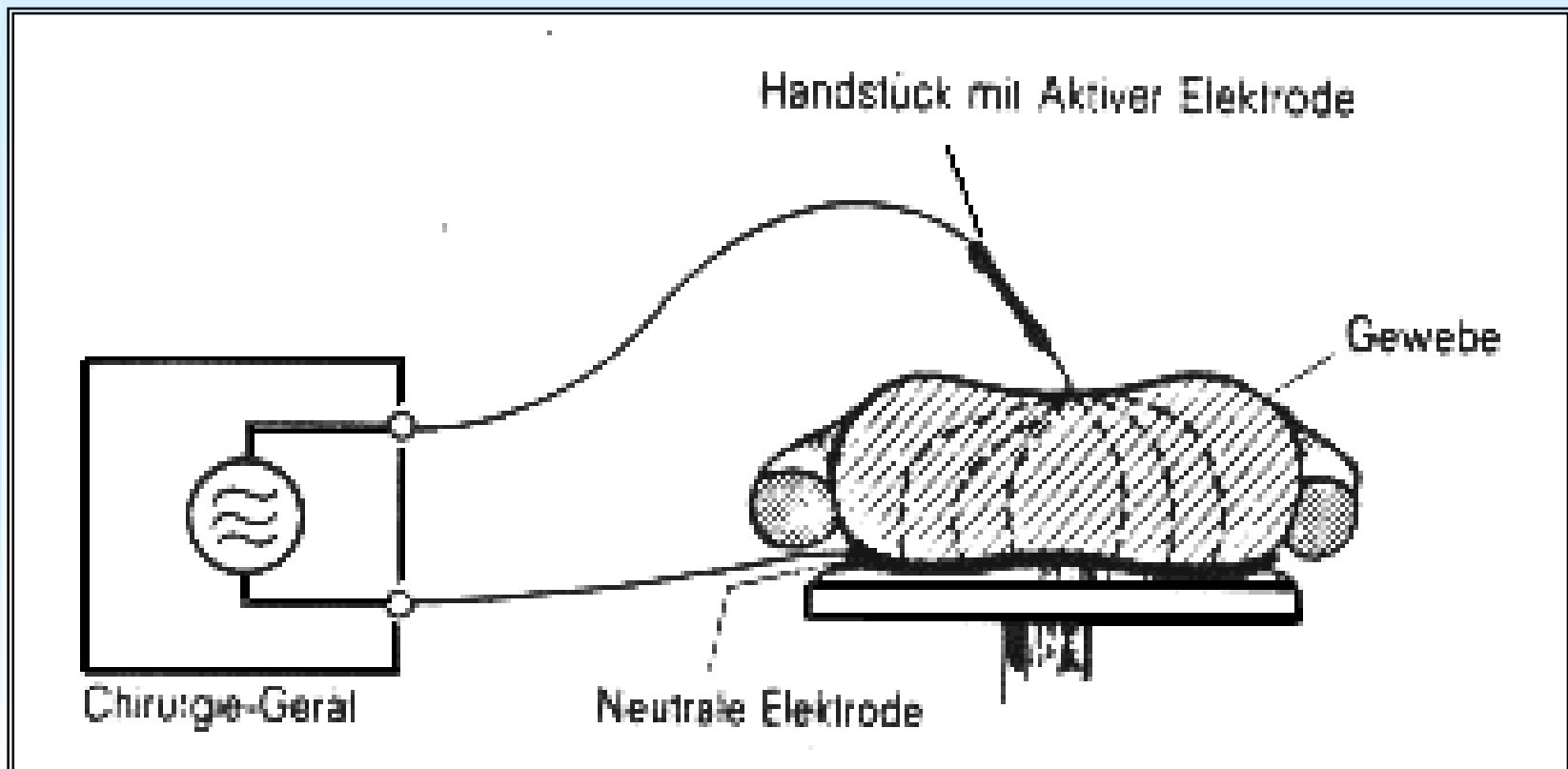




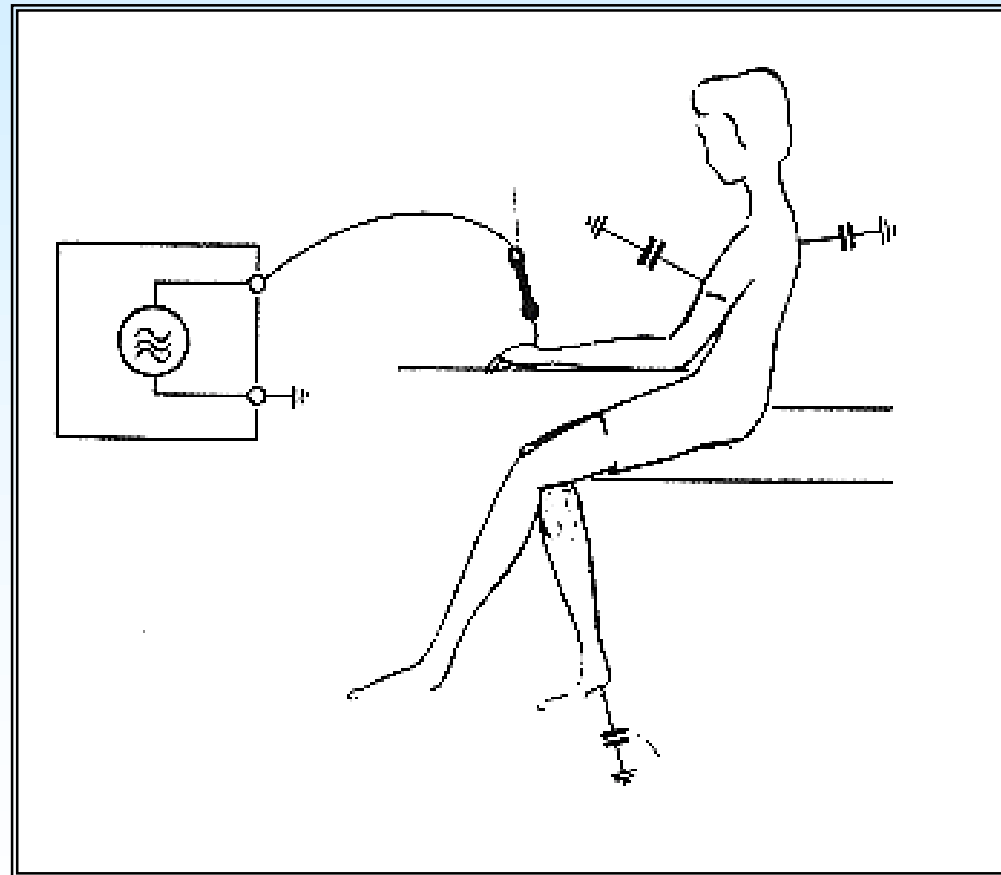
# Electrosurgery

- *Electrosurgery*, i.e. the conduction of a high frequency (more than 300 kHz, usually around 1 MHz) current on or through the patient:
  - ◆ *Either between a neutral electrode with a large surface and an active electrode with a small surface area (mono-polar mode).*
  - ◆ *Or between two active electrodes (bipolar mode).*
- The current density produces enough heating of the tissue cell fluids to vaporize (*cutting mode*) or to clotting (*coagulation mode*).

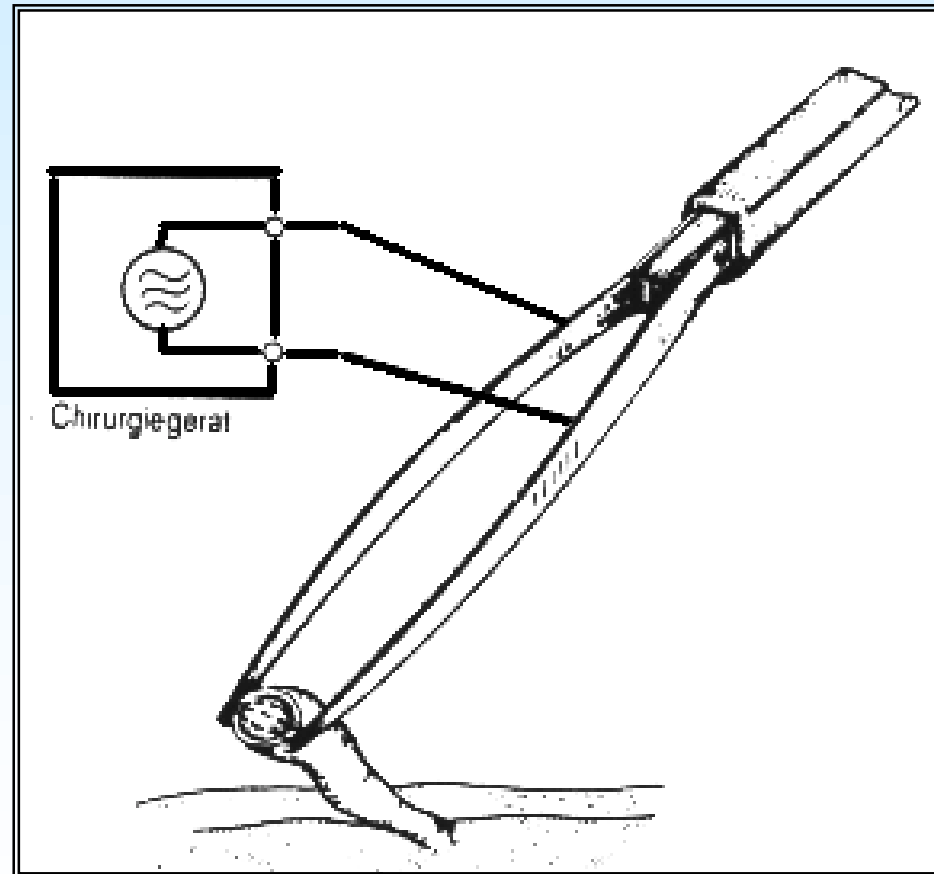
## Electrosurgery: Mono-polar mode



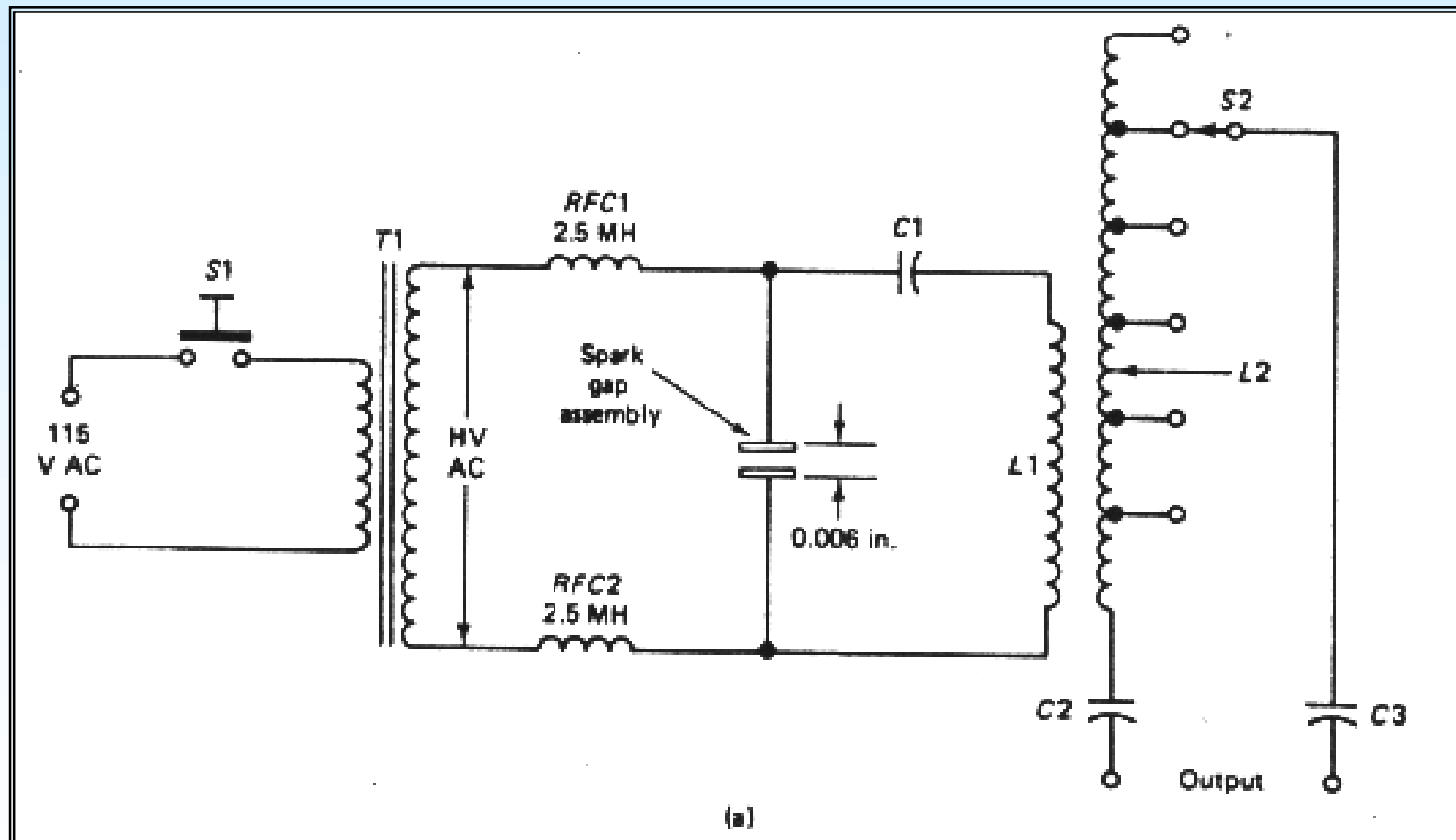
## Electrosurgery: Earthing through the body



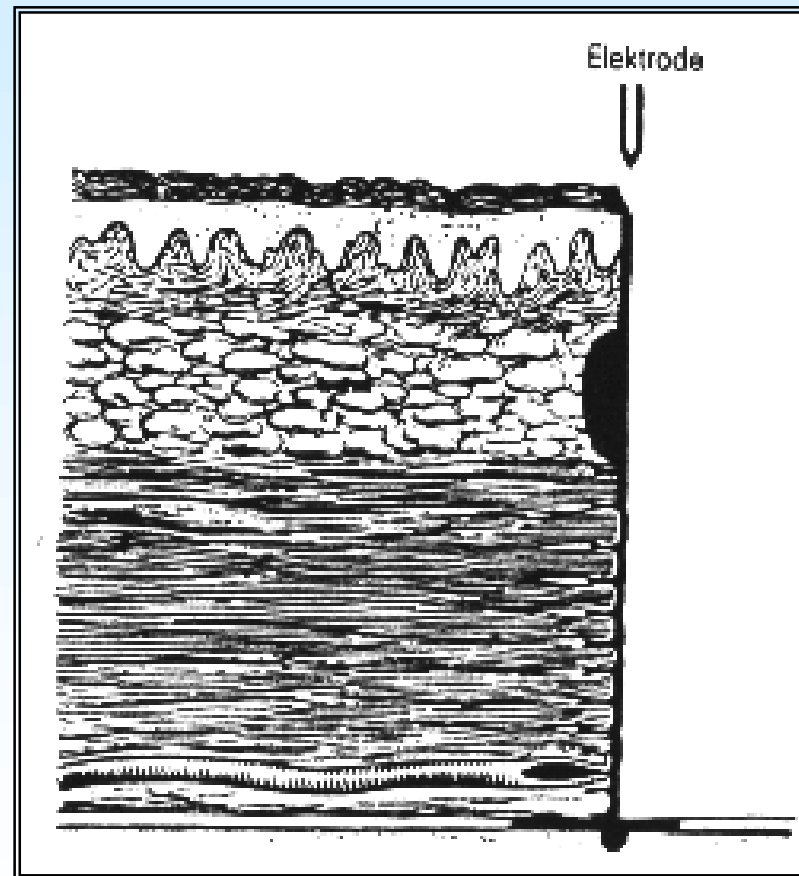
# Bipolar Electrosurgery System



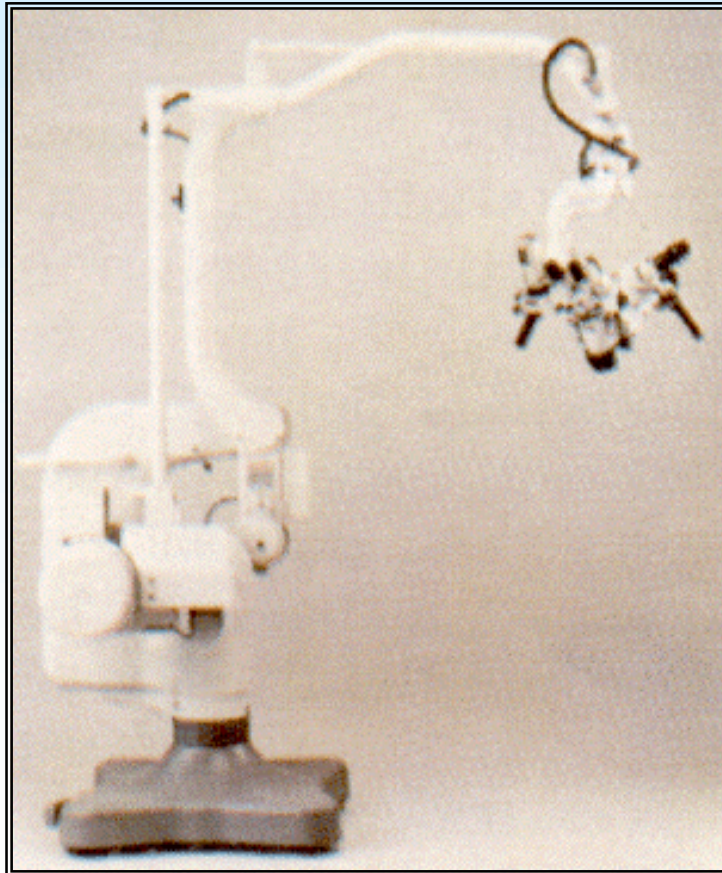
# Spark-gap generator



# Electrosurgery System: Current / heat dissipation in depth

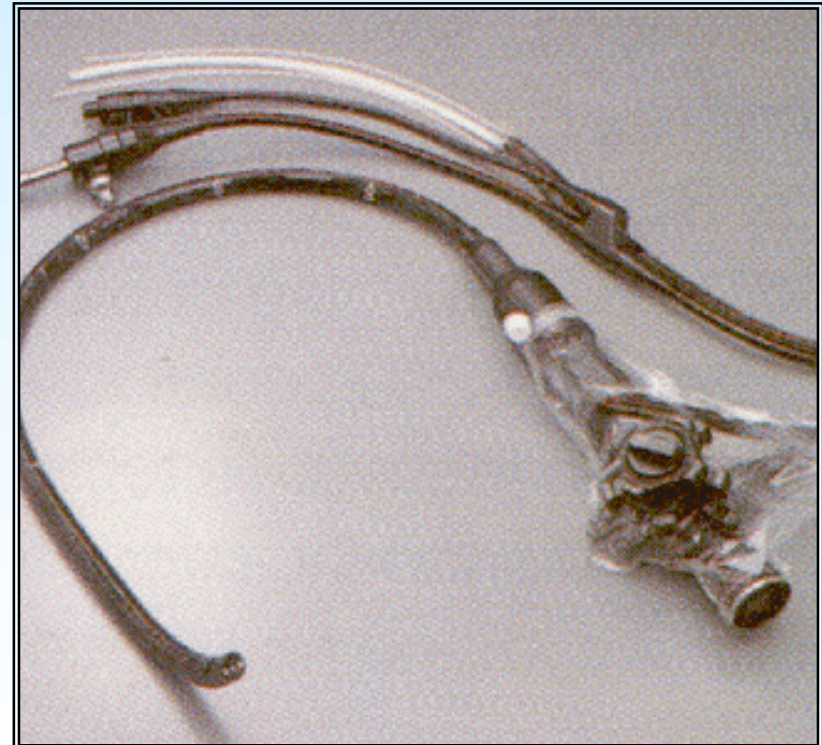
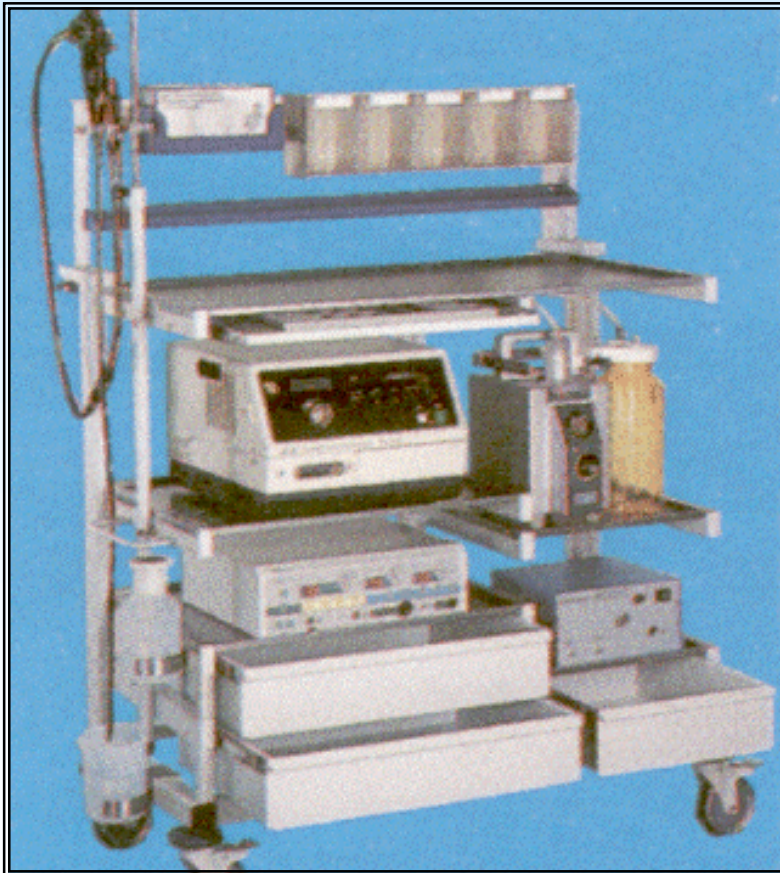


# Operation Microscopes



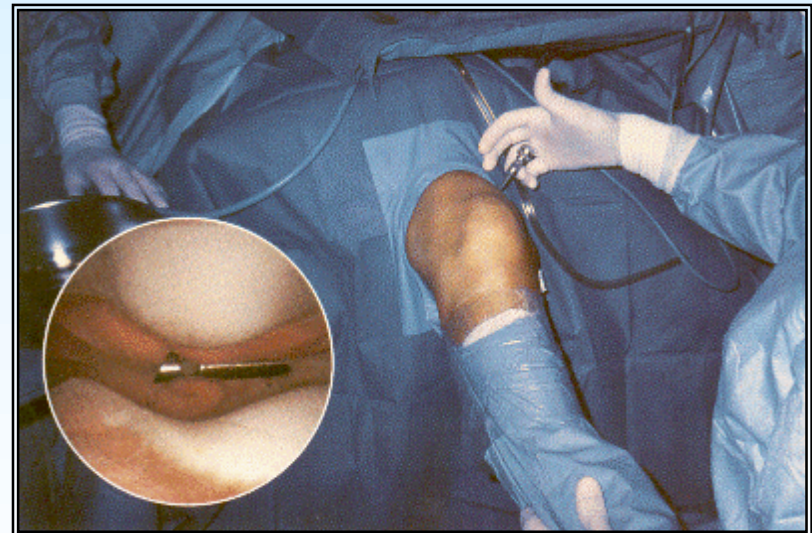
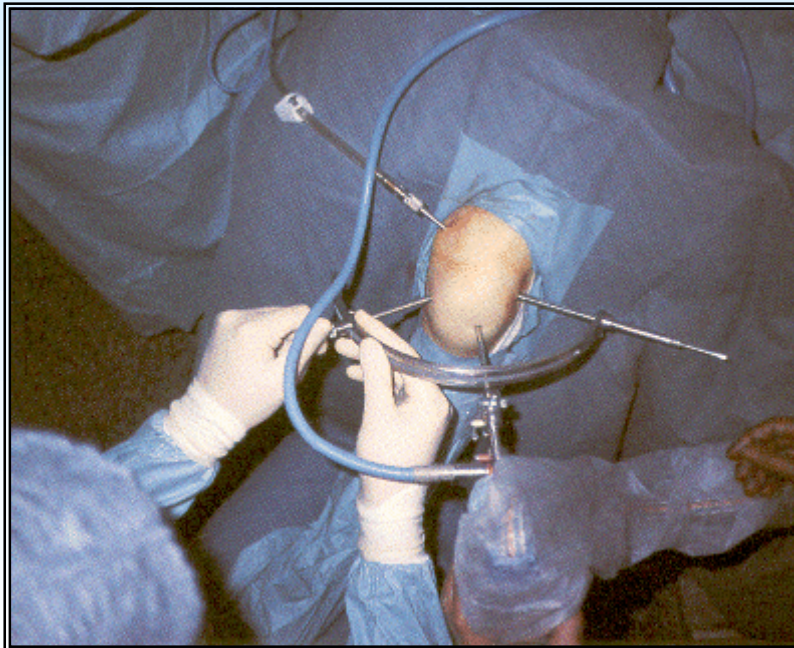


# Endoscopy System

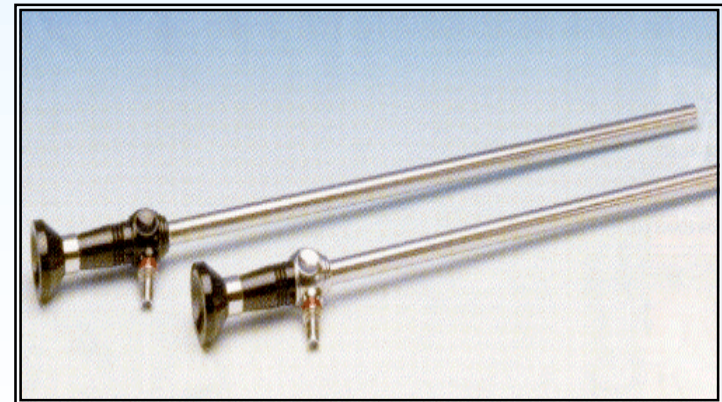
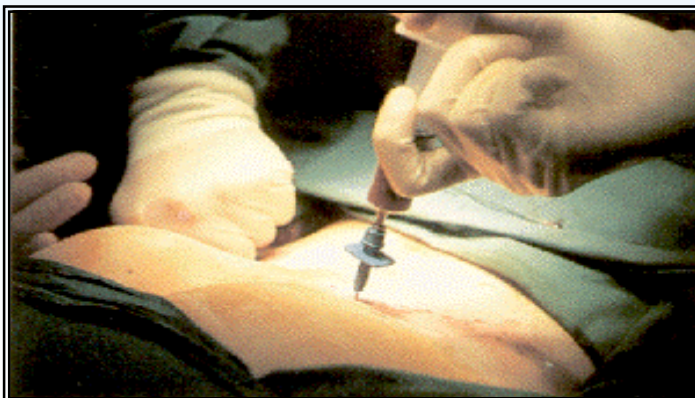
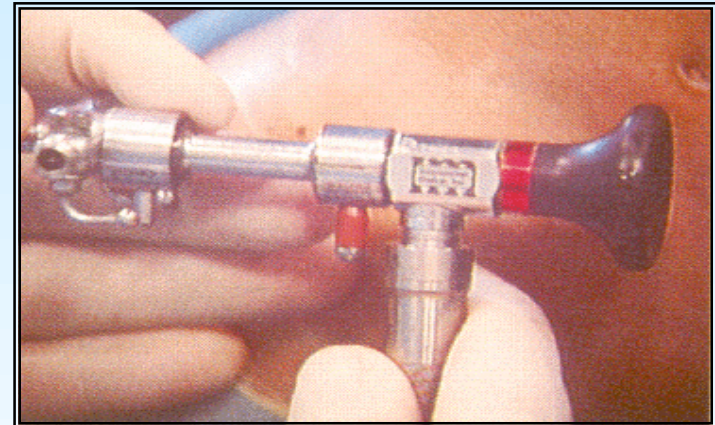
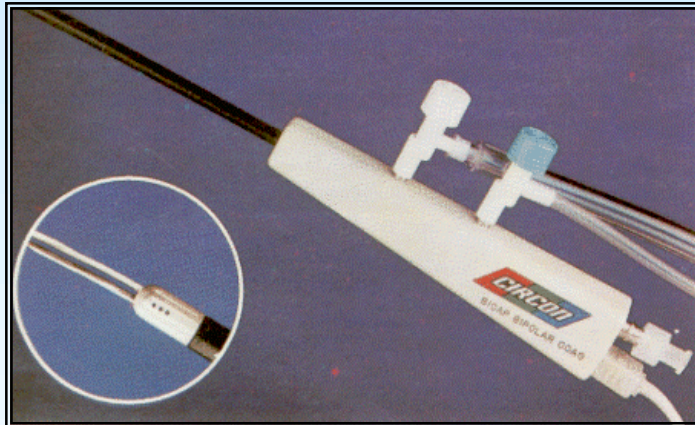




# Arthroscopy

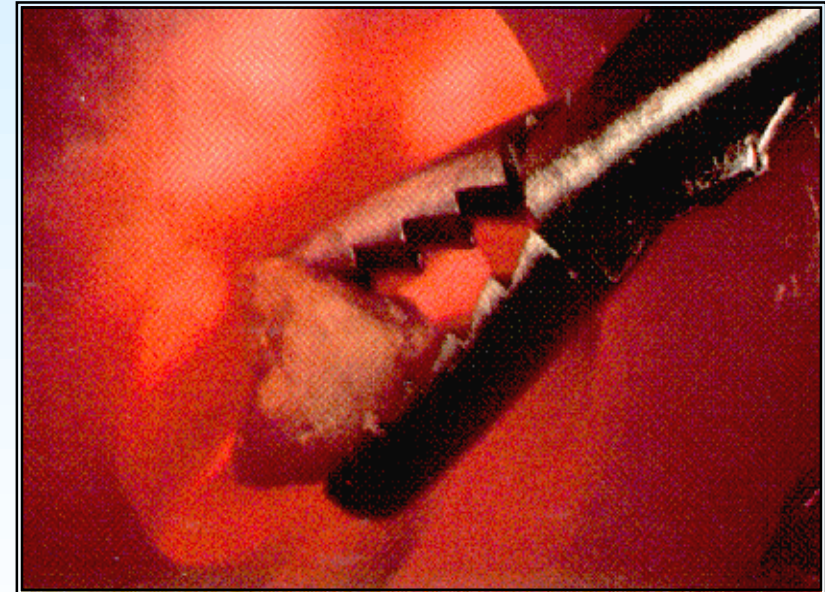


# Laparoscopy

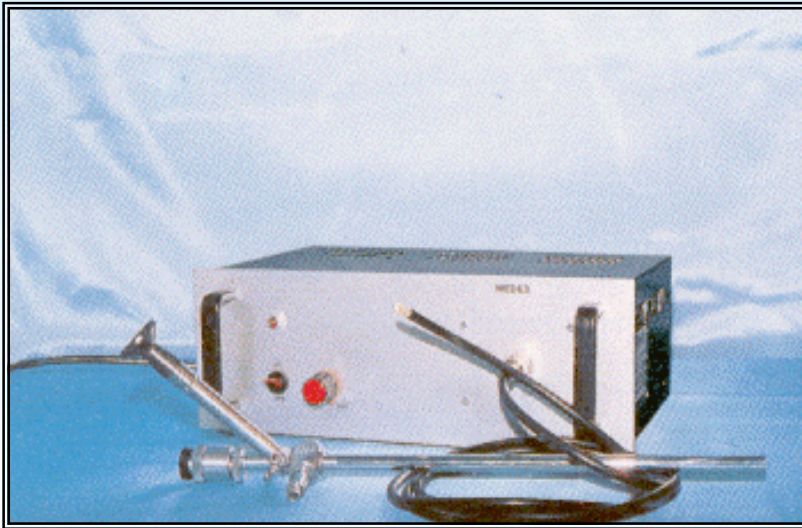




# Endoscopic Surgery



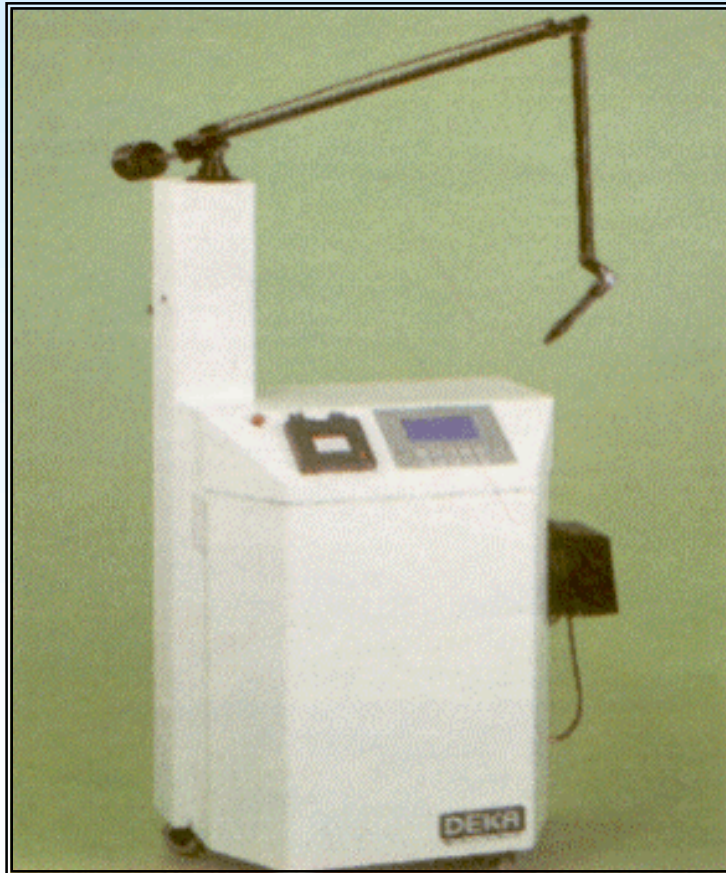
## Endoscopy: Light Source and Disinfecting



# Surgical LASERS

- Surgical LASERS (NdYAG, CO<sub>2</sub>) can be applied:
  - ◆ *Intra-arterially.*
  - ◆ *Intra-cavitary.*
  - ◆ *As a scalpel.*
- It is offering a relatively nontraumatic operation, reducing infection risk and increasing the accessibility of the tissue to be removed.
- A typical surgical LASER system, includes the focusing head, the manipulator arm, the LASER, the control console and the external cooling and suction system.

# Surgical LASER





# Cryosurgery

Cryosurgery, is based on the use of liquid  $\text{NO}_2$  that is brought through a hollow probe into contact with “diseased” tissue, which after being exposed to freezing disintegrates painlessly and sloughs away.

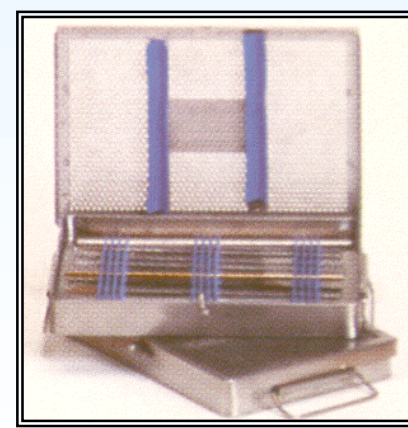
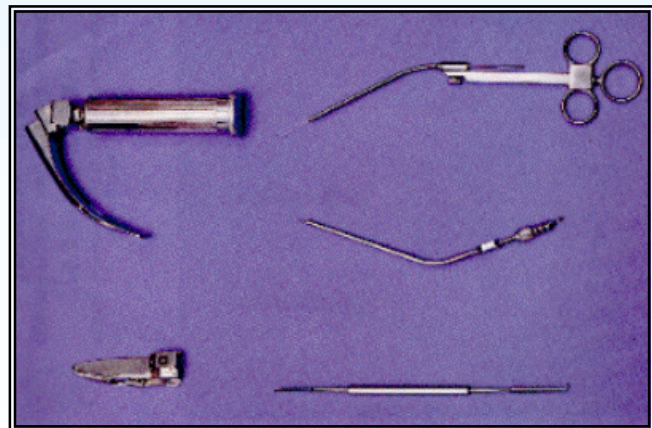
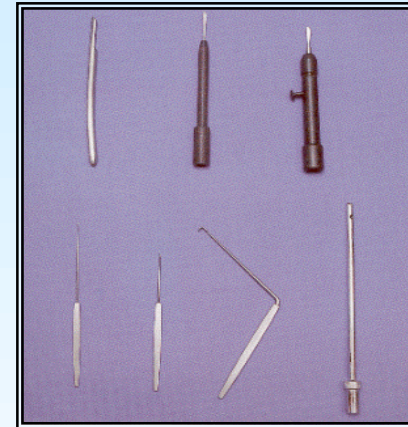
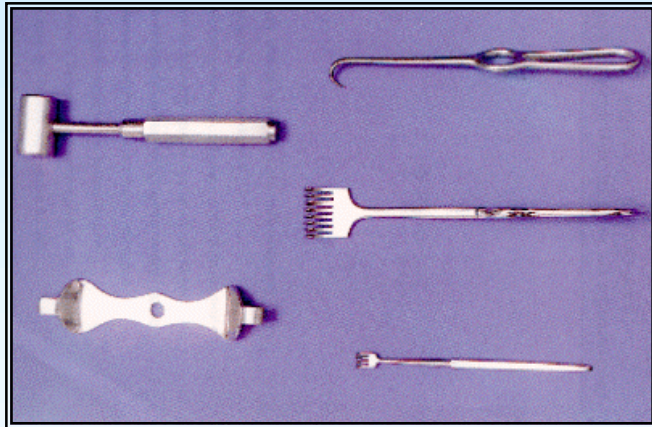


## Surgical Instruments

- Surgical Instruments include scalpels, scissors, forceps, artery forceps, cotton swab forceps, retractors, spatulas, probes, applicators, suture sets, dressings, and numerous other items, specific for various surgical applications, within several medical and surgical specialties.
- Because of the enormous number of individual instruments, a strict classification and codification system is required, based usually on a numerical order, managed nowadays by appropriate programs. Surgical instruments are usually manufactured from stainless steel, but gold, titanium and other coatings are also used, to produce LASER or Electrosurgery compatible Instruments.



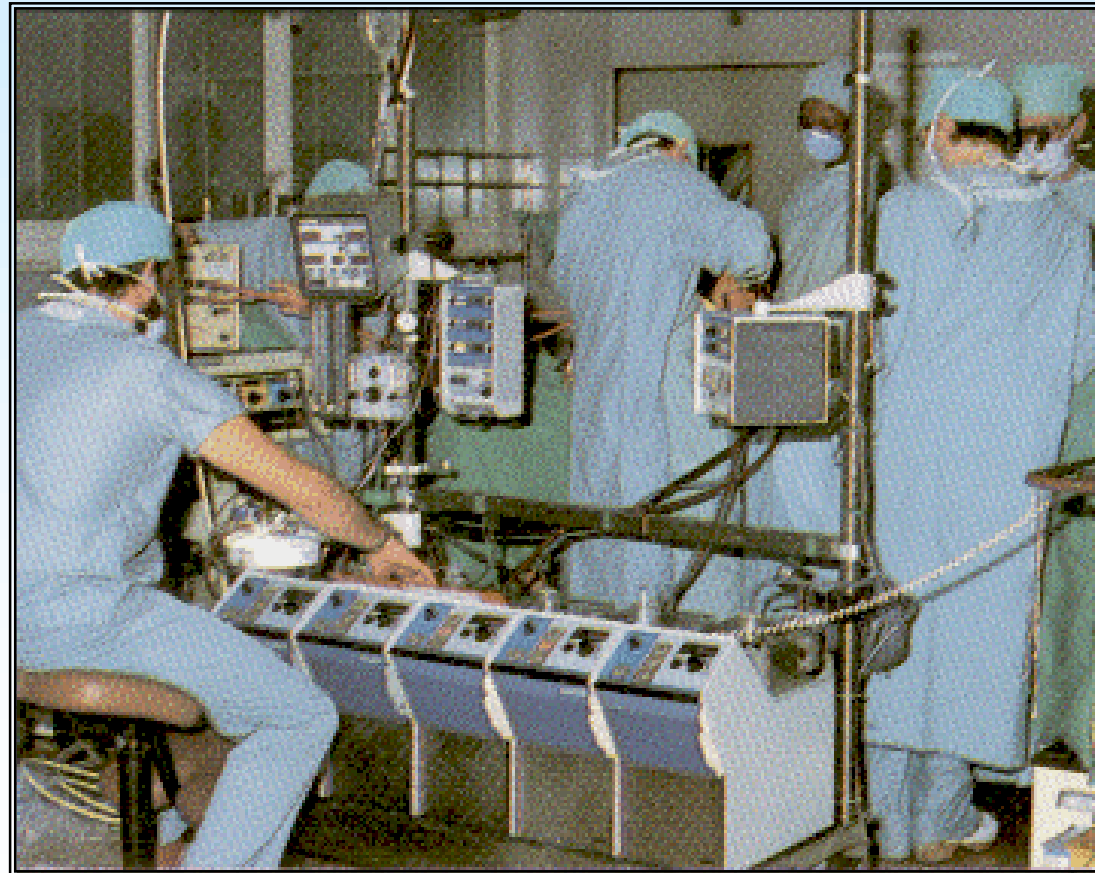
# Surgical Instruments sets



## Auxiliary and operation specific equipment

- In the operation room, a lot of auxiliary or operation specific equipment are also in use, beginning from simple *Mayo-tables*, *suction units*, through *rigid and flexible endoscopes* and *operation microscopes*, to extremely complicated systems as a heart-lung machine.
- A detailed study of them, exceeds the scope of this presentation.

# Heart - Lung Machine



## Sterilization

- The preparation of surgical department supplies proceeds both in the sterile service area of the surgical unit and in the hospital's central supply department.
- Operation room instruments and some anaesthetic equipment are preferably maintained and sterilized in the instrument service of the surgical department and not in the central sterile supply department.
- Although the amount of pre-sterilized and disposable equipment has increased, there is a considerable residue of non-disposable items that require sterilization.

## Items beyond Instruments that require Sterilization

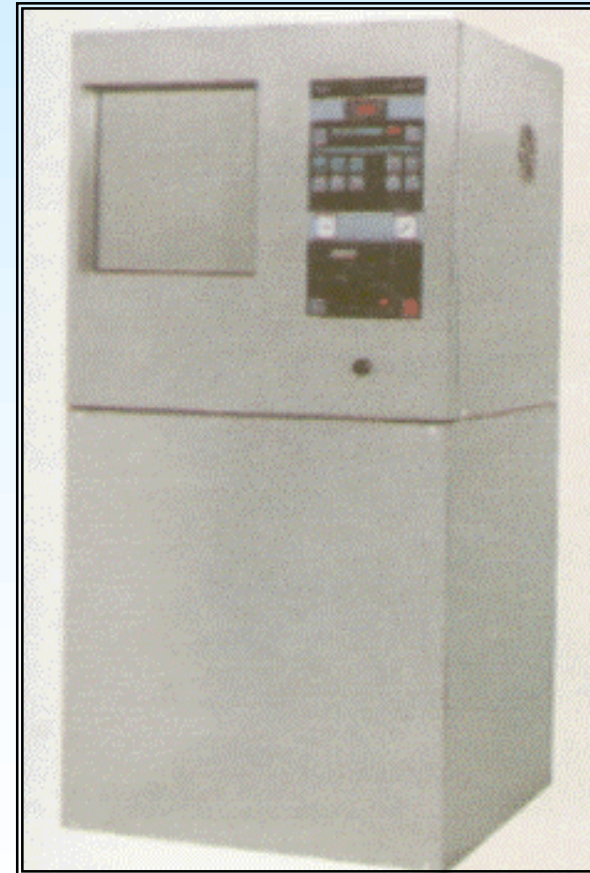
- Materials such as tubes, rubber goods, stainless steel and plastic items are cleaned and sterilized in the central supply department of the hospital department.
- Alternatively, a special area within the sterile service of the surgical department is provided for these procedures.
- Linen sets for the surgical department are sterilized in the central supply department after they are washed in the laundry.

## **Instrument service before Sterilization**

- Storage cupboard for non-sterile instruments.
- Slope sinks and wash basins.
- Drainer with a fairly soft surface for washed instruments.
- Washing machine and rinsing equipment for instruments.
- Work benches and stacking racks.
- Instrument inspection and wrapping benches.
- Storage cupboard for wrapping material.
- Ultrasonic-chemical pre-sterilizer (80 °C).

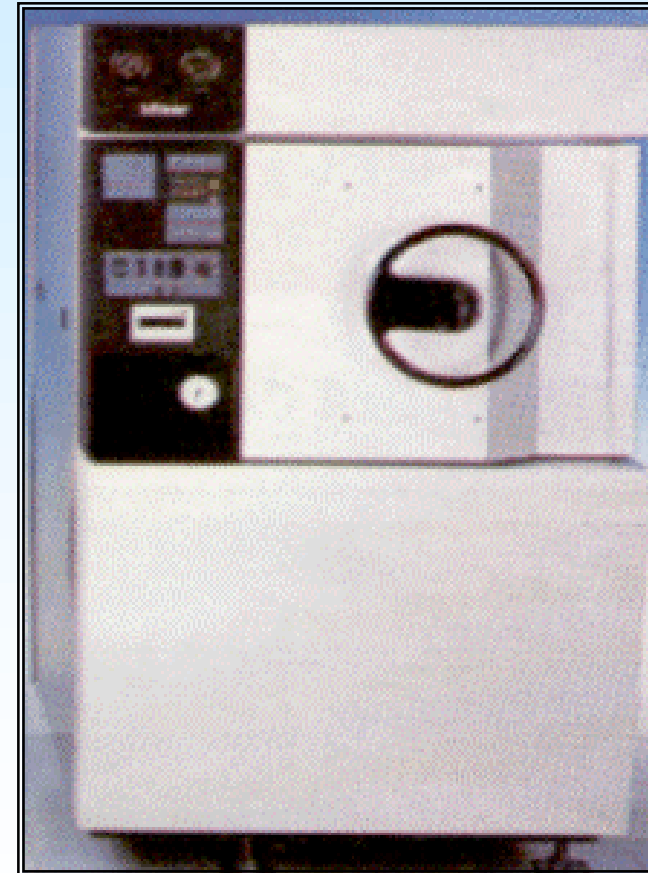
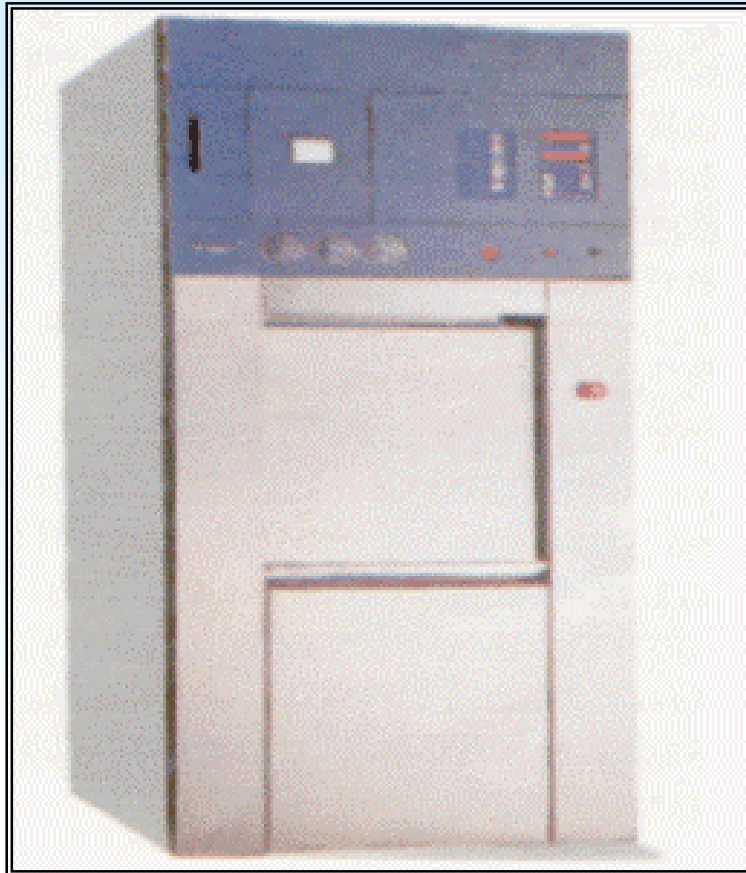
## Main Sterilization Techniques

- **Steam Autoclaves** with a sterilization temperature variable between 134 °C and 143 °C with a pre-vacuum and post-vacuum equivalent for 20 torr.
- **Gas sterilizer** (ethylene oxide or formaldehyde) for non heat-resistant items (57 °C steam).
- Alternatively, **dry hot air or hot glass-beads** (250 °C) sterilizers might be used for local, small range needs.



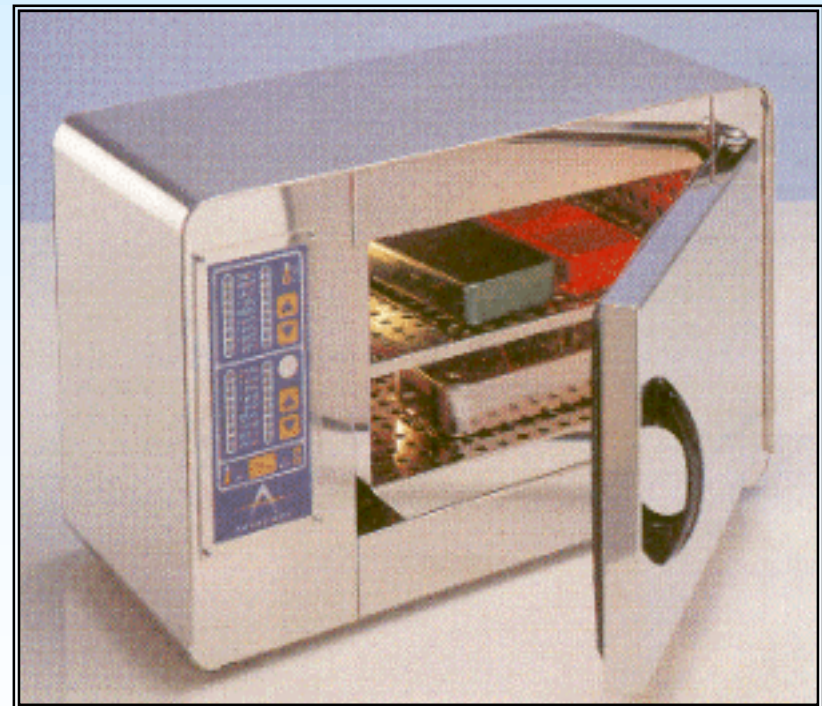
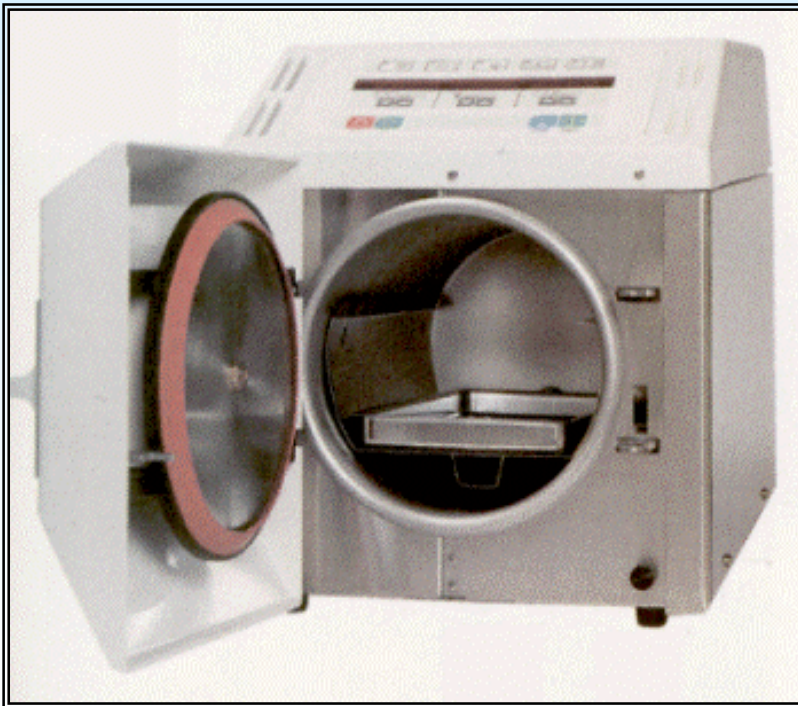


## Steam Autoclaves





## Small steam sterilizers



## Several types of sterilizers

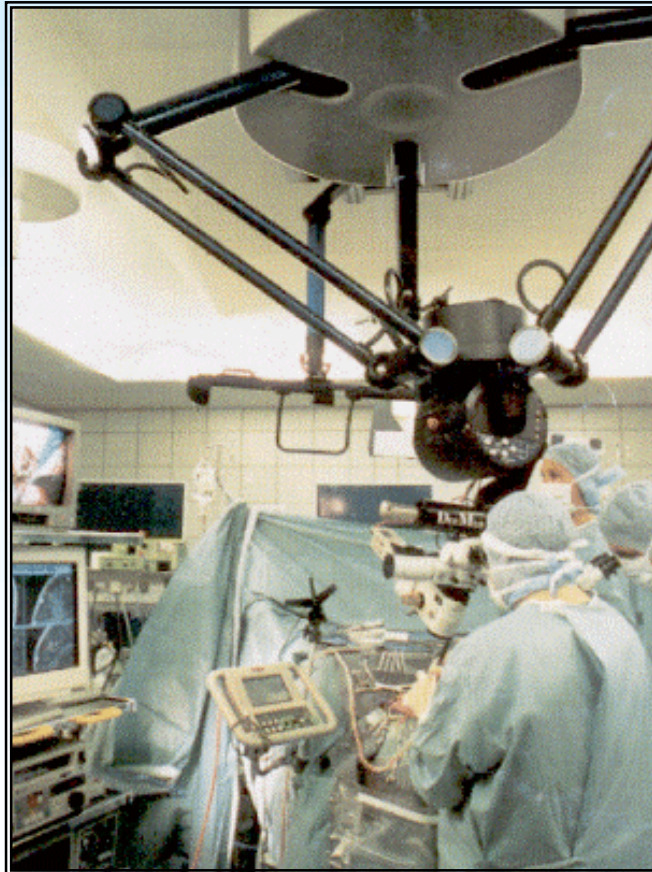


## Maintenance of sterility

- Maintenance of sterility of sterilized supplies depends on adequate wrapping of packs.
- Double wrapping prevents contamination during opening of packs.
- The packs must be protected against moisture.
- A repair shop should also be available.



# Technological Perspectives in Surgery



- *New Instruments and Devices.*
- *LASER - FEL.*
- *Intra-Operative Radiotherapy.*
- *Endoscopic Surgery.*
- *Robotics.*
- *Tele-surgery.*
- *Post- operative Care.*
- *Rehabilitation.*