## Medical and Biological Engineering

### From Ideas to Successful Medical Products

**Content**
- Part 1: Introduction and General Statements
- Part 2: Ideas and Roots
- Part 3: Physical and In-Vitro Diagnostics
- **Part 4: Instrumentation for Therapy and Surgery**
- Part 5: Imaging and Image Processing
- Part 6: Implants and Technical Aids

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Tools for surgery (1st century A.C.)
Special tool for the removal of skull bone fragments and the lowering of elevated intracranial pressure (published 1517)
Special saw and saw blade for skull surgery (published 1666)

Im reich bebilderten Werk des Ulmer Wundarztes Johann Sculetus findet sich auch die Konstruktionszeichnung eines "Sägleins", das dazu diente, zwischen Bohrlochern im Schädeldach den Knochen aufzusägen, so daß Öffnungen von beliebiger Form und Größe geschaffen werden konnten. Die Darstellung ist so sorgfältig erfolgt, daß ein interessierter Chirurg leicht einen Nachbau veranlassen konnte.
Operating theater and surgery (about 1774): Amputation of a leg
Dentist’s chair (about 1850)
Pedal-driven drill for dentistry by JB Morrison (patented 1871)

Im Jahre 1871 hat sich der amerikanische Zahnarzt James Beall Morrison (1827-1917) aus St. Louis eine Fußtretbohrmaschine für zahnmedizinische Zwecke patentieren lassen. Damit hielt das wichtigste technische Gerät Einzug in die Zahnheilkunde. Das abgebildete Modell stammt aus der Zeit um 1900.
Modern dental treatment chair
Tool for the thermal cutting of tissue or the stopping of bleeding (described 1876 and used until about 1950). The heat is generated by the burning of petrol.
Electrosurgery control system (Alsa 1990)
Apparatus for HF-surgery (i.e. cutting, coagulation, 400 Watt)
Induction generator for electrotherapy (1880)
Induction generator for electromedical diagnostic and therapeutic applications (about 1890)
Battery-powered generator for electrotherapy (1890)
Solenoid for magnetic stimulation: Schematic and experimental arrangement (J-A. D‘Arsonval himself?, 1893, based on research work by N. Tesla)
Apparatus for electrotherapy (d‘Arsonvalisation, diathermy)

(J-A. D‘Arsonval, 1892)
Apparatus for electrotherapy (1920)
Electro-therapy apparatus with antenna applicator (about 1960)
Transcutaneous Nerve Stimulation TENS (method used since the 1970s)
Apparatus for the recovery of apparently dead persons (i.e. by „defibrillation),
Ch. Kite (1788)
First extracorporeal defibrillator applied (1947)
Extracorporeal defibrillator (1978)
Defibrillator for extracorporeal application
Portable defibrillator (Hellige 1994)
Implantable defibrillator (dimension scale: inches)
Drum kidney 1943 (William Kolff, died Feb. 14, 2009)
Reconstruction of the Kolff drum kidney
Artificial kidney – Kolff type (a. 1973, b. 1988)
Wearable artificial kidney Kolff type (Utah University, 1988)
Artificial kidney – Kill type (1973)
Artificial kidney
Dialysis treatment place
Special microscope for microsurgery and used by two persons

2 separate viewing hoods for assistance
First microscope-based microsurgery equipment (Zeiss, 1953)
Microscope based microsurgery equipment for ophthalmology with speech control (Zeiss, 1988)
Navigation-system for microscope-based microsurgery (Zeiss, 1996)
Operating microscopes (2008)

- a. eye surgery
- b. general surgery
Surgical microscope (Zeiss, 2009)
Surgical dental microscope (ZUMAX, 2009)
Surgical microscopes (2009)

a. Zeiss

b. Leitz
Dental microscopes (Zeiss, 2009)

a. fully motorized  
b. manually operated
Radiation therapy (about 1905)
HV-based X-ray generator (Siemens 1919)
Cobalt-60 and caesium-137 γ-radiation generator for tumor treatment
(Siemens 1956)
Linear accelerometer type standing waves (Varian, 1968)
Linear accelerometer (Varian, 1988)
Accelerator for radiation therapy using electron and photon generation
(Siemens 1995)
Radiation therapy equipment
Two different heart-lung machines used in 1958 in Germany
Heart-lung machine
Extracorporeal disintegration of kidney stones – schematics (1975)

The patient is positioned in a water-filled bathtub („the most expensive bathtub ever built“)
Shockwave generator for animal experiments (Dornier, 1977)
Appliance for the positioning of animals in the bathtub (Dornier, 1978)
Extracorporeal electro-hydraulic shock wave lithotrispy (Dornier, 1988)
Patient is positioned in a bathtub with the shock wave focused on the kidney stone
Extracorporeal kidney stone lithotriptor 1980
Advanced working place for extracorporeal kidney stone disintegration (2003)
Lithotriptor for the destruction of kidney stones by shock waves (2005)
First machine for anesthesia by vaporized ether (Draeger, 1903)
Two different types of iron lungs or cabinet respirators (1920 – 1970)
Ventilator driven manually with a crank working on a rotating plate

(H. Draeger, 1907)
Anaesthesia working station (Draeger, 1990)
Ventilator with electronic control and monitor
Ventilator for mobile application (e.g. emergency service)
Mobile anaesthesia workstation
Monitor and control unit for anesthesia machine
Da Vinci laparoscopic surgical robot (launched 1999, FDA approved 2000)
The Karlsruhe Endoscopic Surgery Trainer as an Example for Virtual Reality in Medical Education
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Minimal-invasive surgery with 3D-imaging
Robotic brain surgery with hexapod-supported actuator platform