Medical and Biological Engineering

From Ideas to Successful Medical Products

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Mobility aids (painter: Brueghel the Older, 1559)
Teeth are made from ivory with springs for coupling the two parts.

Tooth of hippopotamus as carrier and supplied with some human teeth.

Dentures of the former US president George Washington (1789)
Aluminium 1914

Vulcanize 1910

Ivory

Aluminium 1914

Vulcanize and cover with gold foil 1920

Courtesy to Drd W. Uriciuc
Wipla 1925

Casted Paliac 1935

Co-Cr 2004

Courtesy to Drd W. Uriciuc
a. Upper jaw full prothesis

b. Lower jaw full prothesis

c. Lower jaw partial prothesis (bridge) with clamp fixation

d. Dental implants

e. Dental implant schematics

Advanced teeth replacement
Scoliosis orthosis (presented in Milwaukee, 1988)
Design of a total leg prothesis by Ambroise Paré
and manufactured by a French smith (1552)
Prothesis for short lower extremity (1901)
Prothesis for short lower extremity (Otto Bock, 1993)
Ortheses for the lower extremity (1988)
Prothesis for lower-leg amputees (1901, left, and 1920, right: a mass product for first world war victims)
Flexible knee-joint for lower-leg amputees
Schematics of 3-segment modular total leg protheses with flexible knee joint, ankle joint and force damping
Total leg prosthesis in modular construction mode
Boy whose both legs have been amputated at the upper-leg supplied with flexible protheses
Appliances for the fixation and immobilization of the lower extremities (1988)
Arm prosthesis, rendering possible gripping functions (about 1500)
Construction draft for a movable hand prothesis (Ambroise Paré, about 1550)
Arm prothesis (1901)
Arm prothesis using muscle activation (F. Sauerbruch, about 1930)
Myo-electrically controlled hand-prothesis
Total-arm-prosthesis
Hearing aids (No 3 was used by the German composer Ludwig van Beethoven, about 1800)
Pocket type hearing aid (Siemens, 1950)
Pocket type hearing aid (1973)
High-tech hearing aids, No 1 and 2 „behind the ear“, No 3 and 4 „in the ear“
Induction Coil Stimulator by Emil du Bois-Reymond (1848). This regularly repeating stimulator may be the first electro-medical device, later on produced by Werner von Siemens (and used by him for tooth pain-suppression in his brother).
First "artificial" pacemaker with spring-driven pulse generation and with 3 different pacing rates (30 min\(^{-1}\), 60 min\(^{-1}\), 120 min\(^{-1}\)) by A.S. Hyman (1932)
Reconstruction of the first „artificial“ pacemaker with crank and spring-driven pulse generation (A.S. Hyman, 1932)
Historical X-ray image depicting the chest of W.T.O. Forssmann (Nobel Prize 1956). The first catheterization of the living human heart. The catheter is running through the antecubital vein of his left arm to the heart (1929)
Portable, extracorporeal electrical cardiac pacemaker with two different types of intracardiac electrodes (J.C. Callaghan, & W.G. Bigelow, 1951) with technical support by J.A. Hopps
First implantable cardiac pacemaker with fixed leads

(R. Elmquist & A. Senning, 1957)
First permanently implantable (screw-in) pacemaker electrodes (1964)
Single-chamber implantable pacemaker (without metallic housing, 1968). Zinc mercury batteries had been in use since 1958
Pacemaker with 2 leads and 5 zinc-mercury batteries: cathode and anode
Epoxy-embedded two-channel cardiac pacemaker (bi-focal or sequential stimulation) with bipolar electrodes (about 1966)
Two „early“ programming devices for implanted cardiac pacemaker with the nicknames (a) „coffee grinder“ (manually operated, only stimulus intensity) and (b) „iron“ (stimulus intensity, stimulus rate)
Cardiac pacemaker with nuclear battery using Plutonium$^{238}$ isotope (1970)
Thermoelectric nuclear generator based on plutonium 238

(Numec Corporation, 1975)
Metal-encapsulated bi-focal cardiac pacemaker with different atrial and ventricular electrodes (about 1984)
DDDR pacemaker with home monitoring feature provided with Lithium-Iodine batteries (such batteries have been used since 1972)
DDDRV pacemaker with home monitoring feature (2005)
Wheelchair for rich people (18th century)
Basic configuration of a modern wheelchair
Modern wheelchair
Hip joint total endoprothesis: titanium, ceramic head, polyethylene acetabular cup (2006)
First implantation of a platinum-hard rubber endoprothesis by J. P. Pean (1893).
Artificial knee joint prothesis (MMG 2002)
Active surfaces of the femur and tibia

Model Based System for Computer Assisted Knee Surgery

Gábor Renner and György Szántó

Optimization of the ligament position
Different forms of artificial heart valves, e.g. caged-ball mode (a, b, 1960), tilting disk valve (c, 1969) and bileaflet valve (d, 1983)
Different xenograft cardiac valves

Hancock porcine bioprothesis (1970)
Carpentier-Edwards porcine bioprothesis (1975)
Ionescu-Shiley bovine bioprothesis (1976)
Mitral-Medial bioprothesis (about 1975)
Stents including coronary stents (Charles Dotter 1958, Andreas Gruentzig 1977)
Left-ventricular blood pump with pneumatic control for animal tests in cows (about 1975)
Jarvik-7 biventricular artificial heart (ellipsoid heart) with 4 valves (implanted for the first time: 1982), developed by R.K. Jarvik
„Utahdrive“, the controlling system for the Jarvik-7 artificial heart (1982)
Left ventricular assist device LVAD with hydraulic pumping
The Novacor Left Ventricular Assist System (LVAS) is an implanted, wearable, mechanical system that provides pulsatile circulatory support for more than six years. Batteries, „skin“ transformer and control unit are incorporated in a belt. First implantation 1984.
AbioCor Implantable (2001, FDA approved): Biventricular device, valves, hydraulic pumping with 4000 – 8000 rotations/minute
Patient transport vehicles pulled by horses (used until 1920s)
Rescue helicopter with equipment for emergency care and patient transportation
Manually adjustable operating table with flexible joints (about 1890)
Adjustable operating table with key-board control
Elektro and his dog Sparko  
(Westinghouse, 1939)
ASIMO: 130 cm, 54 kg, 6 km/h (Honda, 2005)
Two Care-O-bot roboters for home-nursing (Fraunhofer Institute IPA), remote control (key board, voice), autonomous intelligence, sensors (orientation, movement)