Medical and Biological Engineering

From Ideas to Successful Medical Products

Content

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Mobility aids (painter: Brueghel the Older, 1559)

Reading glasses (1466)

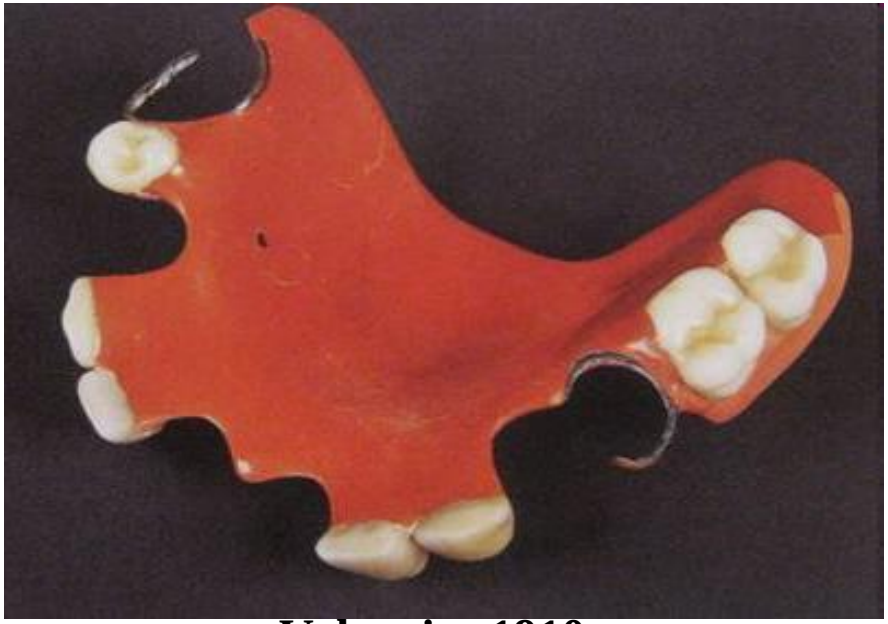
(a)

Teeth are made from ivory with springs for coupling the two parts

(b)

Tooth of hippopotamus as carrier and supplied with some human teeth

Dentures of the former US president George Washington (1789)



Vulcanize 1910

Aluminium 1914

Ivory

Vulcanize and cover with gold foil 1920

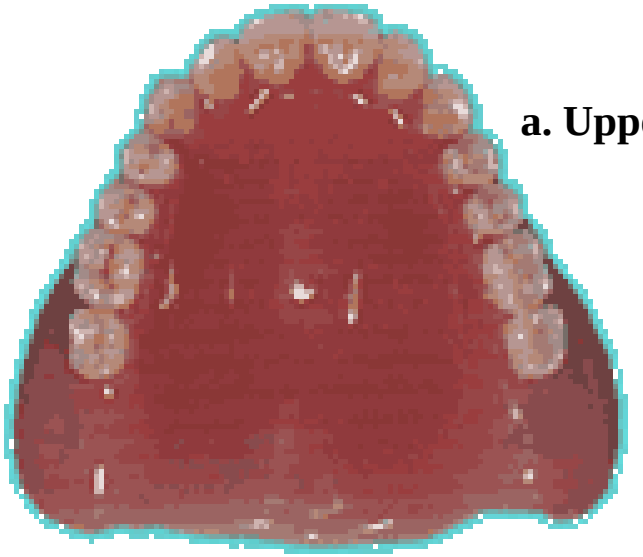
Courtesy to Drd W. Uriciuc

Wipla 1925

Casted Paliac 1935

Co-Cr 2004

Courtesy to Drd W. Uriciuc

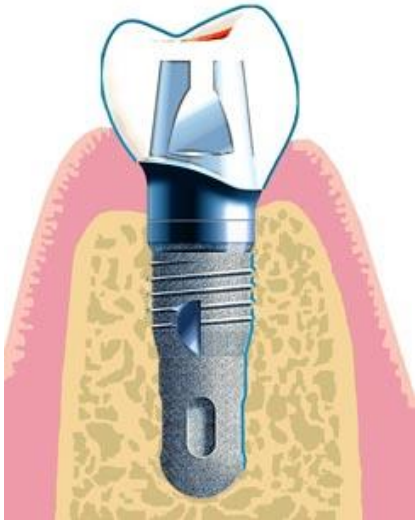


a. Upper jaw full prothesis

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

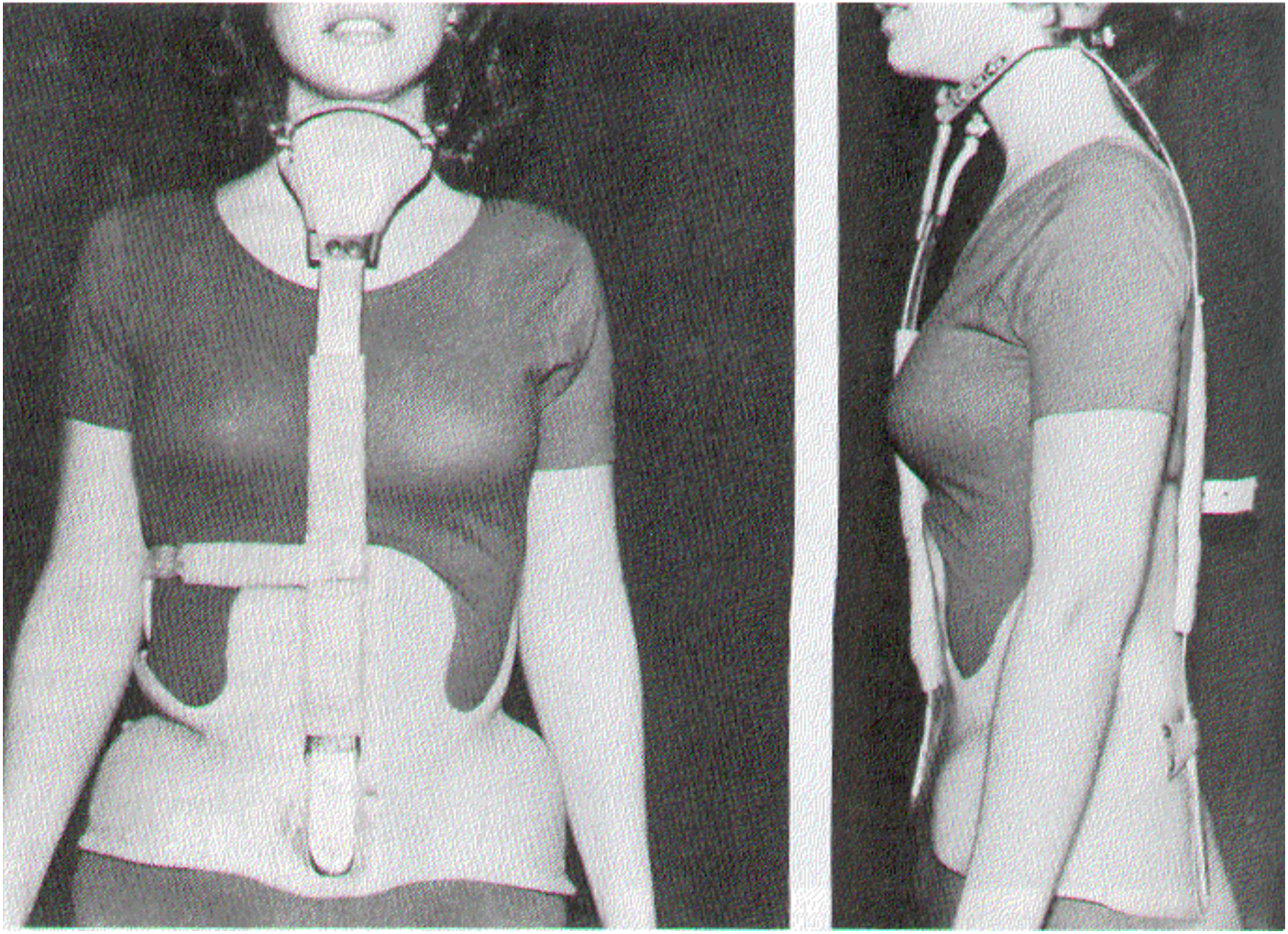
b. Lower jaw full prothesis

d. Dental implants



e. Dental implant schematics

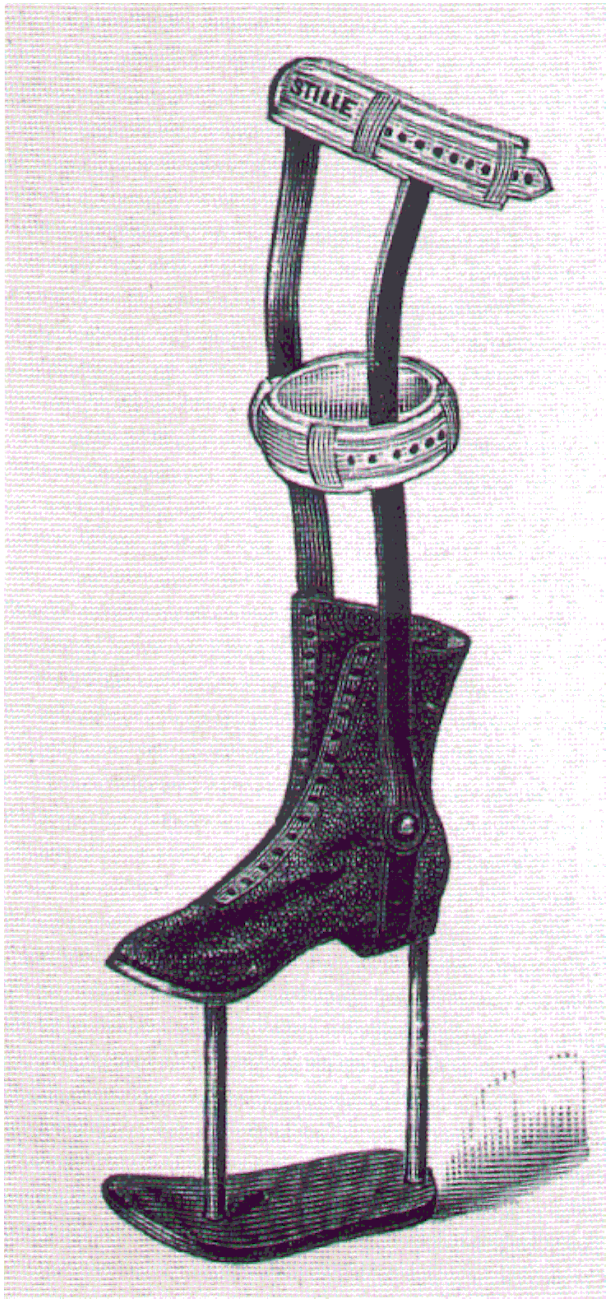
Advanced teeth replacement



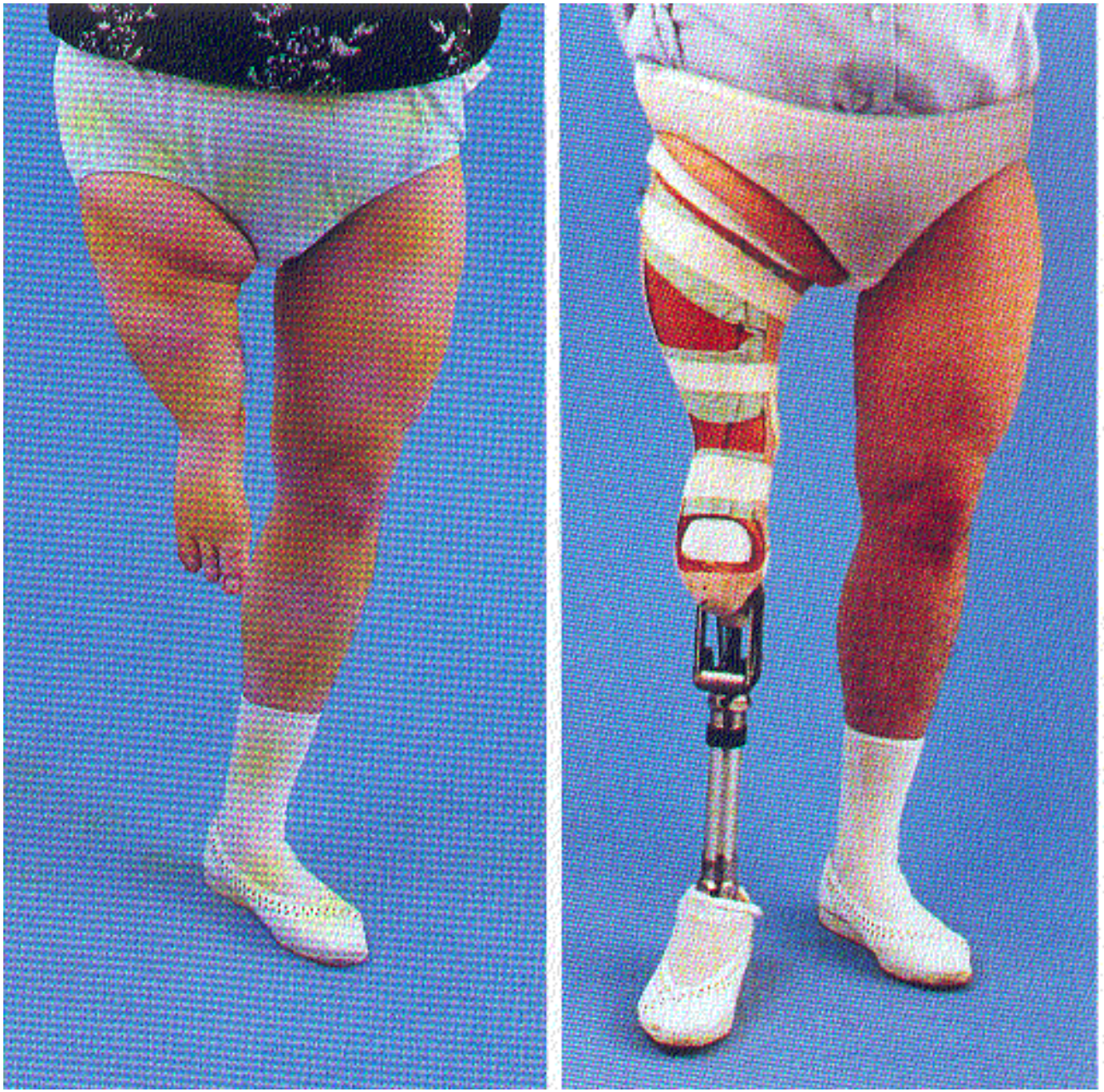
Scoliosis orthesis (presented in Milwaukee, 1988)

Design of a total leg prothesis by Ambroise Paré

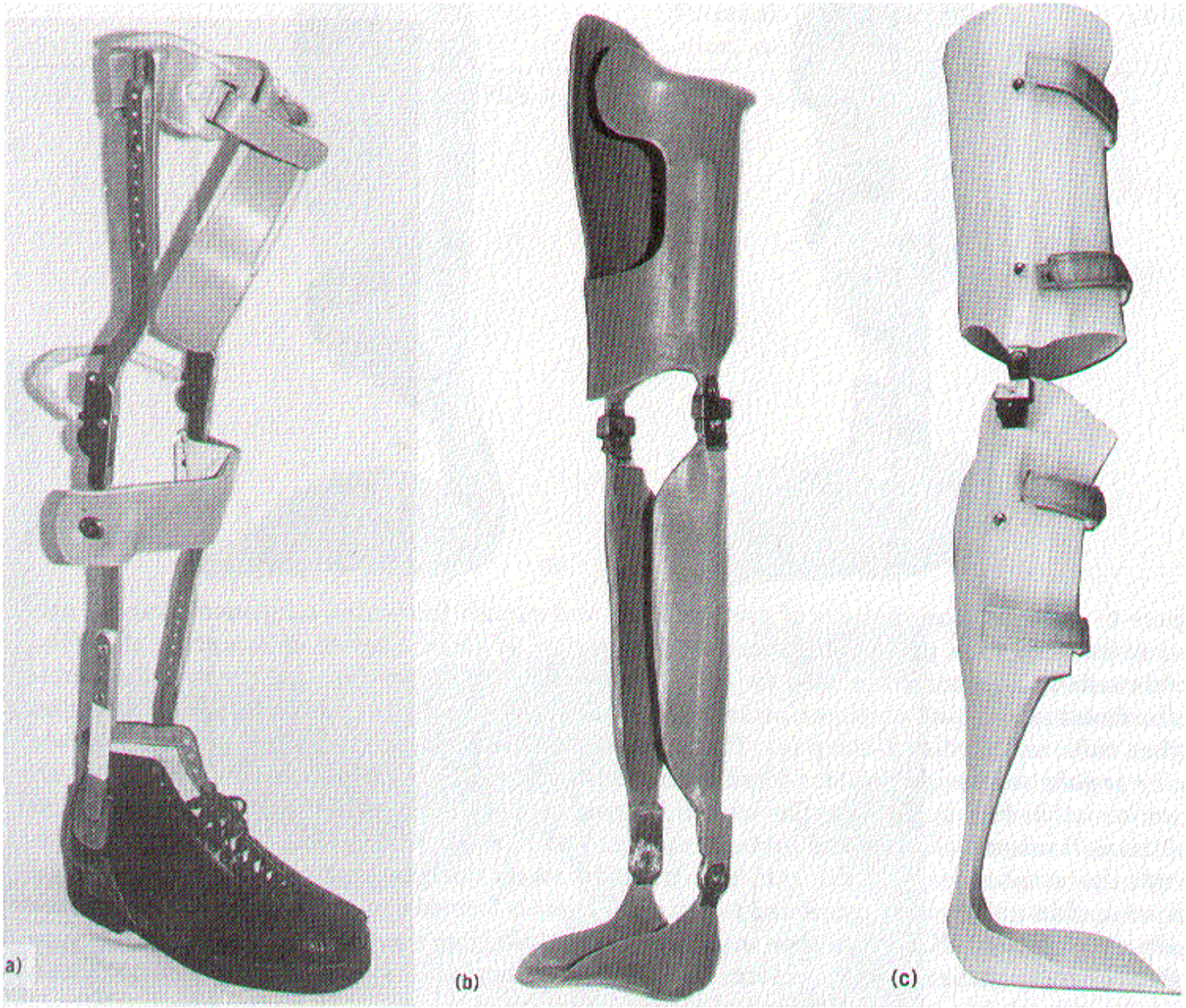
and manufactured by a French smith (1552)



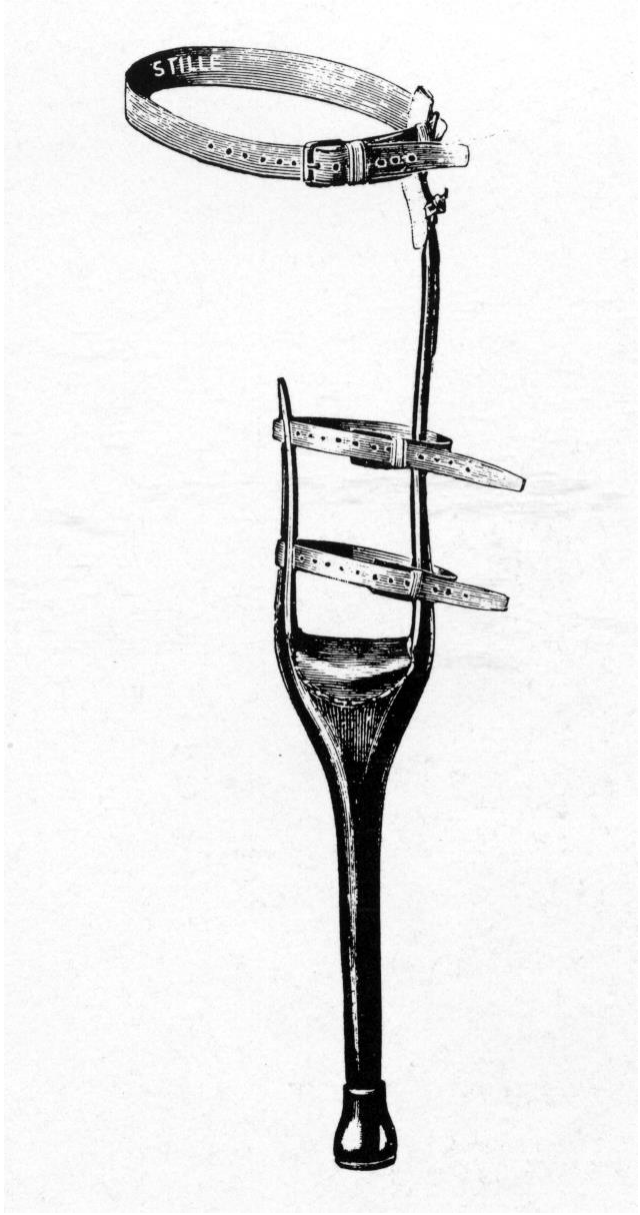
Prothesis for short lower extremity (1901)



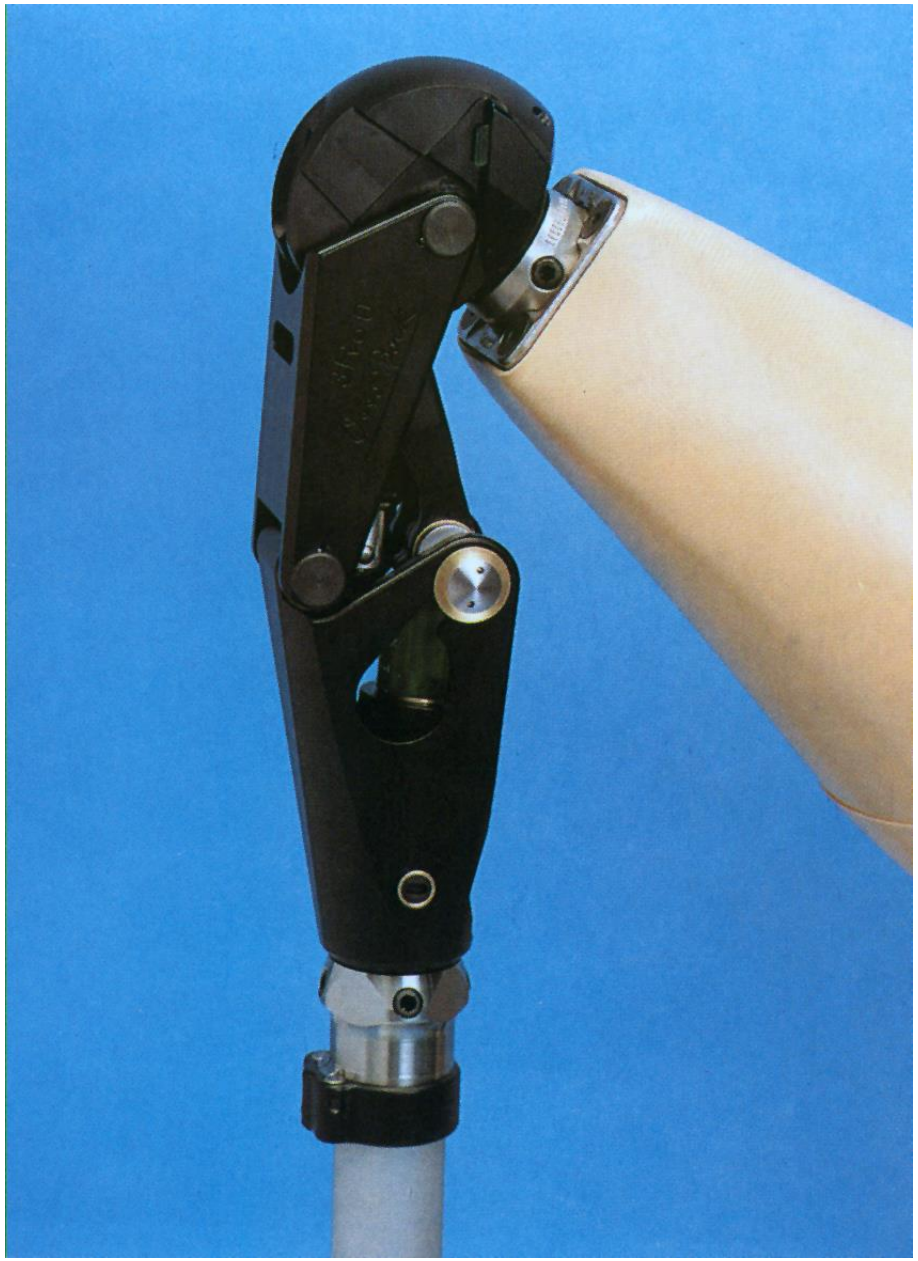
Prothesis for short lower extremity (Otto Bock, 1993)



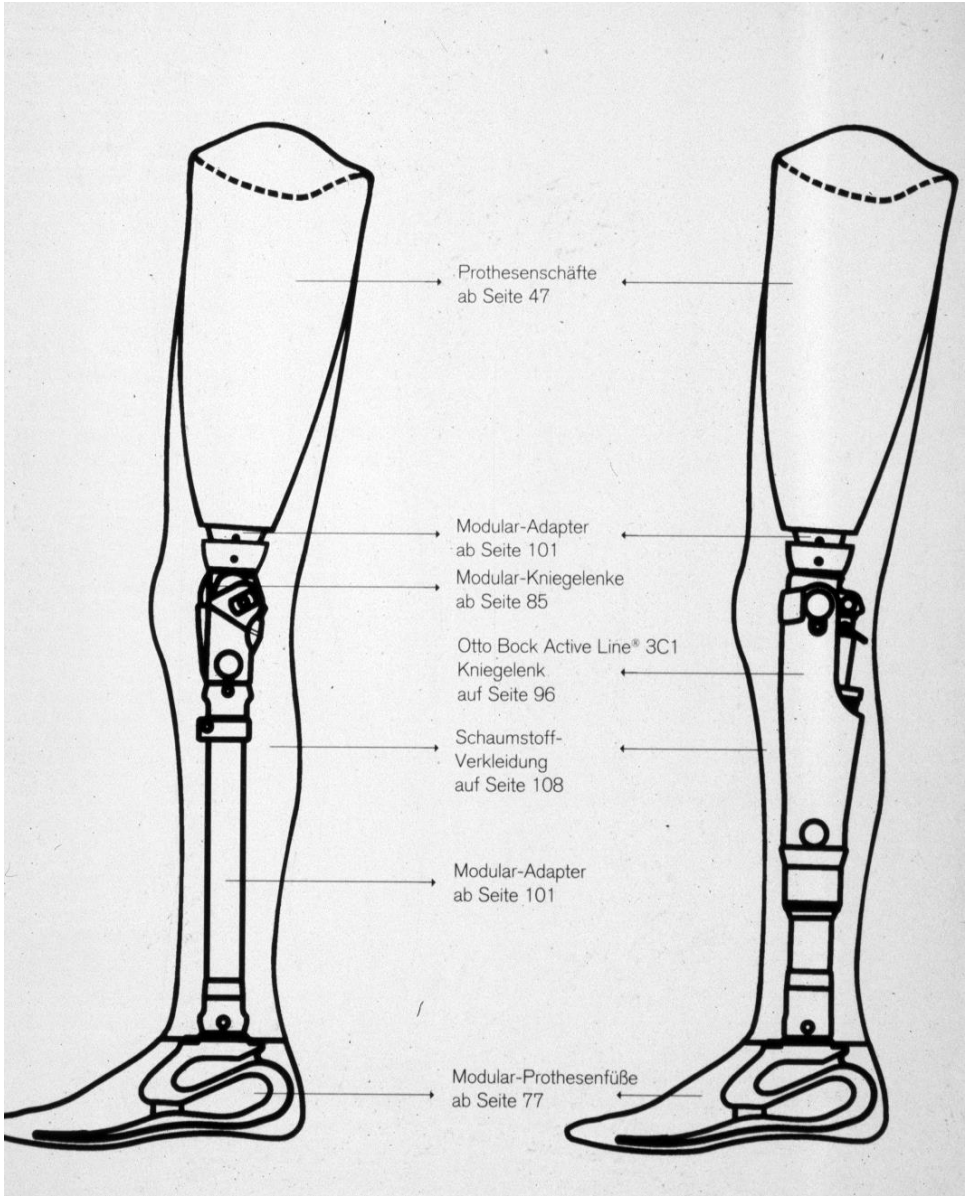
Ortheses for the lower extremity (1988)



Prothesis for lower-leg amputees (1901, left, and 1920, right: a mass product for first world war victims)

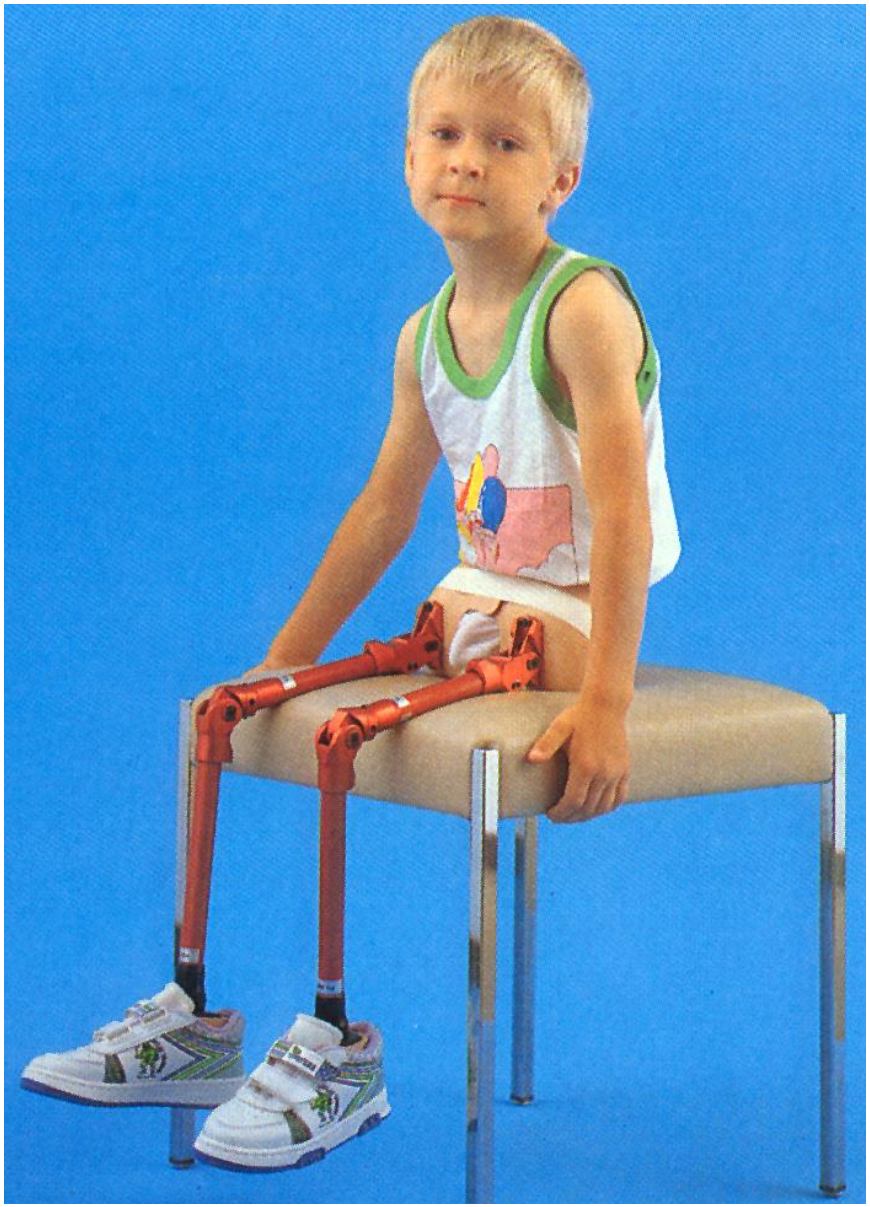


Flexible knee-joint for lower-leg amputees

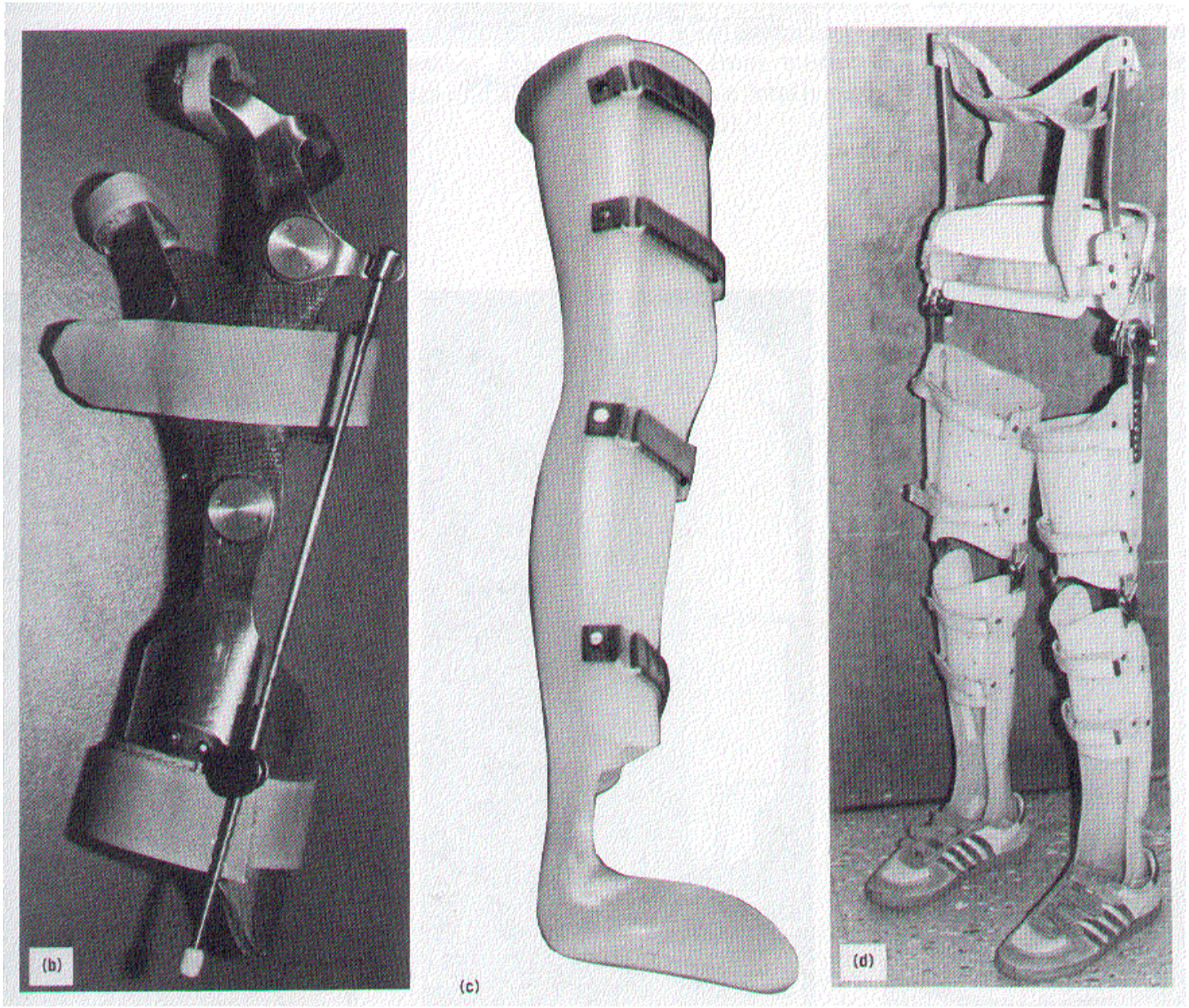


Schematics of 3-segment modular total leg protheses with flexible knee joint, ankle joint and force damping

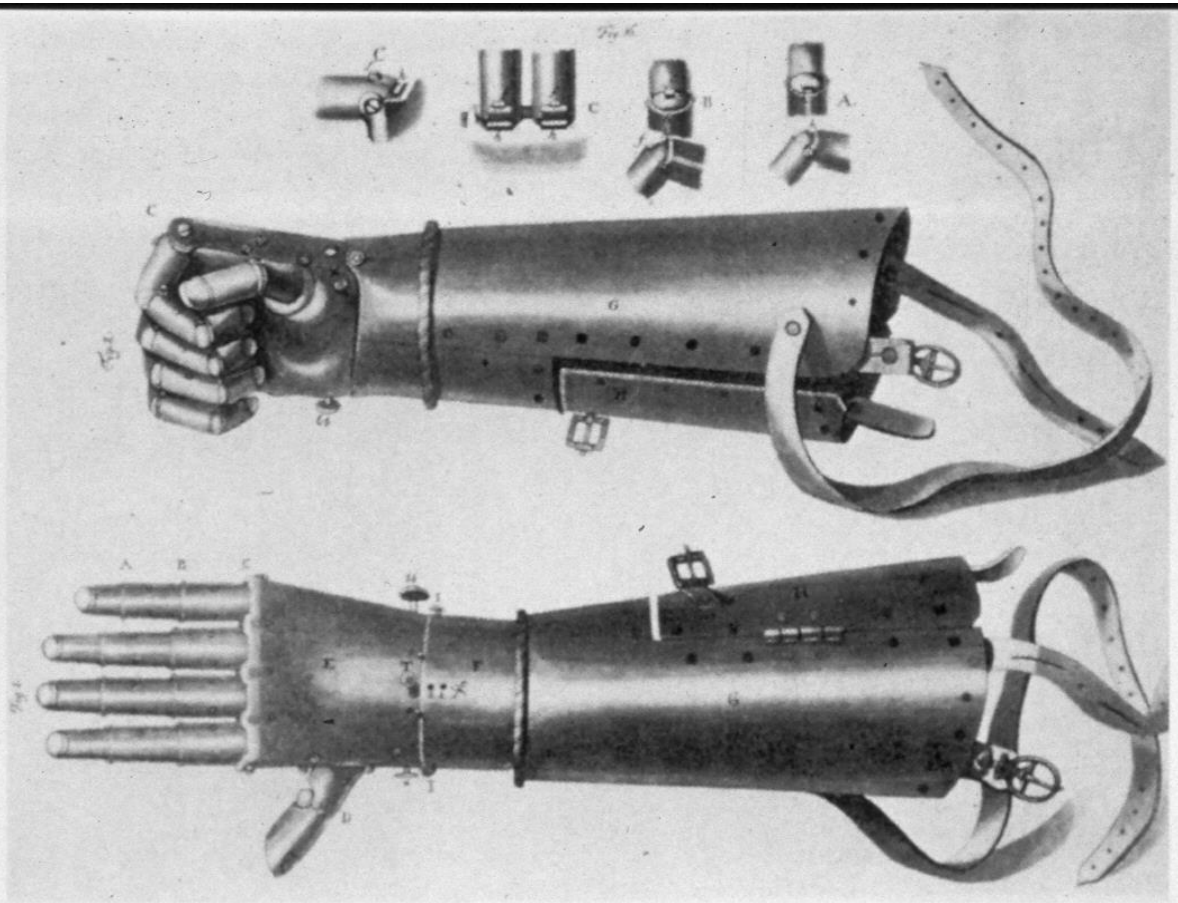
Total leg prothesis in modular construction mode



Boy whose both legs have been amputed at the upper-leg supplied with flexible protheses

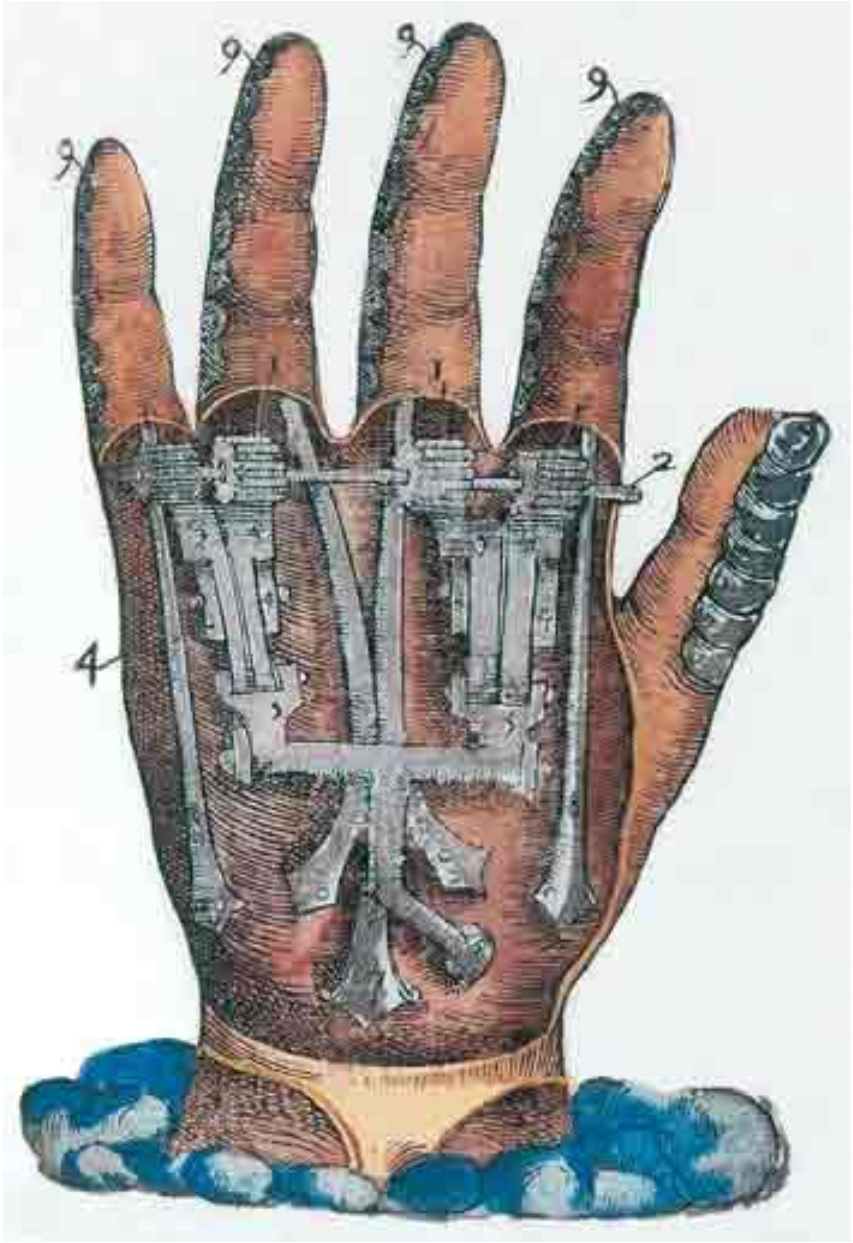


Appliances for the fixation and immobilization of the lower extremities (1988)

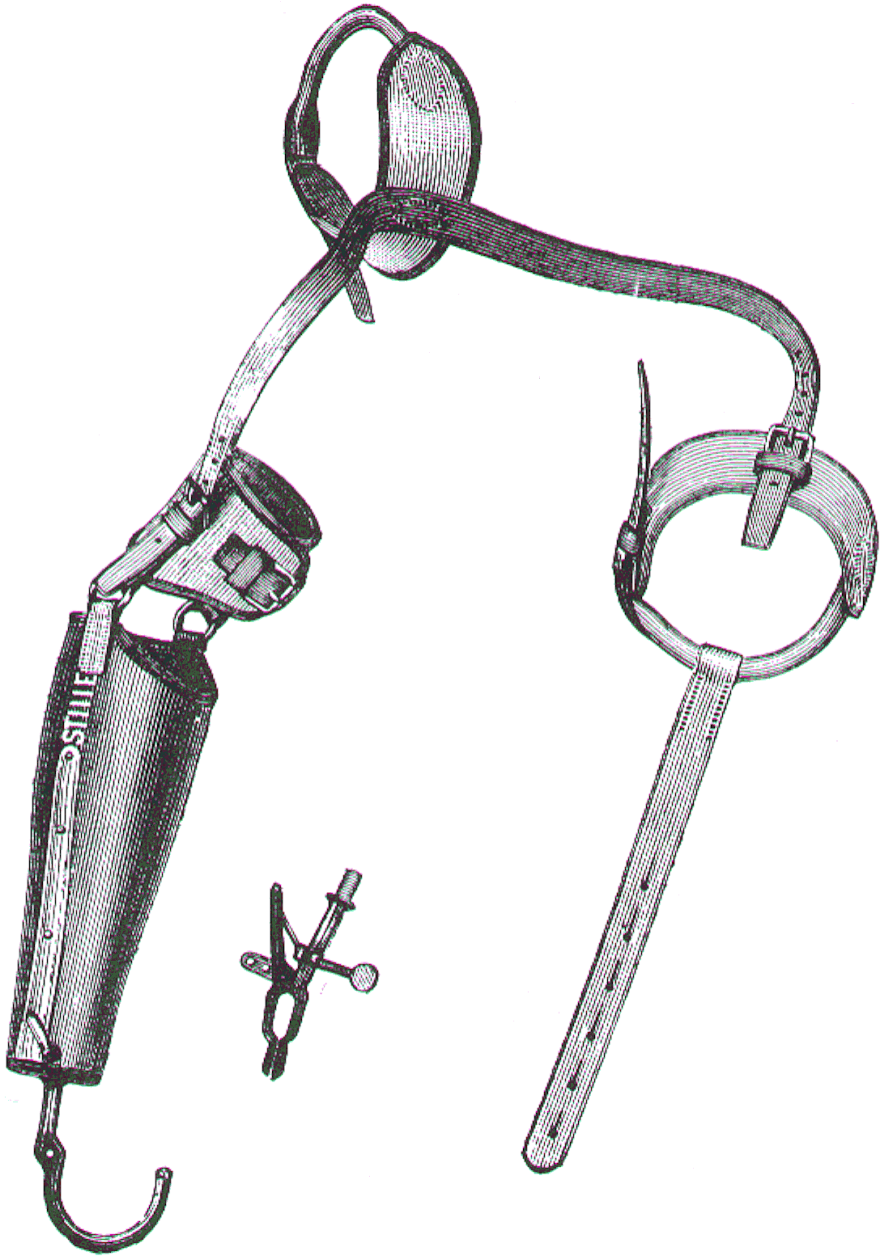


Die „eiserne Hand“ des Reichsritters Götz von Berlichingen (1480-1562), deren Original noch heute im Schloßmuseum der Götzenburg in Jagsthausen erhalten ist, gilt als Musterbeispiel einer mit einem Greifmechanismus ausgestatteten, funktionsfähigen Prothese.

Arm prothesis, rendering possible gripping functions (about 1500)

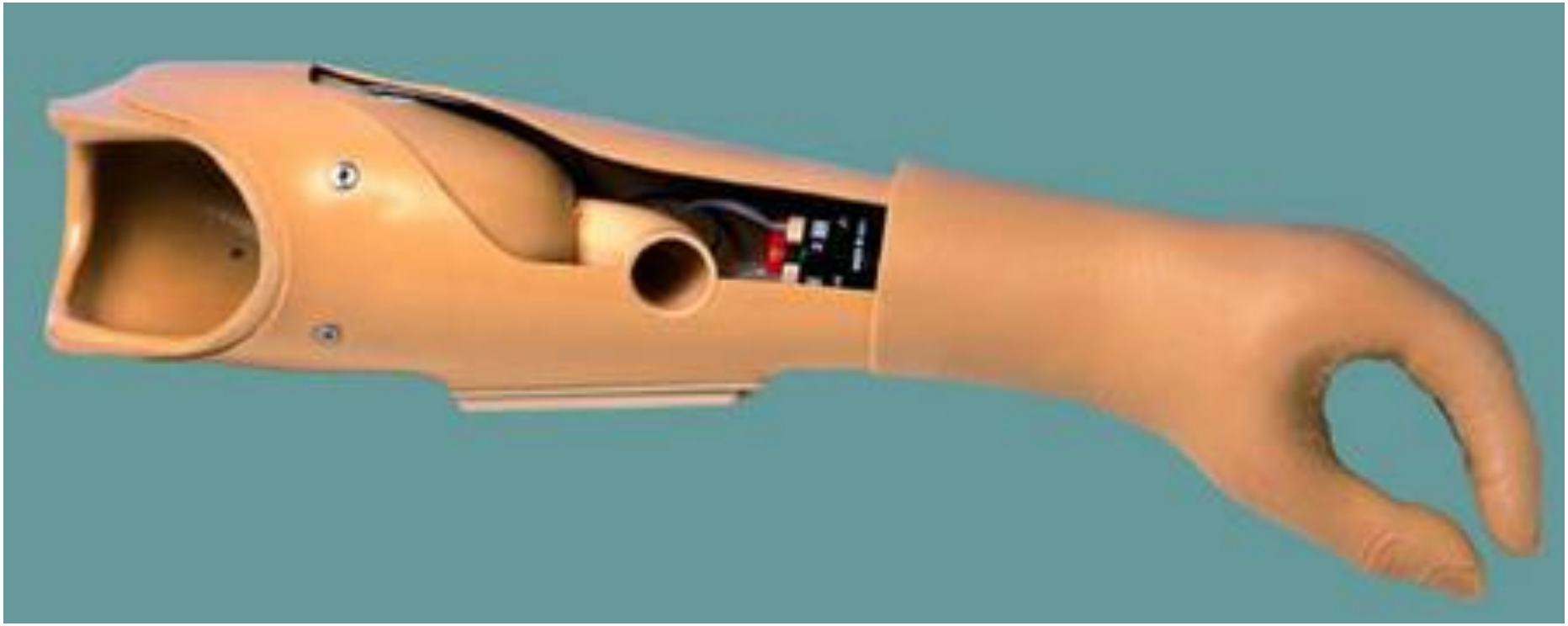


Construction draft for a movable hand prothesis (Ambroise Paré, about 1550)



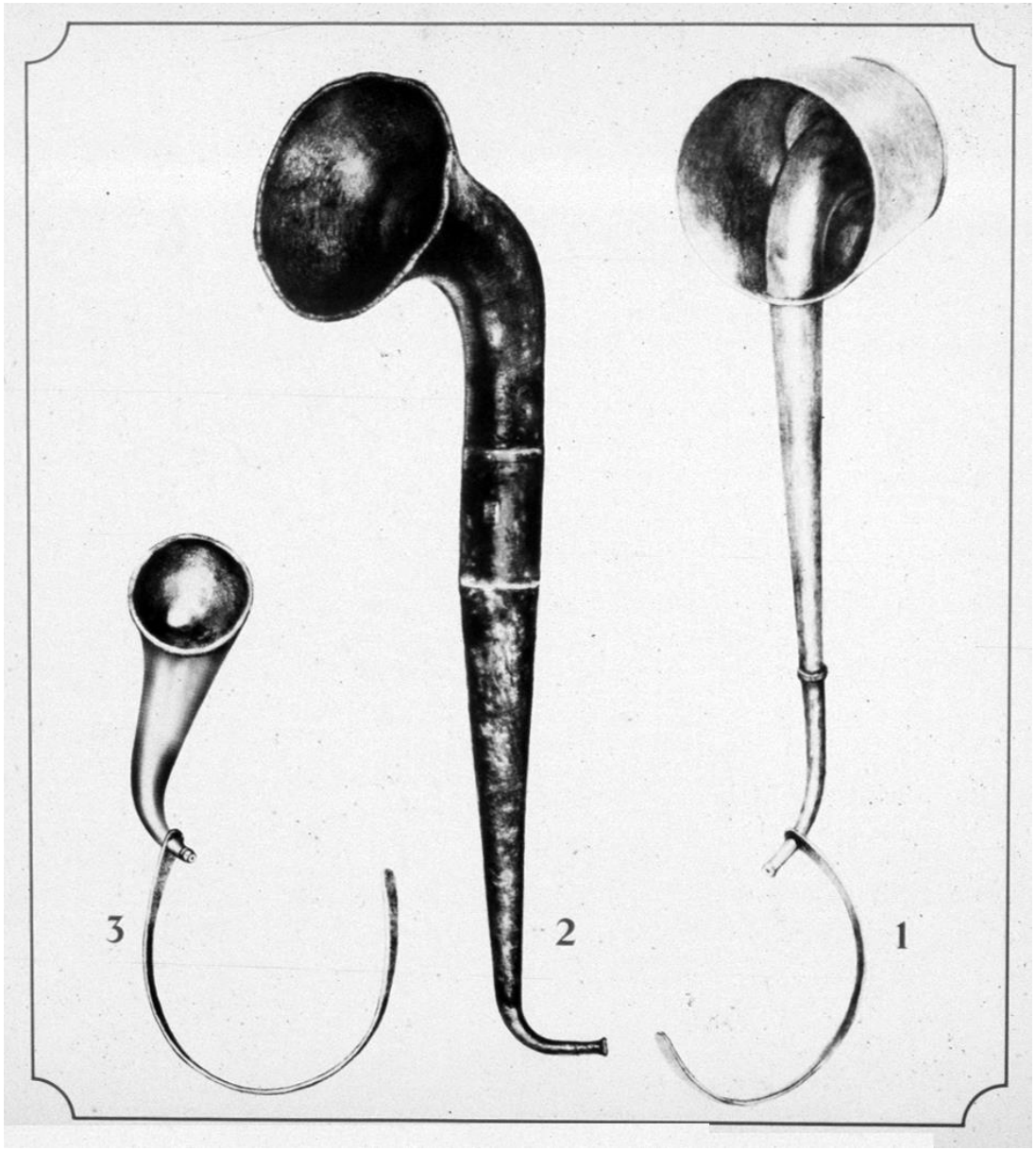
Arm prothesis (1901)

Arm prothesis using muscle activation (F. Sauerbruch, about 1930)



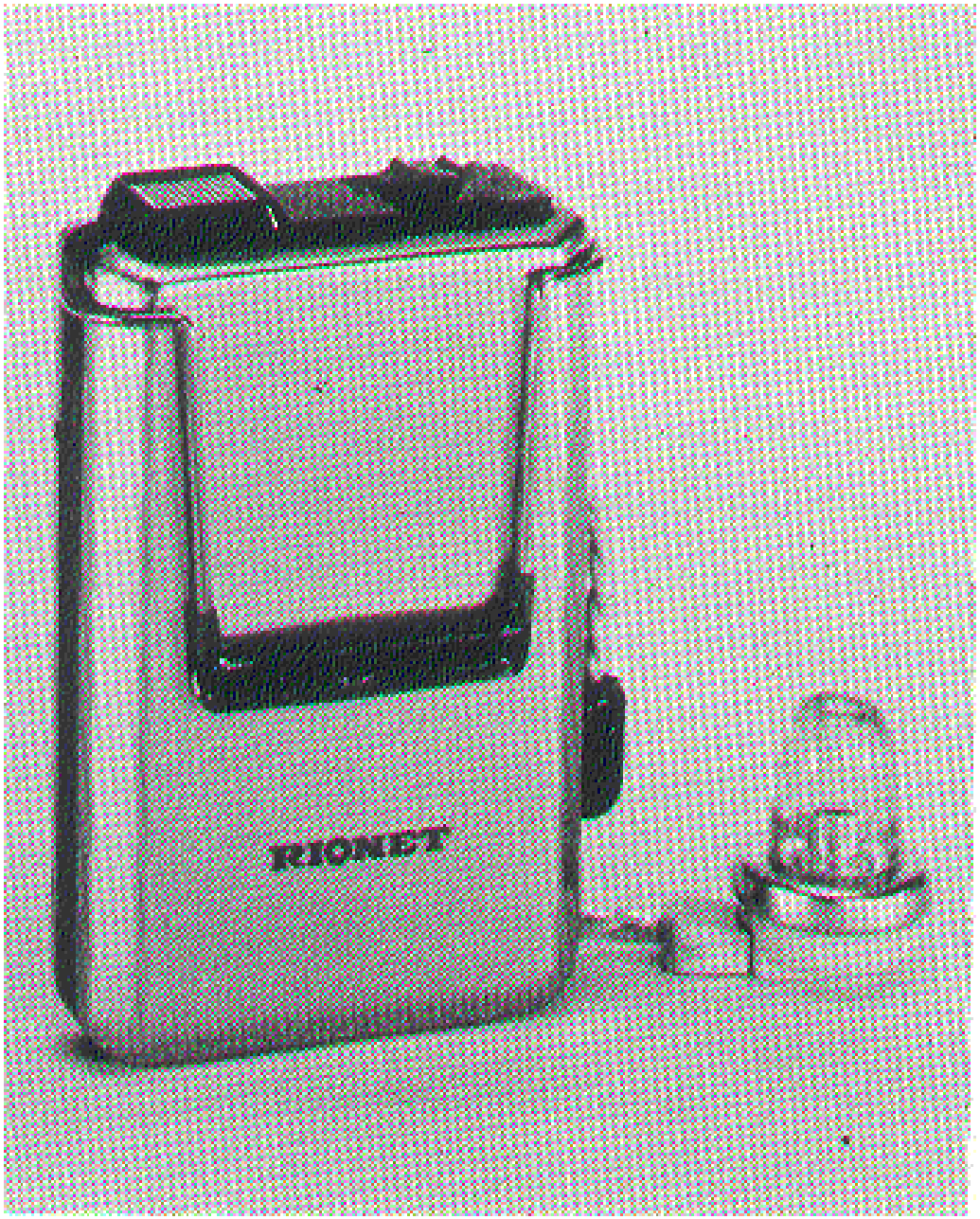
Myo-electrically controlled hand-prothesis

Total-arm-prothesis

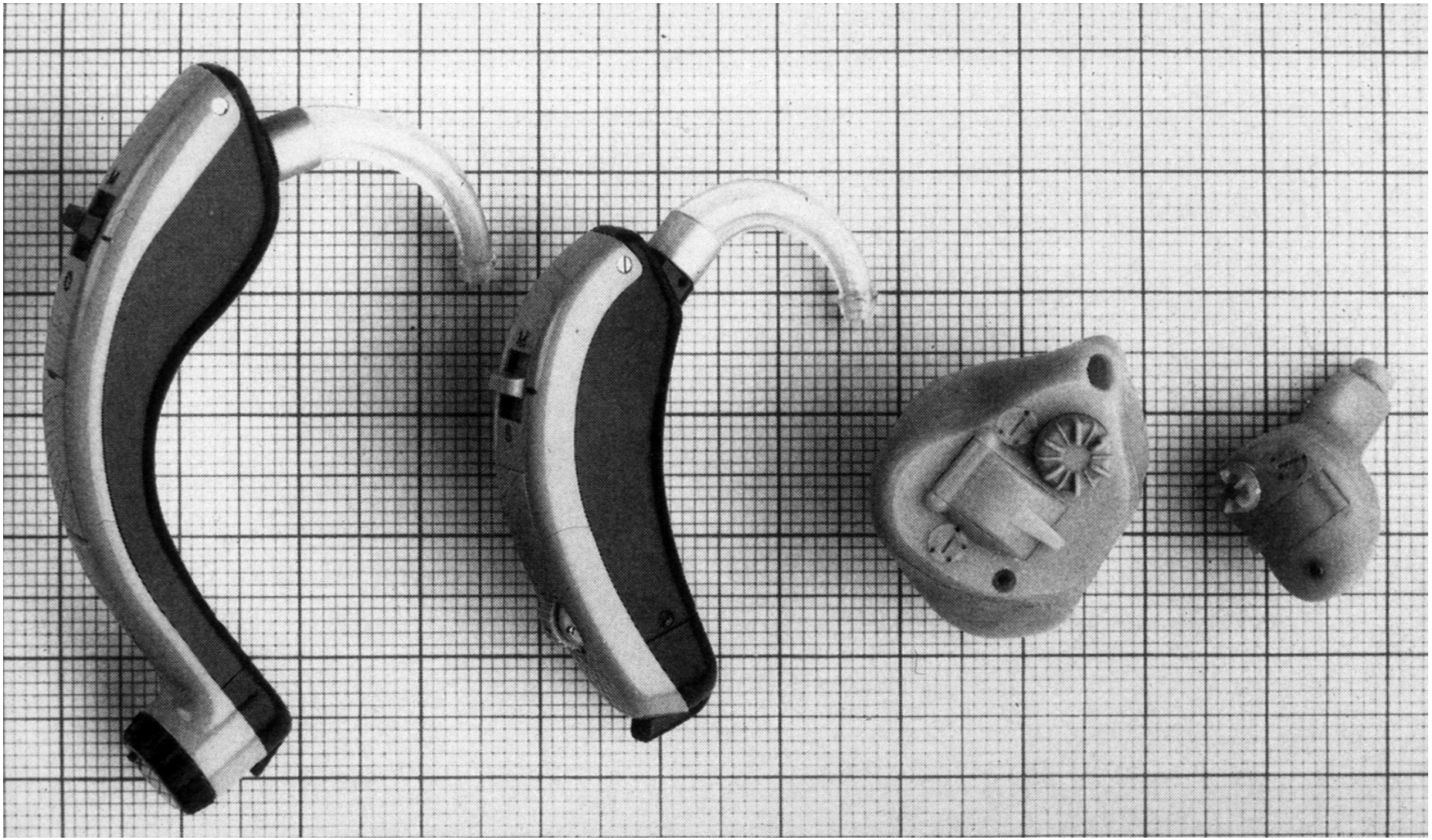


Hearing aids (No 3 was used by the German composer Ludwig van Beethoven, about 1800)

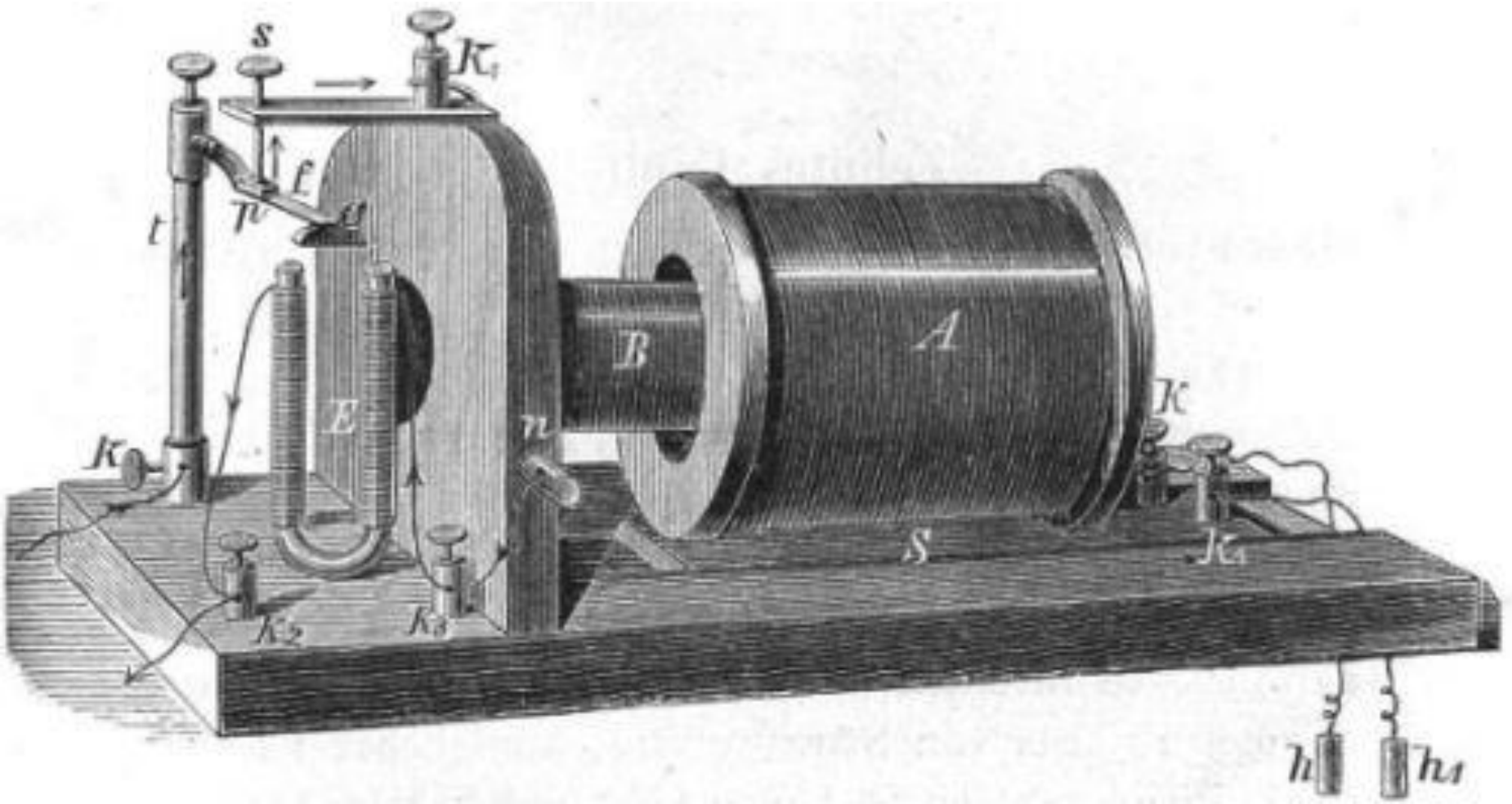
Pocket type hearing aid (Siemens, 1950)



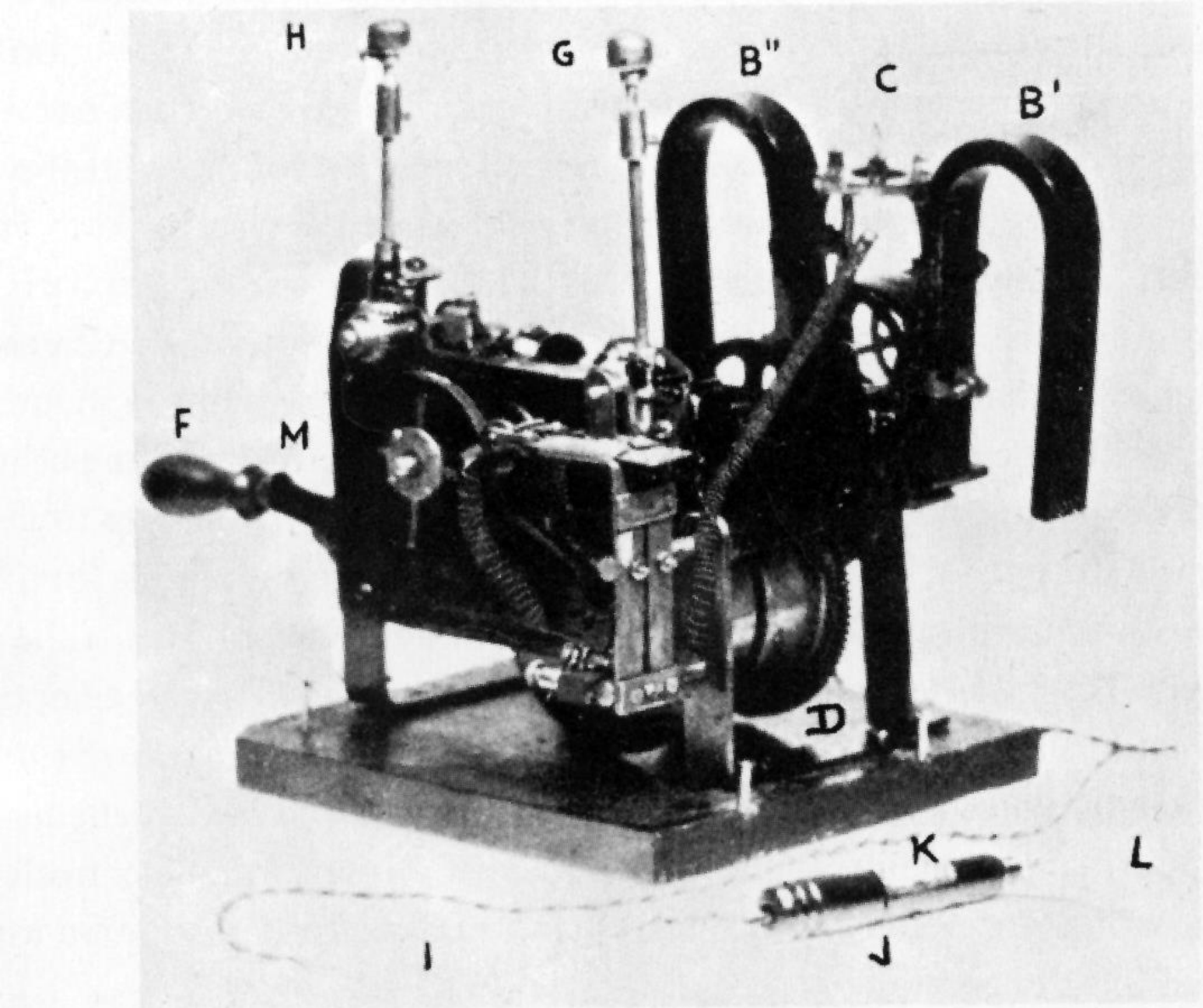
Pocket type hearing aid (1973)



High-tech hearing aids, No 1 and 2 „behind the ear“, No 3 and 4 „in the ear“

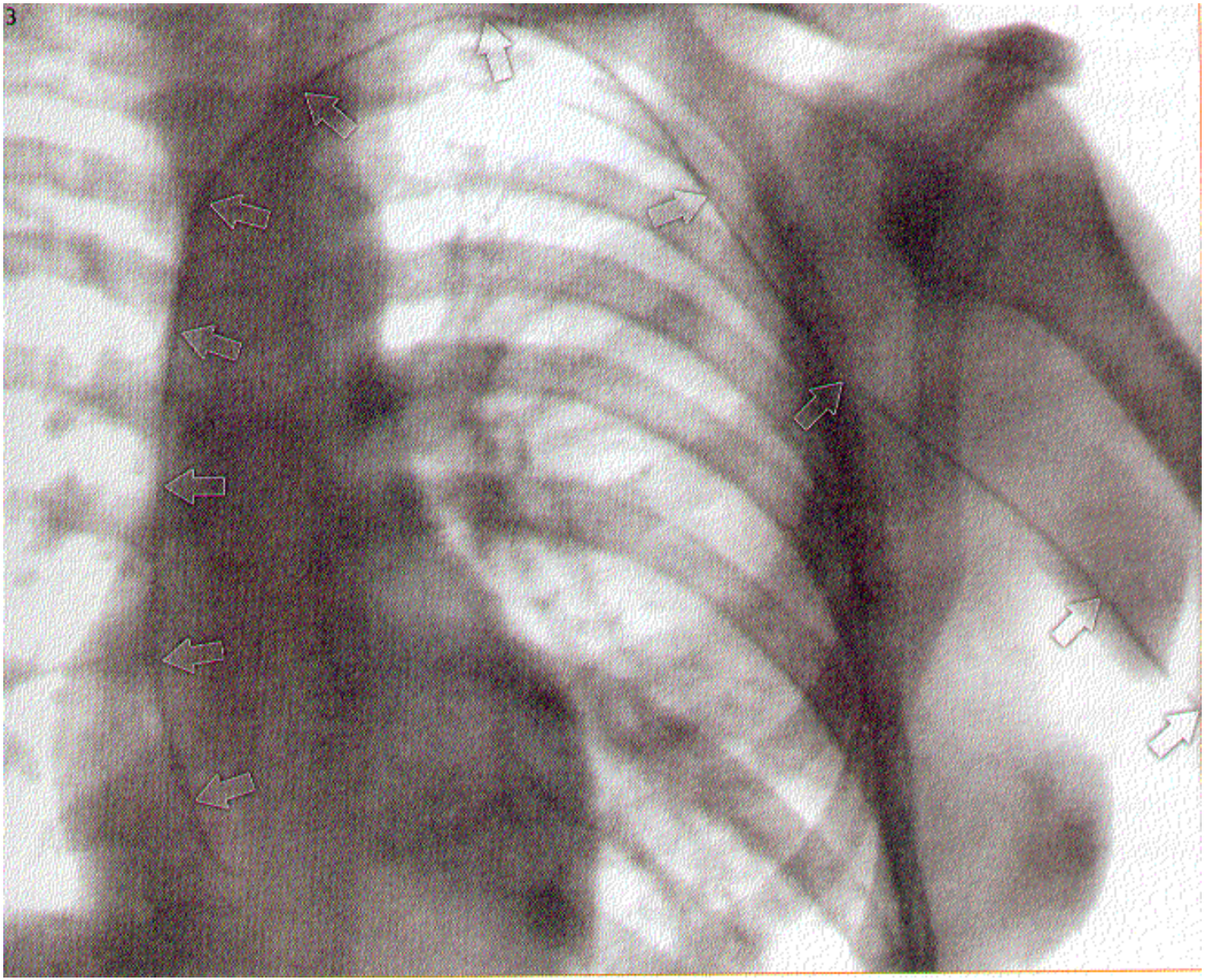


Induction Coil Stimulator by Emil du Bois-Reymond (1848). This regularly repeating stimulator may be the first electro-medical device, later on produced by Werner von Siemens (and used by him for tooth pain-suppression in his brother).



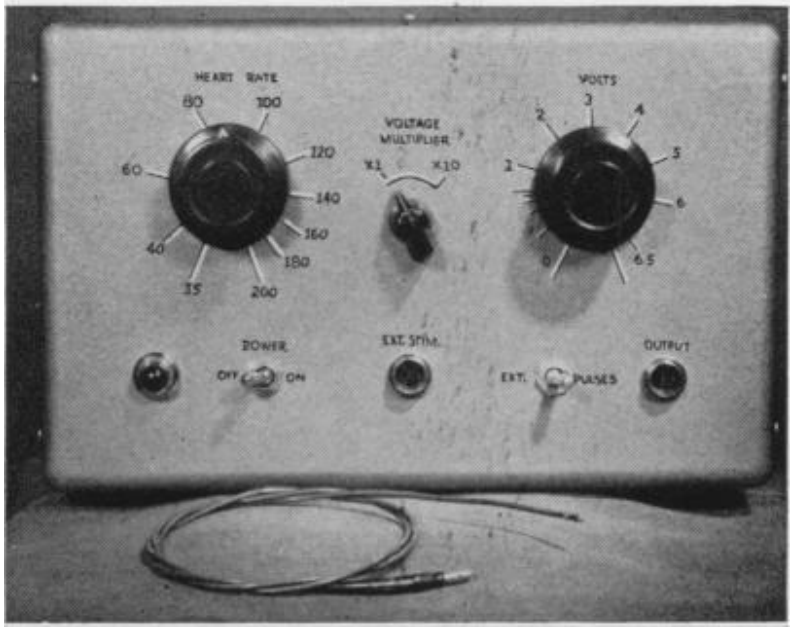
First „artificial“ pacemaker with spring-driven pulse generation and with 3 different pacing rates (30 min^{-1}, 60 min^{-1}, 120 min^{-1}) by A.S. Hyman (1932)

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 catherization of the living human heart. The catheter is running through the antecubital vein of his left arm to the heart (1929)

FIG. 3



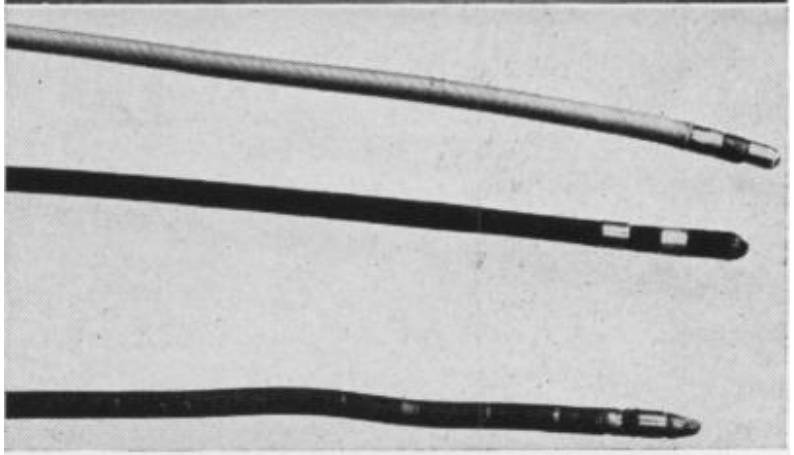
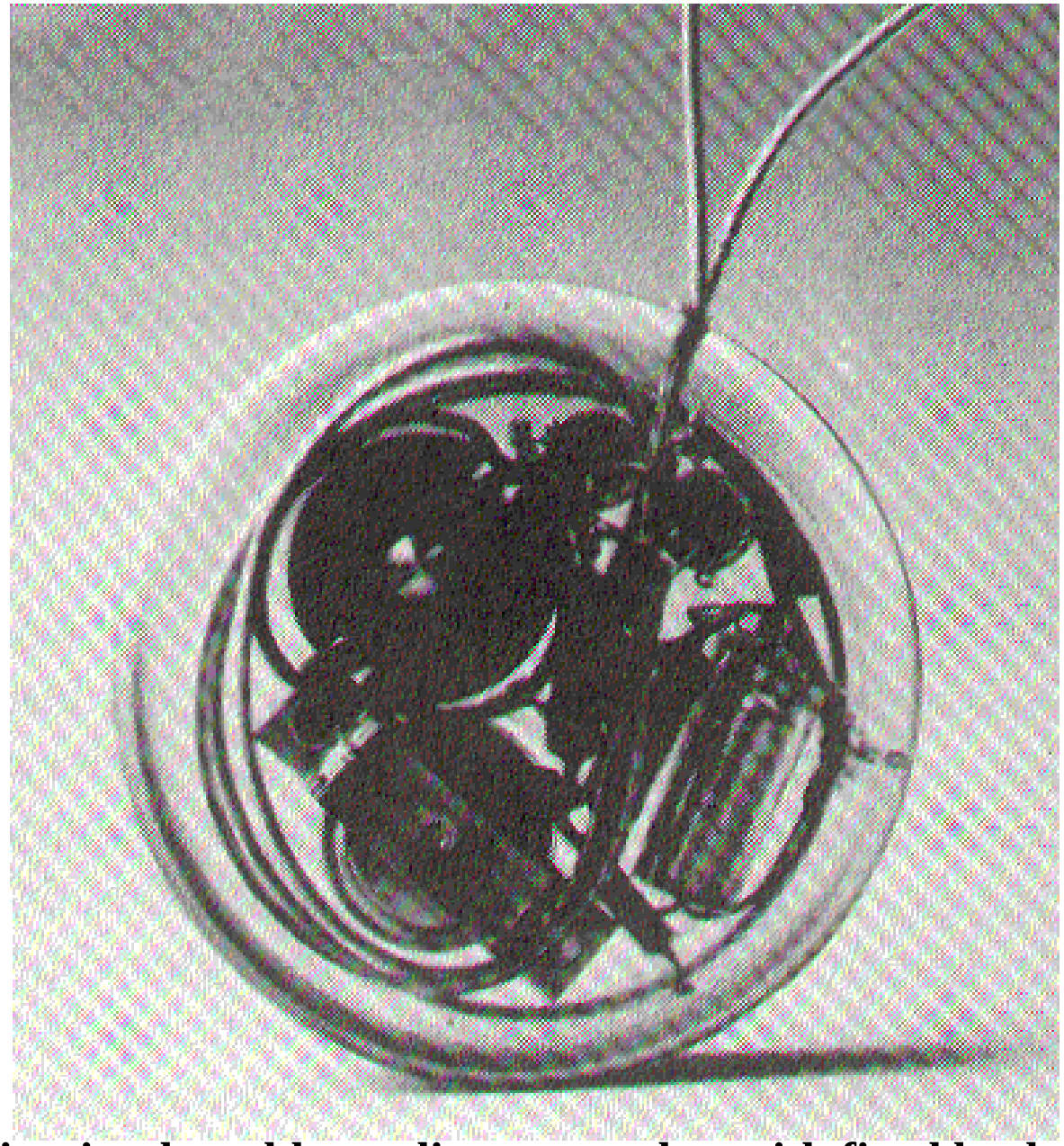


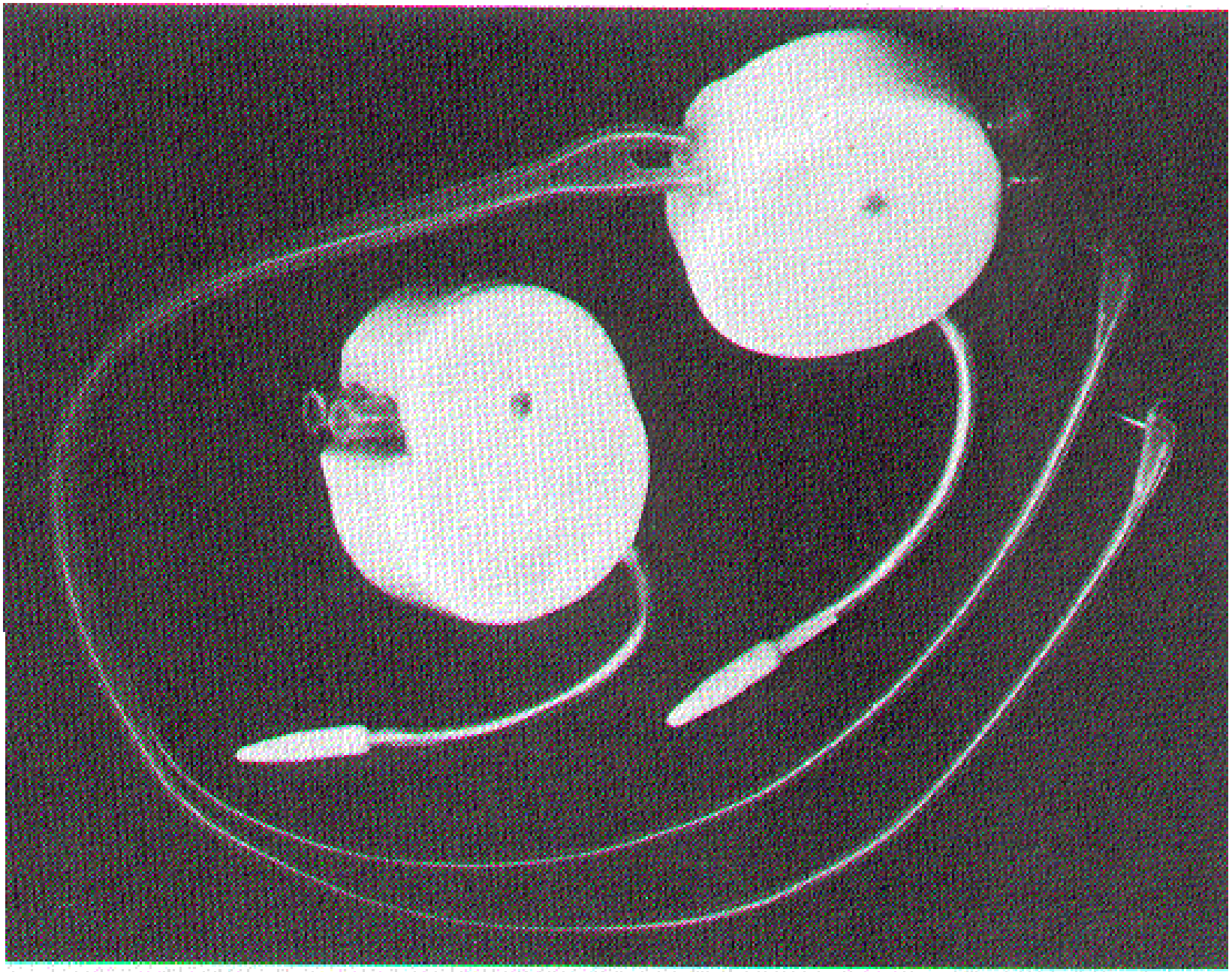
FIG. 4

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

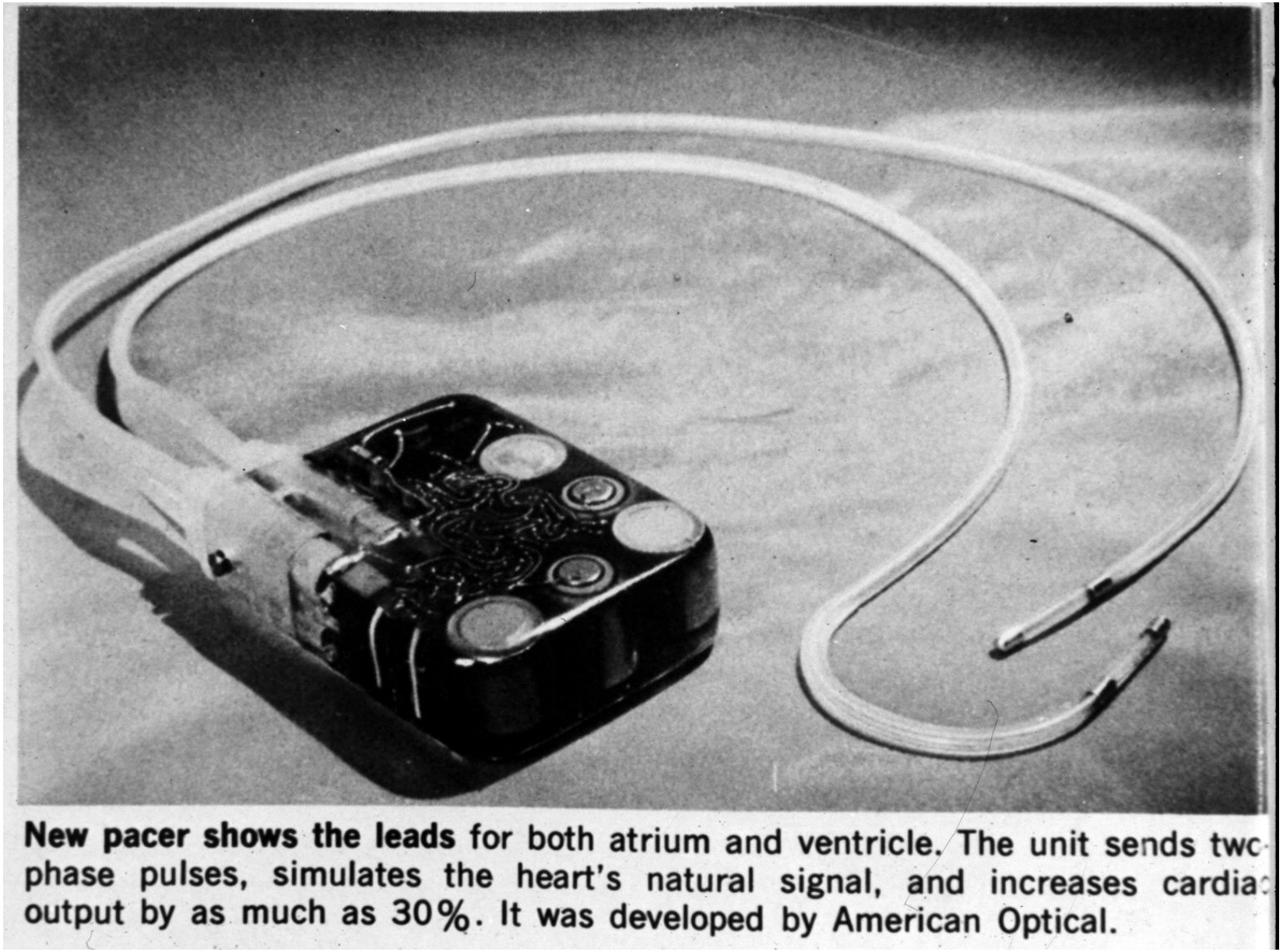
(R. Elmquist & A. Senning, 1957)



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

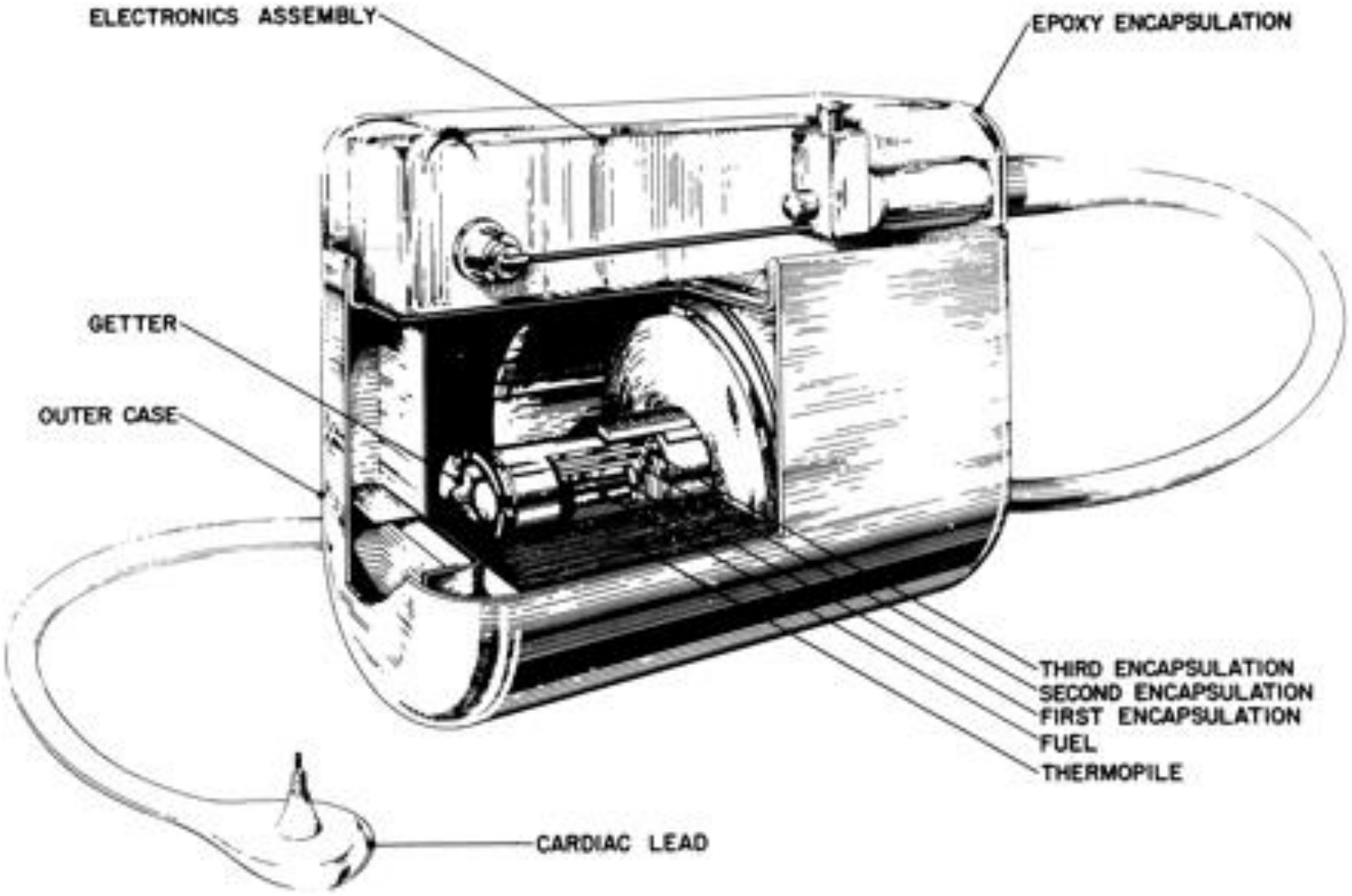


New pacer shows the leads for both atrium and ventricle. The unit sends two-phase pulses, simulates the heart's natural signal, and increases cardiac output by as much as 30%. It was developed by American Optical.

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)

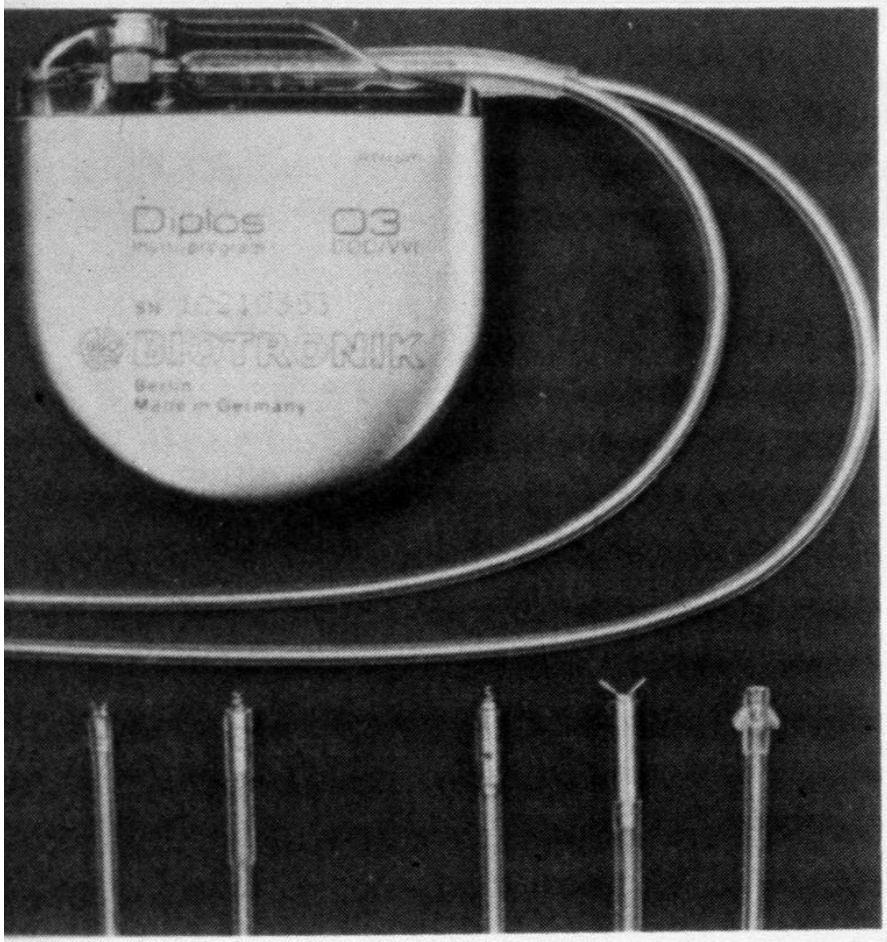
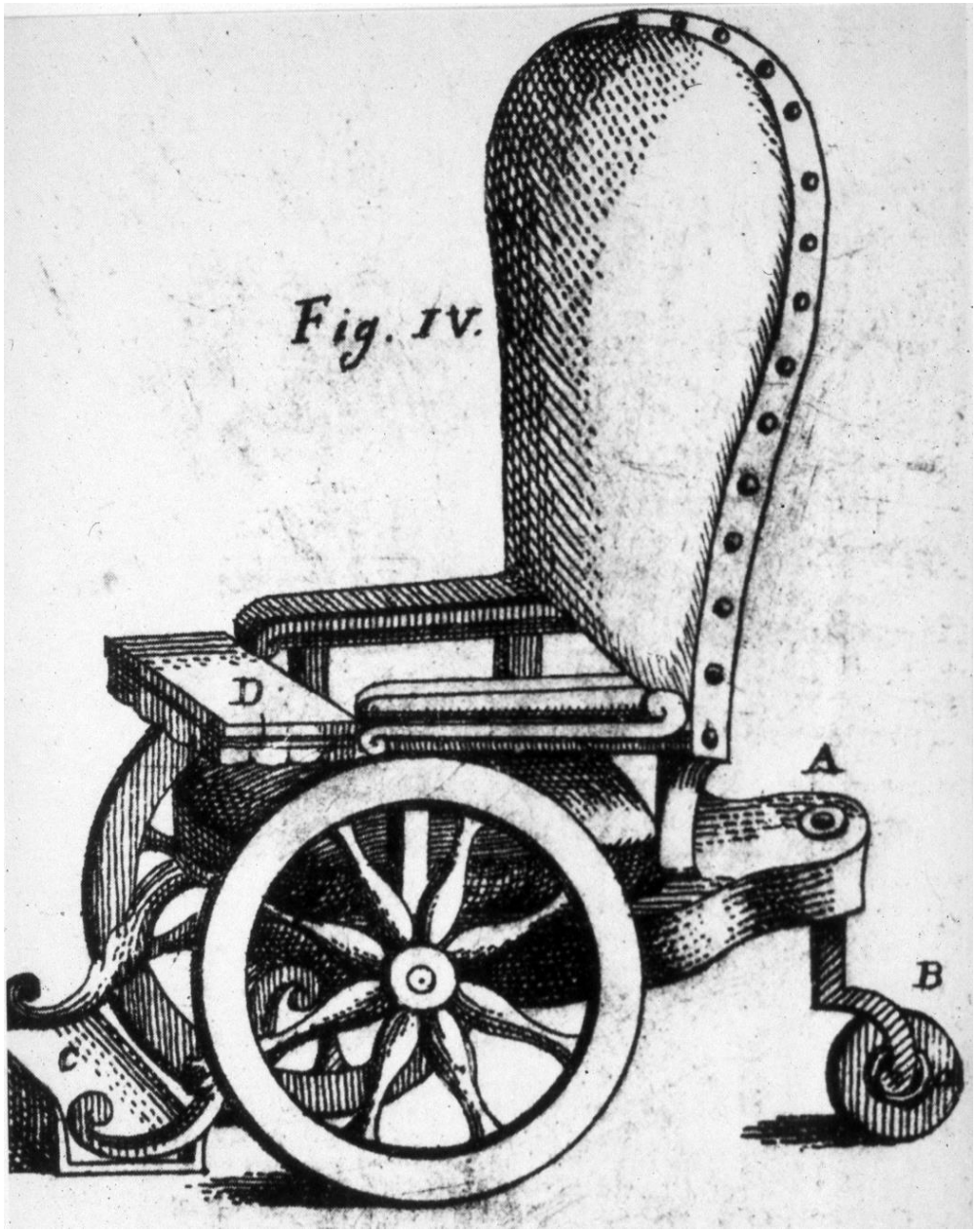


Abb. 9 Physiologischer Schrittmacher Diplos 03 mit verschiedenen Vorhof- und Kammerelektroden. Von links: FH, Y, YR, I 2 und K 10.

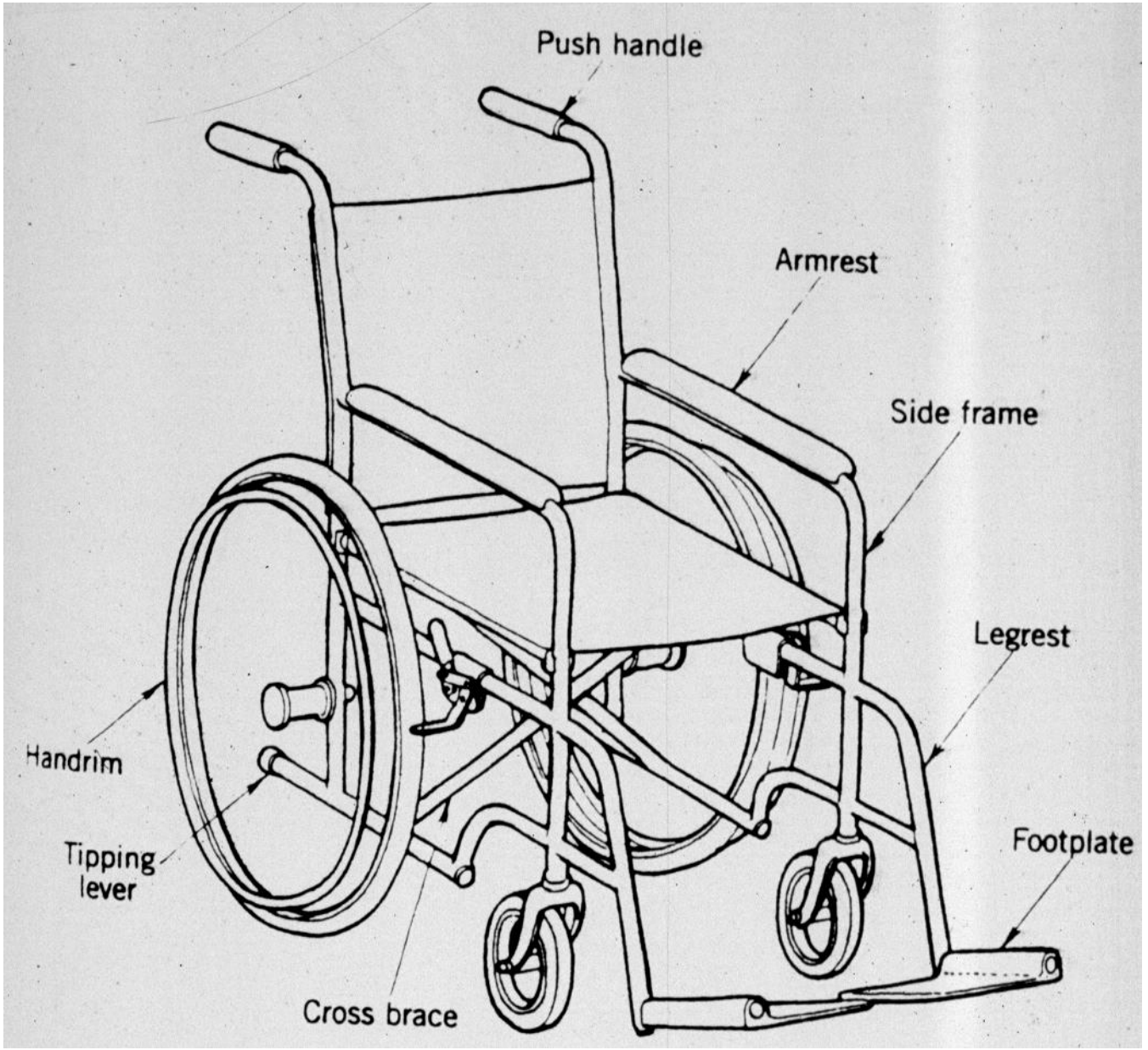
Metal-encapsulated bi-focal cardiac pacemaker with different atrial and ventricular electrodes (about 1984)

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)

1951 (1955)

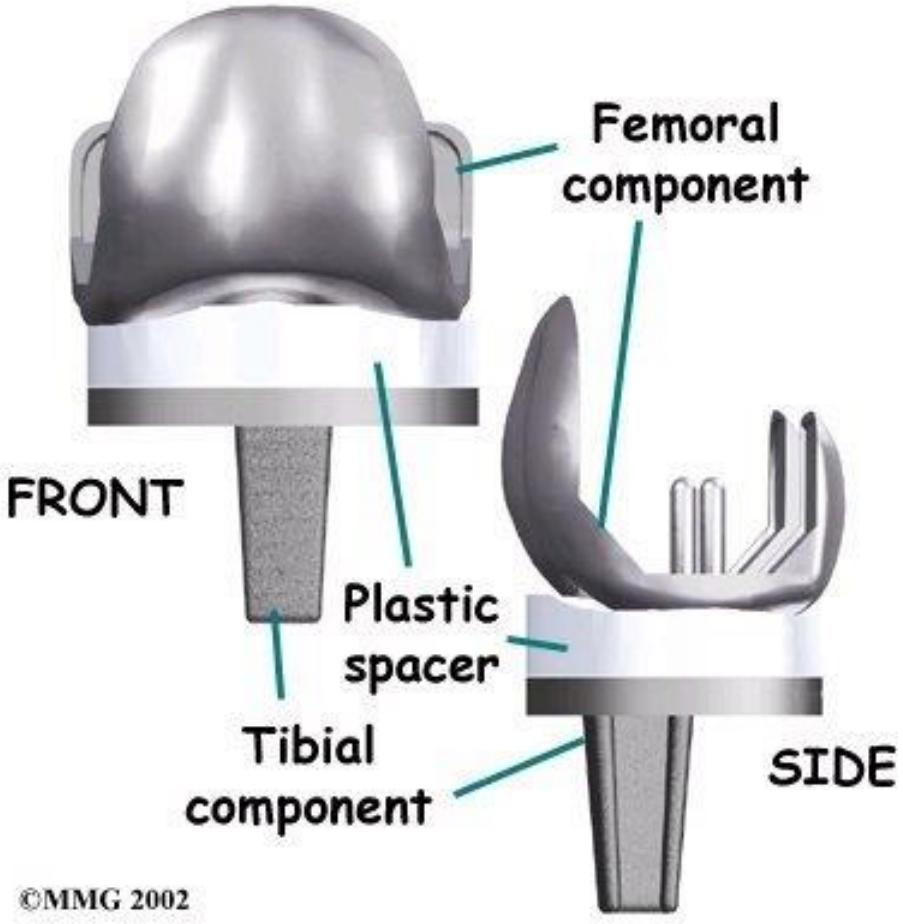
1971

1991

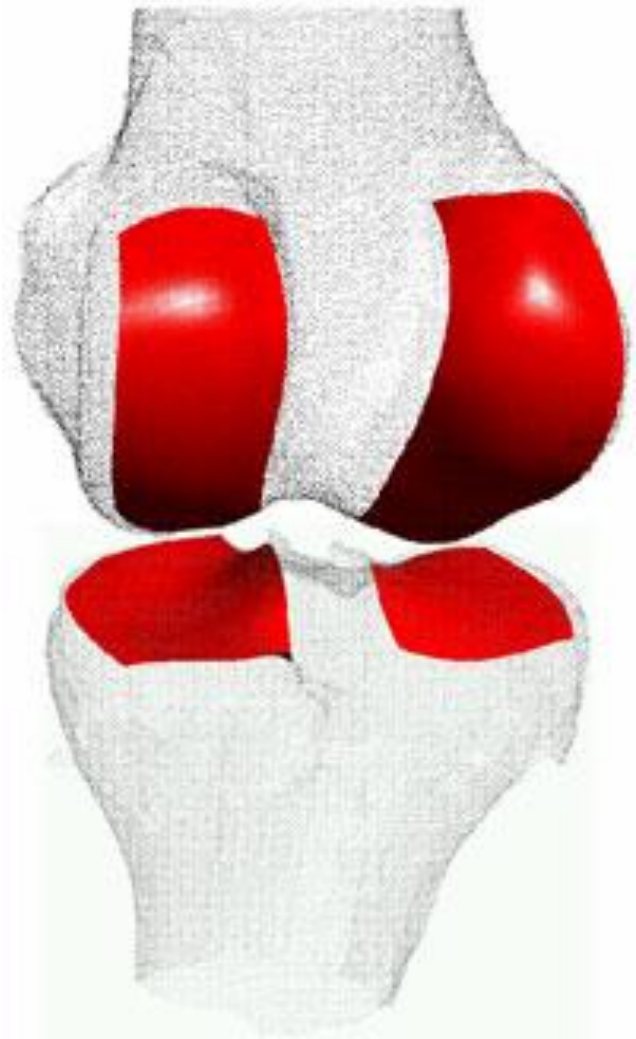
Abbildung 1: Verschiedene Generationen in der Schulterendoprothetik. a) System der ersten Generation (Neer-I-Schulterendoprothese); b) System der zweiten Generation (modulare Neer-II-Schulterendoprothese); c) System der dritten Generation mit exzentrischen Kopfkomponenten (Aqualis-System), aus: Jerosch J, Heisel J: Schulterendoprothetik. Steinkopff, Darmstadt, mit freundlicher Genehmigung: Steinkopff Verlag, Darmstadt.

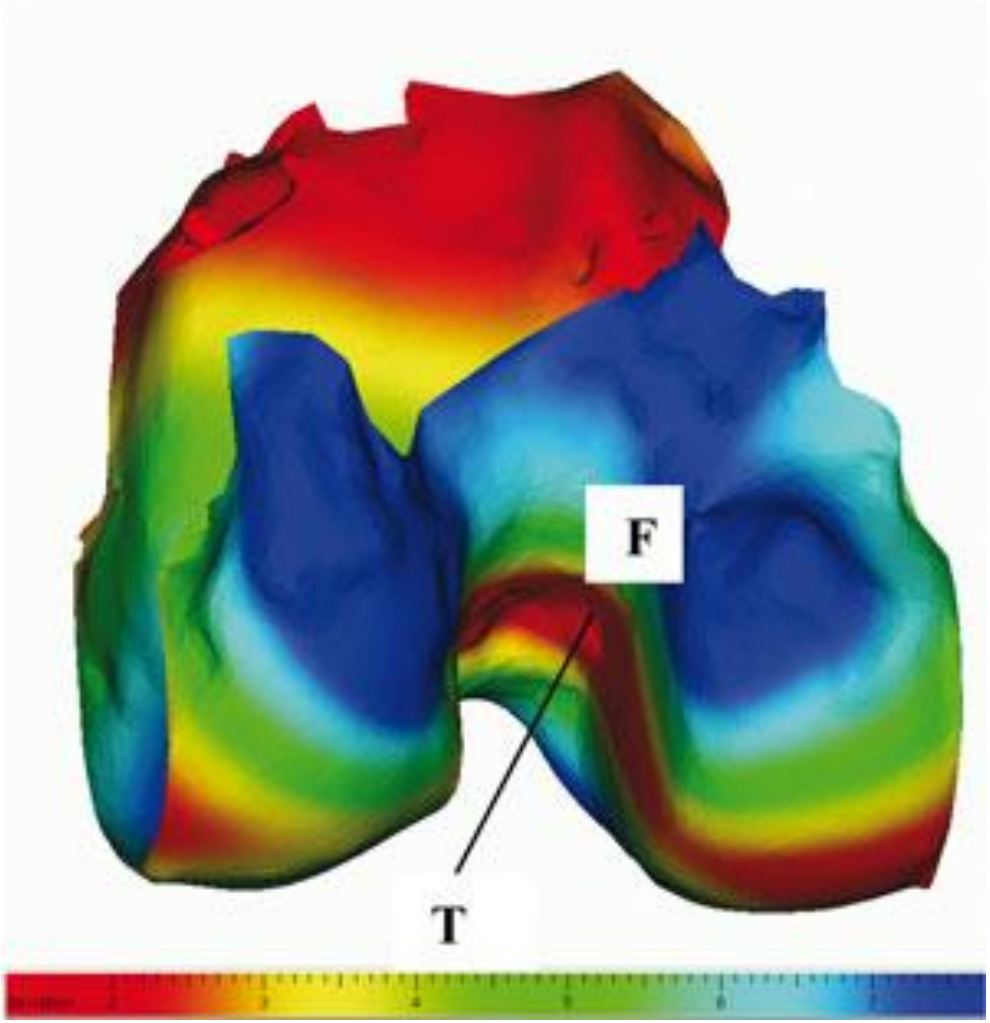
3 generations (1951, 1971, 1991 by Ch.S. Neer) of shoulder total endoprotheses (J. Jerosch & J. Heisel, 2003).

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

Optimization of the ligament position

Model Based System for Computer Assisted Knee Surgery

Gábor Renner and György Szántó

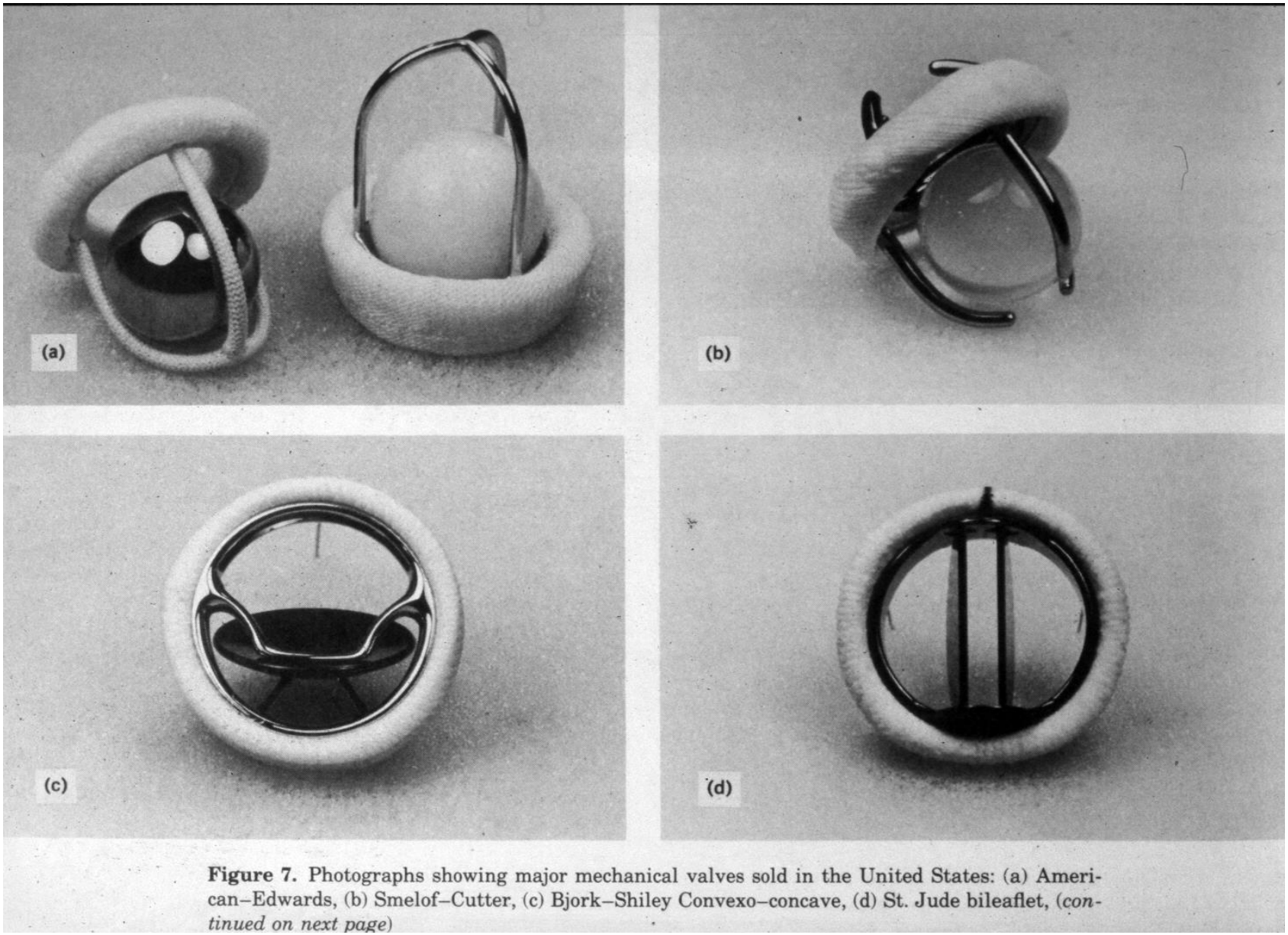
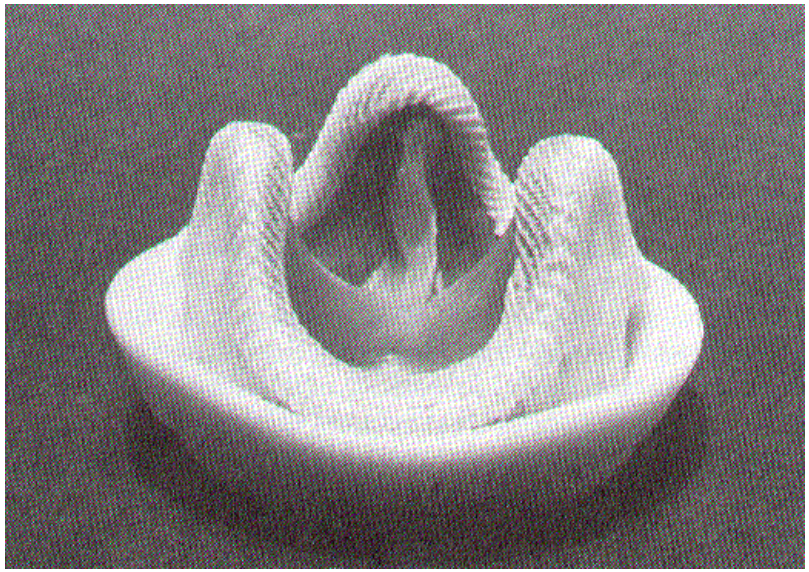
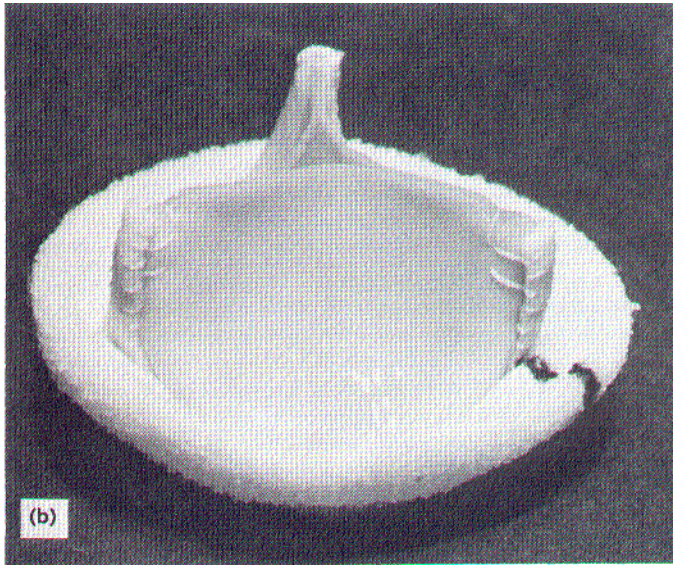


Figure 7. Photographs showing major mechanical valves sold in the United States: (a) American–Edwards, (b) Smelof–Cutter, (c) Bjork–Shiley Convexo–concave, (d) St. Jude bileaflet, (*continued on next page*)

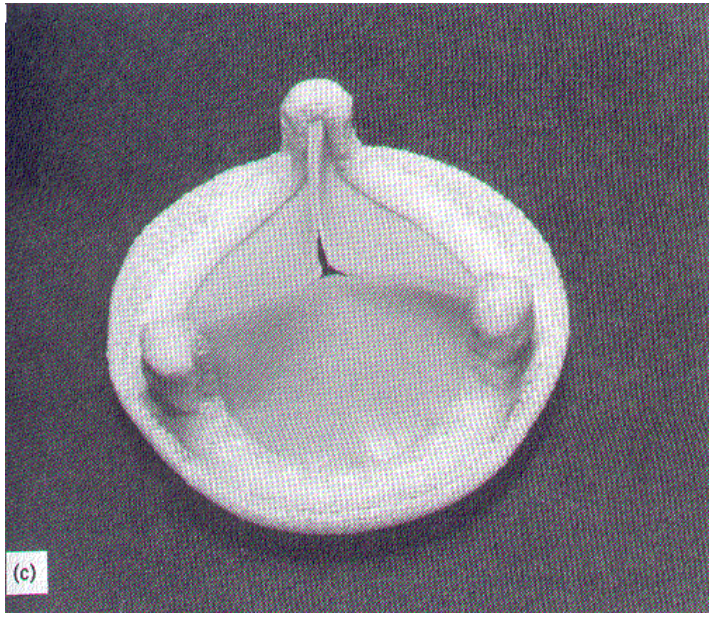
Different forms of artificial heart valves, e.g. caged-ball mode (a, b, 1960), tilting disk valve (c, 1969) and bileaflet valve (d, 1983)



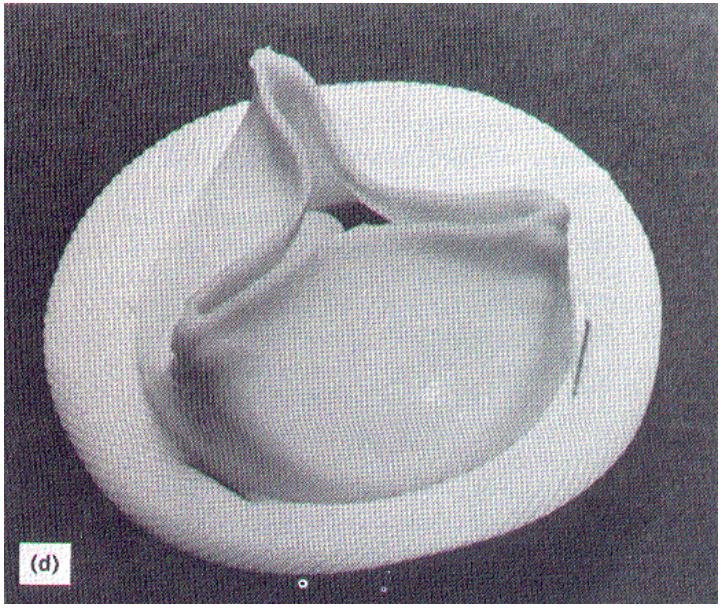
Hancock porcine bioprothesis (1970)



Ionescu-Shiley bovine bioprothesis (1976)

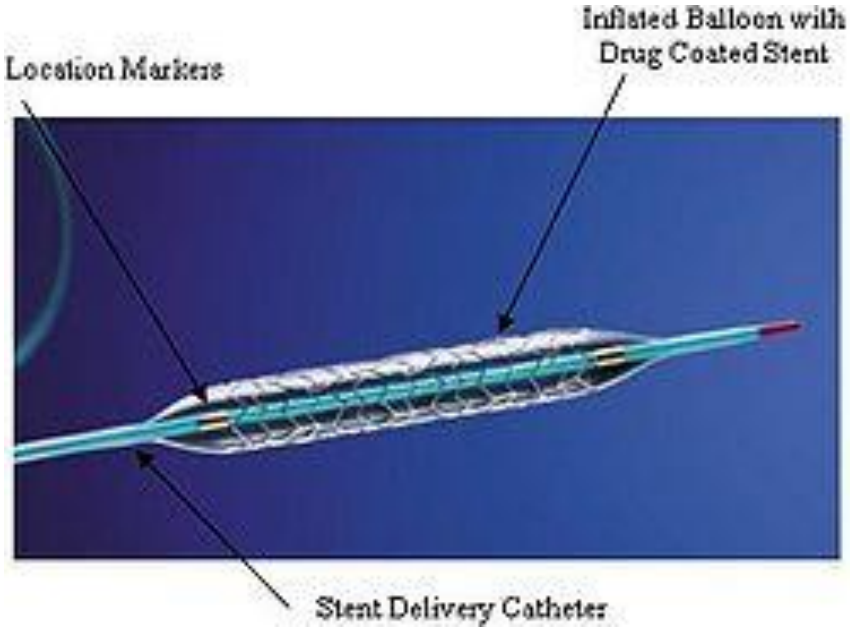


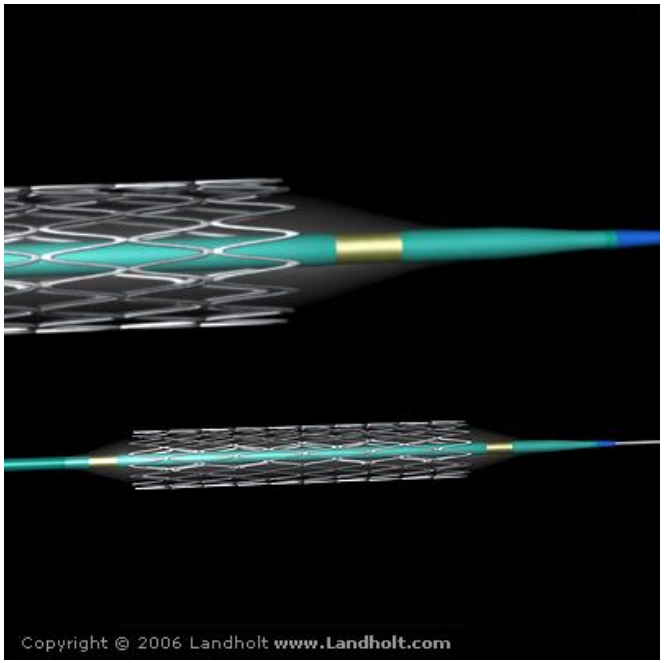
Carpentier-Edwards porcine bioprothesis (1975)



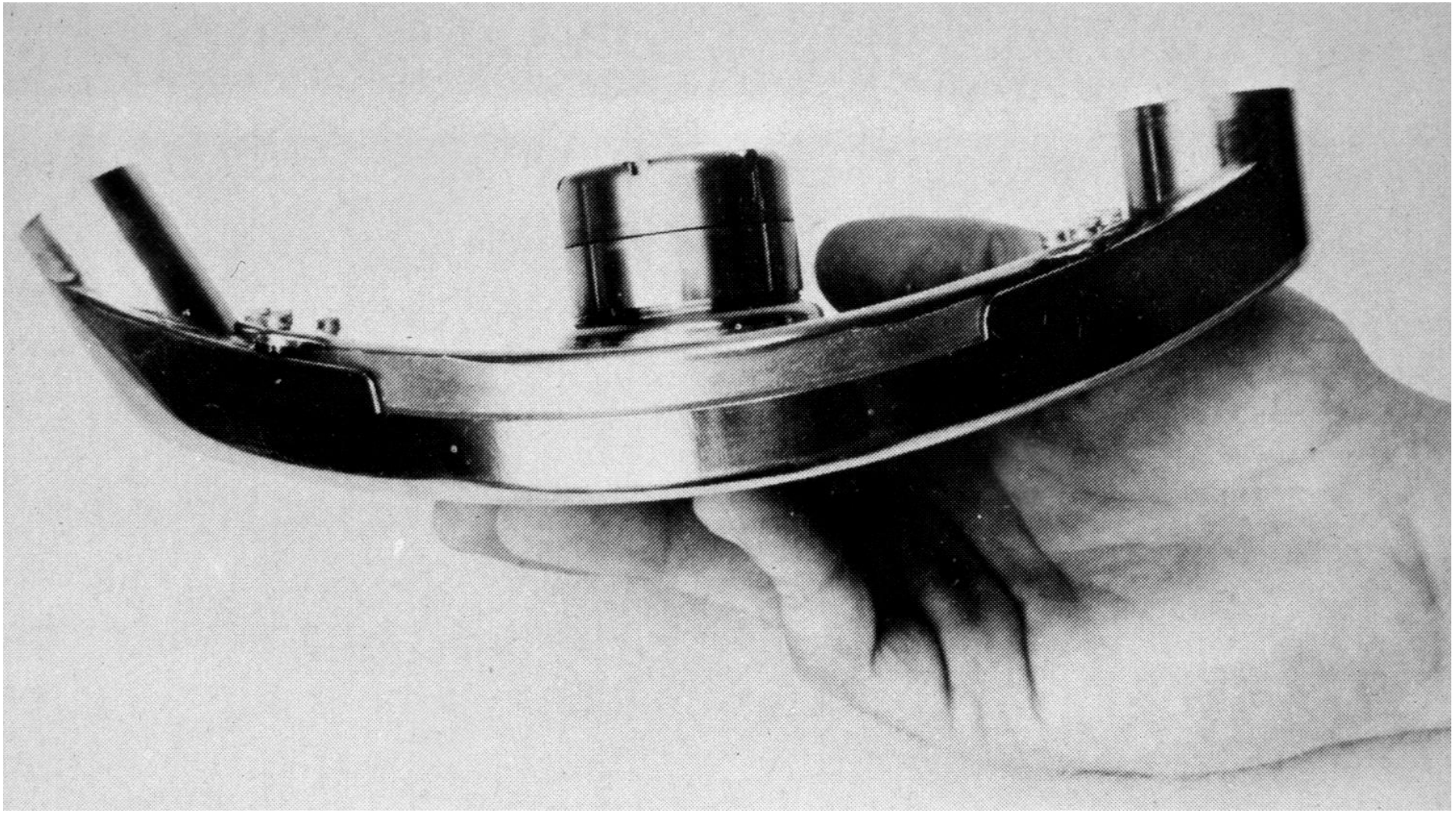
Mitral-Medial bioprothesis (about 1975)

Different xenograft cardiac valves



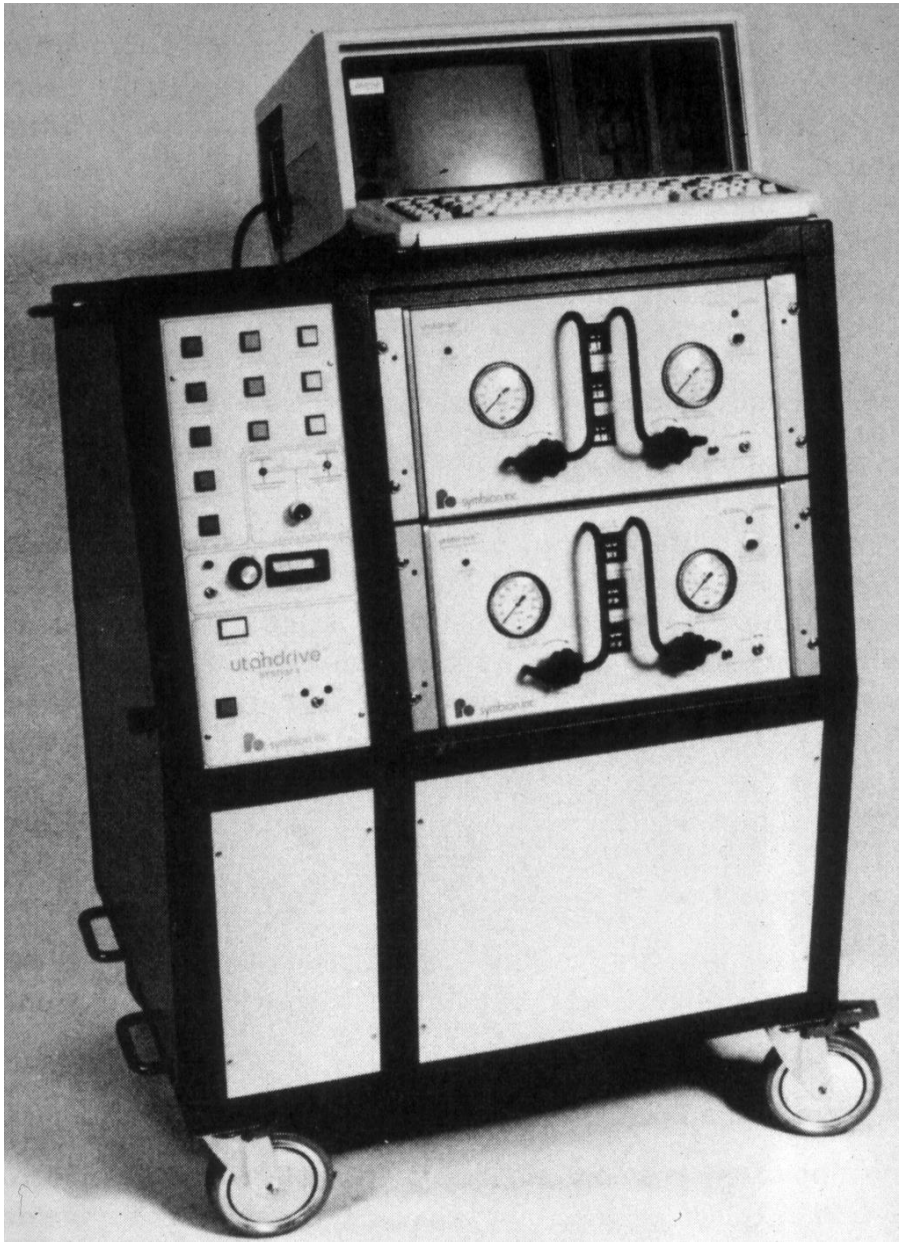


Stents including coronary stents (Charles Dotter 1958, Andreas Gruentzig 1977)



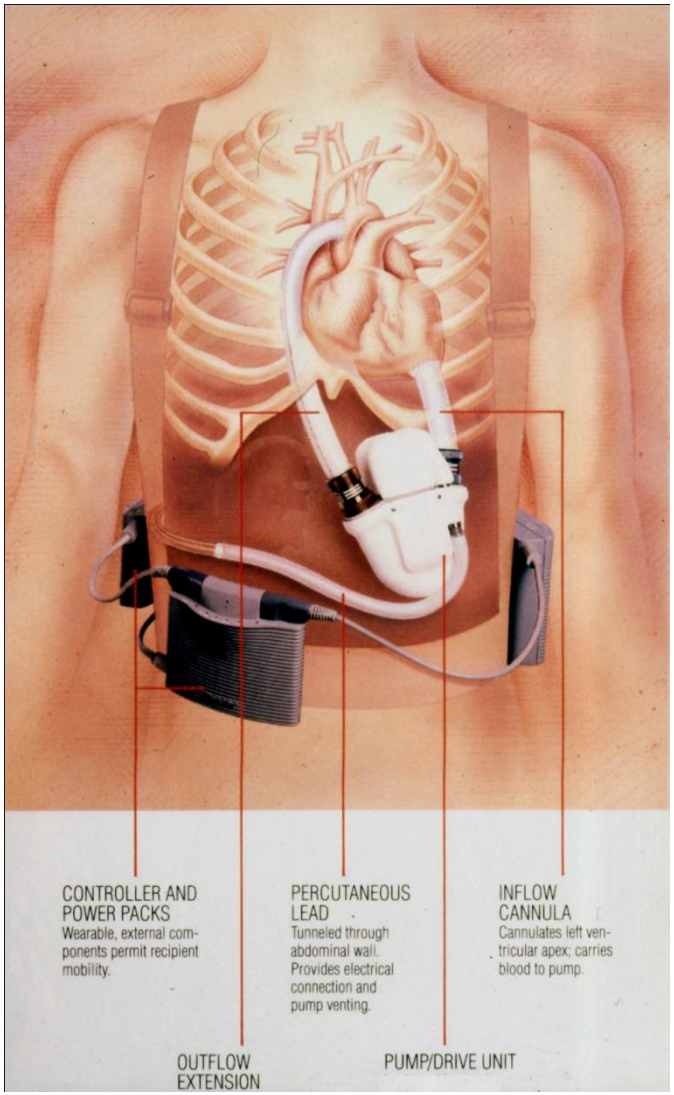
Left-ventricular blood pump with pneumatic control for animal tests in cows (about 1975)

Jarvik-7 biventricular artificial heart (ellipsoidheart) with 4 valves (implanted for the first time: 1982), developed by R.K. Jarvik



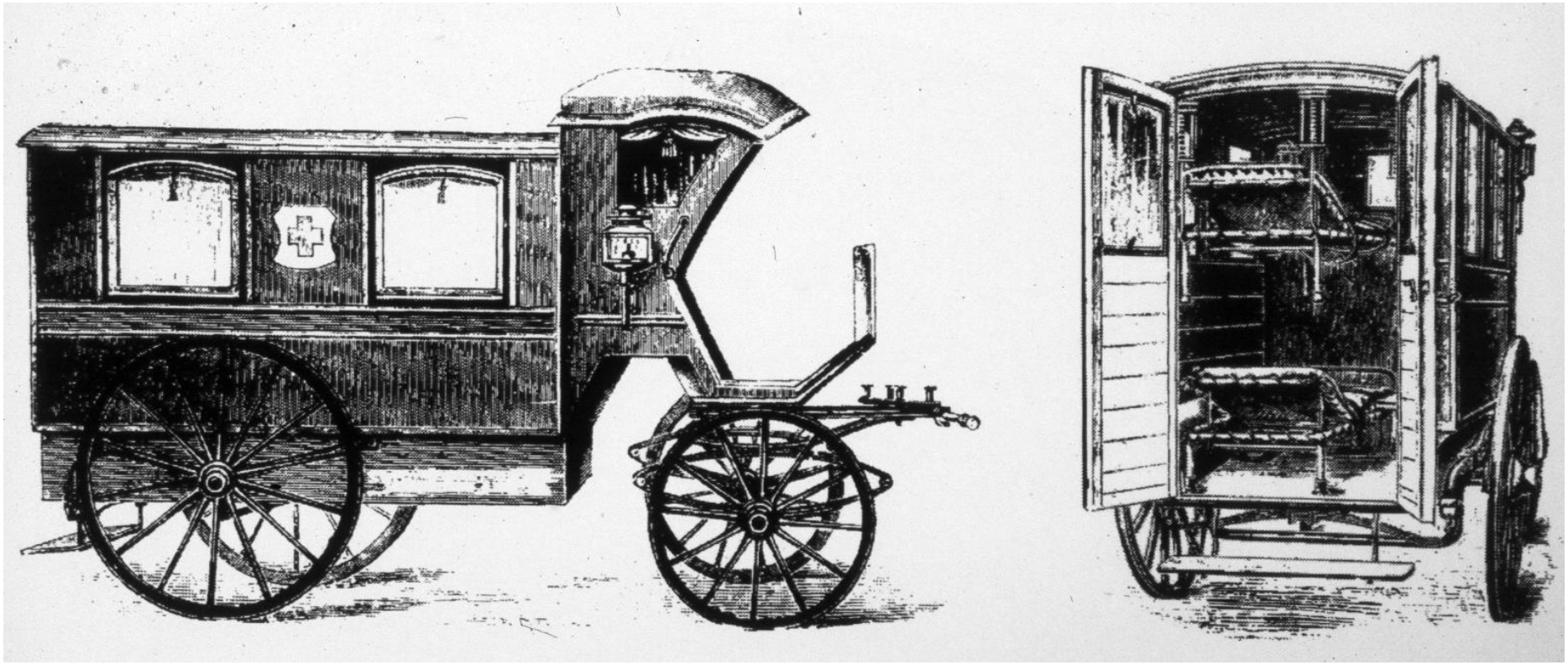
„**Utahdrive“, the controlling system for the Jarvik-7 artificial heart (1982)**

Left ventricular assist device LVAD with hydraulic pumping



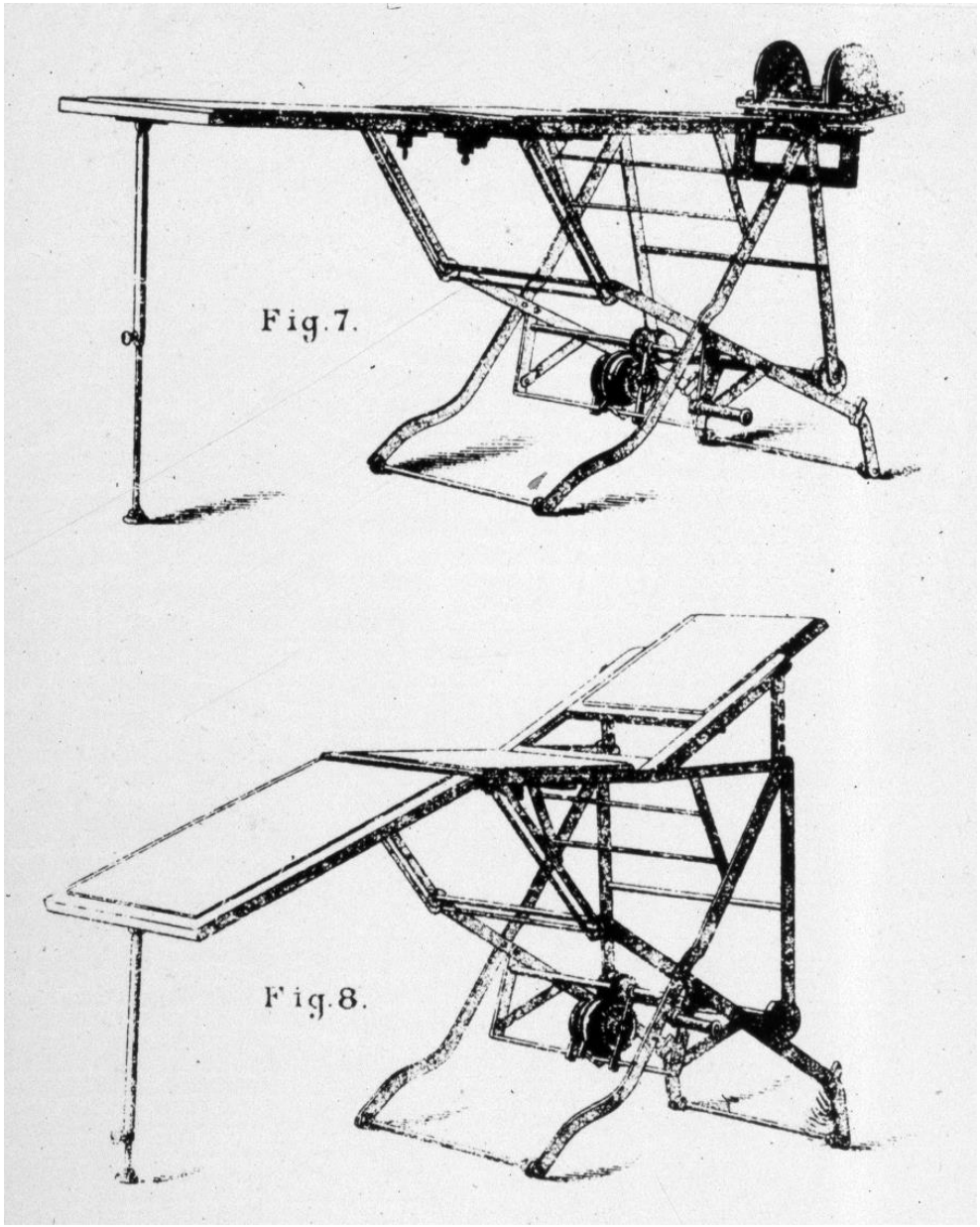
The Novacor Left Ventricular Assist System (LVAS) is an implanted, wearable, mechanical system that provides pulsatile circulatory support for more than six years. Batteries, „skin“ transformer and control unit are incorporated in a belt. First implantation 1984.

AbioCor Implantable (2001, FDA approved): Biventricular device, valves, hydraulic pumping with 4000 – 8000 rotations/minute

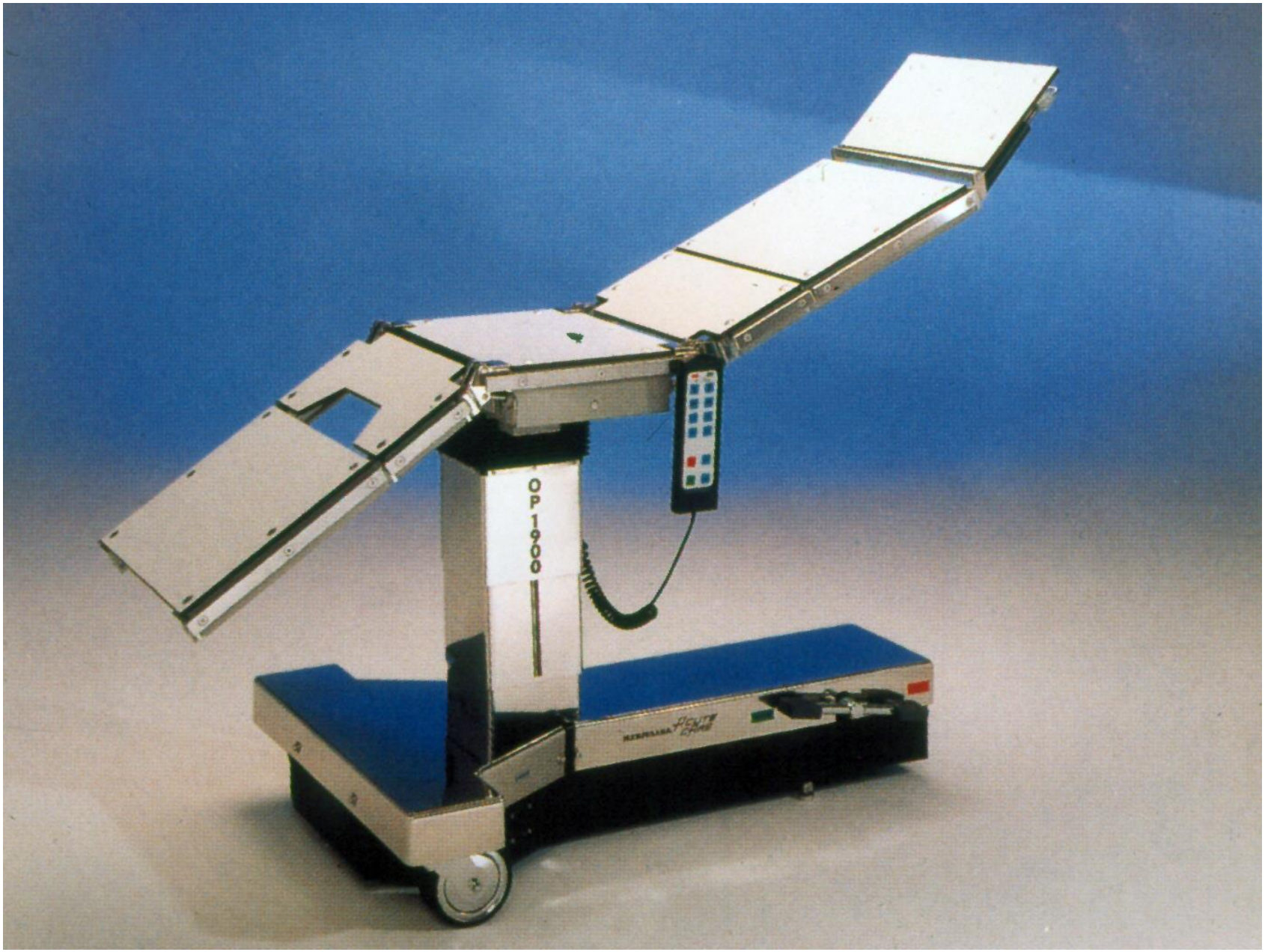


Patient transport vehicles pulled by horses (used until 1920s)

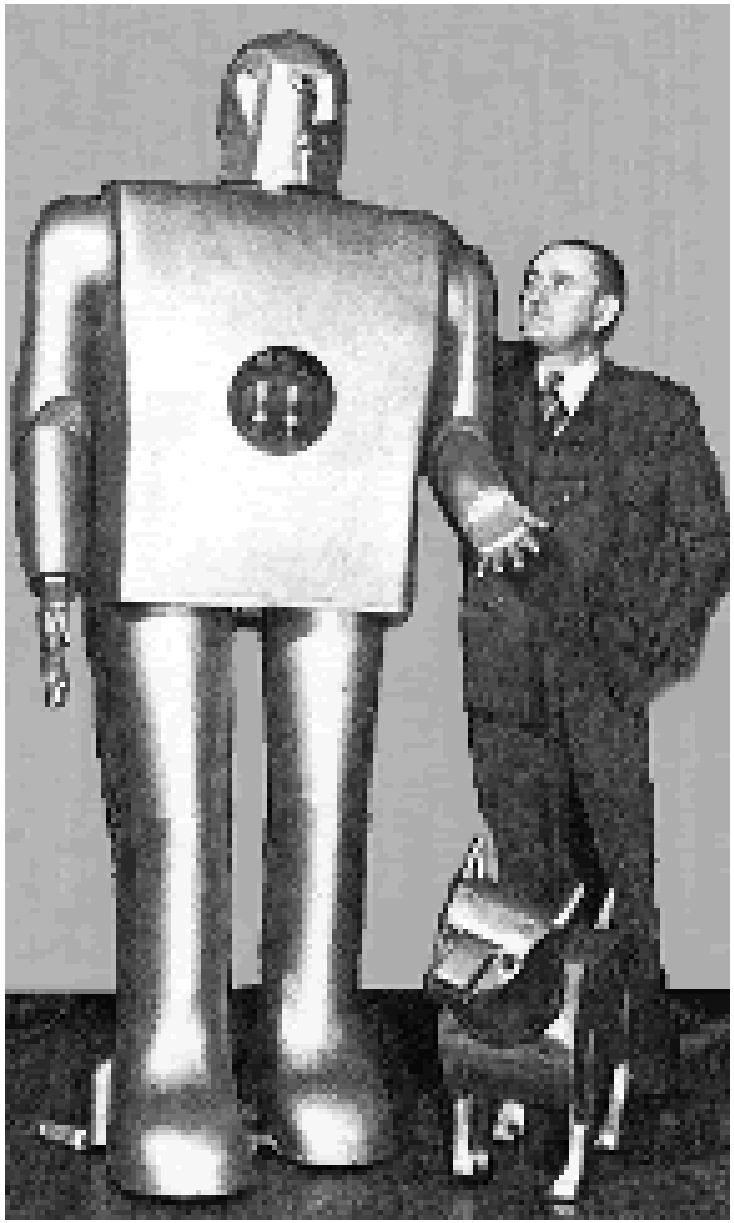
Rescue helicopter with equipment for emergency care and patient transportation



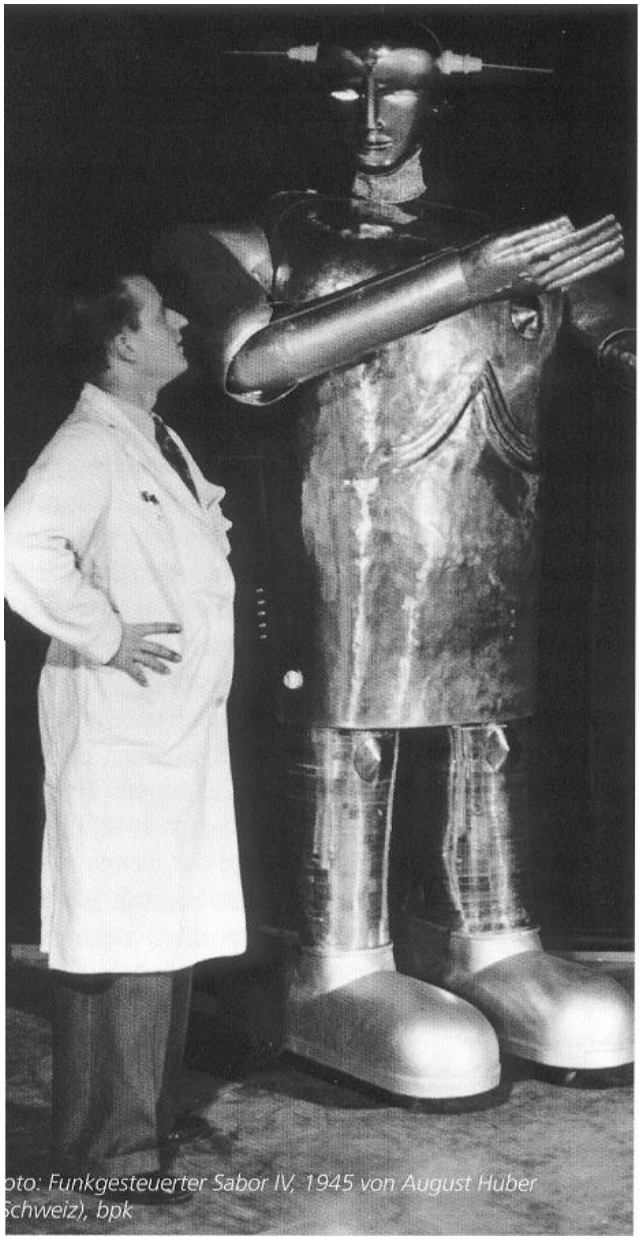
Manually adjustable operating table with flexible joints (about 1890)



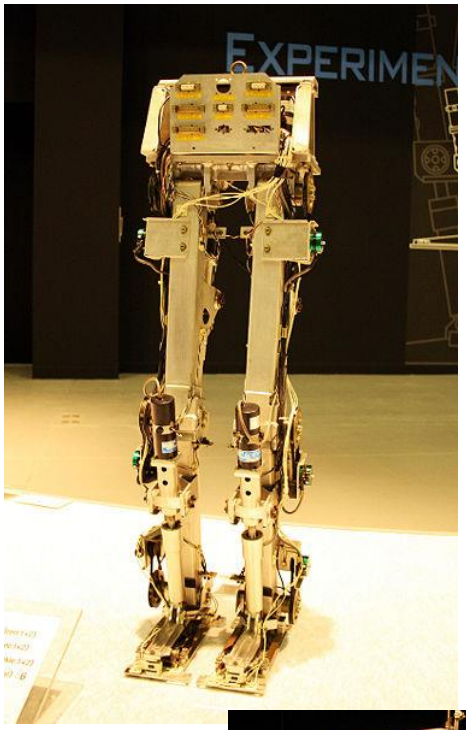
Adjustable operating table with key-board control



Elektro and his dog Sparko (Westinghouse, 1939)

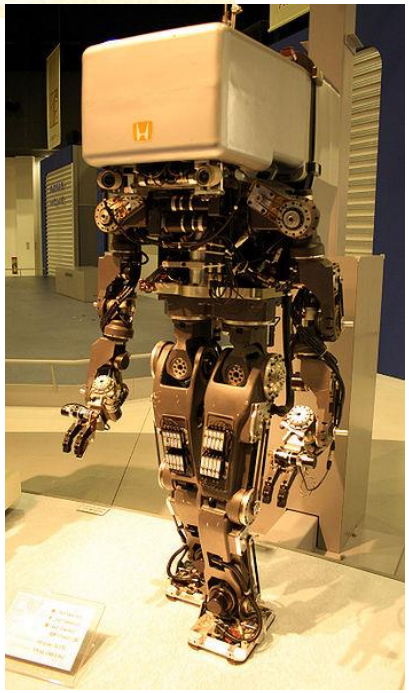


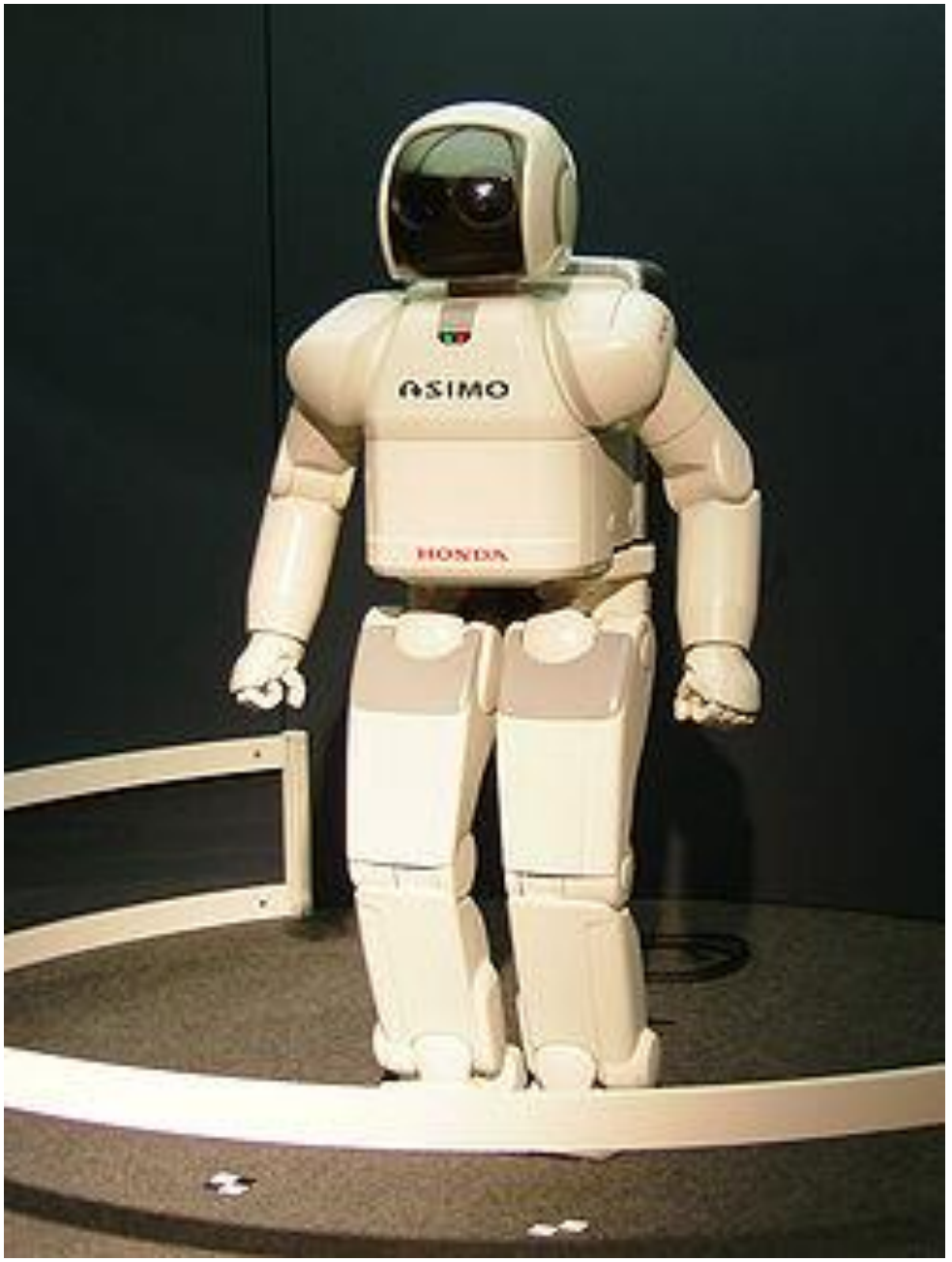
„Humanoid“ remotely controlled roboter (Switzerland, 1945)



1986

1993





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)