

Preface

The balance is one of the oldest measuring instruments of civilised societies. Its invention most probably was in connection with development of commerce, trade routes and the establishment of towns within the Neolithic era, that means about 5000 BC. The oldest findings of weights and parts of scales, however, are from about 3300 BC. Development of balances with regard to sensitivity, precision, and easy operation happened slowly within millennia, answering the prevailing needs and concerning the technical possibilities.

With fast development of techniques and creation of modern chemistry towards the end of the 18th century the demands on sensitive balances grew dramatically and resulted in a relative sensitivity (resolution/maximum load) up to 10^{-9} . Thus, up to the middle of the 20th century balances had been the most sensitive and precise instruments of sciences.

A basic change occurred when electricity was introduced in balance constructions. Now the weighing result is indicated digitally on a monitor or directly evaluated by means of a computer. Still main parts are levers and/or springs. However, using Lorentz force for a reset of the balance to its zero position, measuring the deflection of an elastic body or frequency shift of oscillations, only small paths are to be considered. Thus, the problems of knife edges vanished. In only few years such mechatronic balances superseded the pure mechanical types.

The constructions of mechanical balances is well documented, however reports are distributed in many scientific journals. Because mechanical scales are popular subjects of collectors, we have many collections and some museums specialise on balances. Furthermore often balances are exhibited in museum's covering general techniques. Nevertheless we think it would be useful to write a survey in a lexical form, covering the beginning of balance development up to the present time. That could facilitate finding of more detailed descriptions.

The book starts with a survey on the development of the concept 'mass' and of theories of gravity. Keppler's laws and fundamental forces between basic particles are explained. Mass units and conversion factors are given in tables. Development of weights and their standardisation from antiquity to the present time is described. Examples of weights destined not for weighing are mentioned. A survey on the dif-

ferent methods of weighing is presented. Adjustment and calibration, diminution of erroneous influences, damping and methods of speeding up weighing are discussed. Different extensive and detailed types of balances are described. One chapter deals with some important applications of gravimetric methods and the special types of balances for that purpose: laboratory scales, vacuum and thermo balances, magnetic suspension balances, tensiometer, gravimeter, suspended particles, density, particle size, and magnetic susceptibility determination, post office and coin scales, bathroom and animal scales. Mass determination in astronomy is shortly described and some curiosities are reported.

Often the balance is used as symbolic instrument, e.g. in mythology, religion and esoteric context. In astronomy, commerce and in law it is used as an icon. Sometimes it is depicted in paintings or used as a component of statues. We find the balance in literature, and some poems are set to music.

In tabular form the history of the balance is presented as well as the museums in which balances are exhibited. History and profiles of some important balance manufacturers are reported and the addresses of many companies are listed. The appendix contains tables of prefixes and of recent literature.

Several hundred photographs, reproductions and drawings show instruments and their uses. These include commercial weighing instruments for merchandise and raw materials in workshops, as well as symbolic weighing in the ancient Egyptian's ceremony of 'Weighing of the Heart', the Greek fate balance, the Roman Justitia, Juno Moneta and Middle Ages scenes of the Last Judgement with Jesus or St. Michael, and of modern balances. The photographs are selected from the slide-archives of the late Richard Vieweg (1896–1972) (former President of the Physikalisch-Technische Bundesanstalt, Braunschweig, Germany), of the late Hans R. Jenemann (1920–1996) (former head of the Analytical Laboratory of Schott & Gen., Mainz, Germany) and of his wife Irene (1933–2008) and of Erich Robens.

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Balances

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