The history of technology: Temperature controllers

The history of microbiology and the development of associated methods starts with Robert Koch. Today, AtmoSAFE will take you on a journey from temperature control in gas-heated incubators to the invention and patentation of mechanical temperature control by Willi Memmert.

Robert Koch's incubator at the German museum of medical history

The second half of the 19th century was an exciting time for **science**. Max von Pettenkofer, Rudolf Virchow, **Robert Koch** and Louis Pasteur - to just name a few - were all ground-breaking pioneers in the field of etiology and the development of hygiene standards. The Charité in Berlin, the **Robert Koch** Institute and the Pasteur Institute established their worldwide reputation.

Particularly **Robert Koch**, who - besides **Louis Pasteur** - is considered to be the father of **microbiology**, passionately devoted himself to the development of microbiological methods. He replaced the broth that had previously been used as a breeding medium for germ cultivation by solid and transparent media containing gelatin. Furthermore, his research also paved the way for the perfection of the **incubator**.

Lautenschläger‘s gas-operated temperature controller

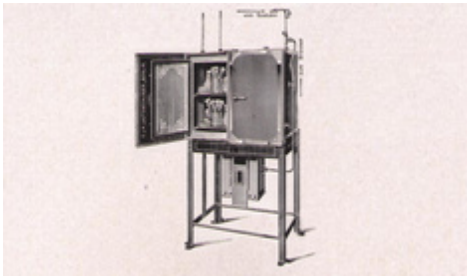
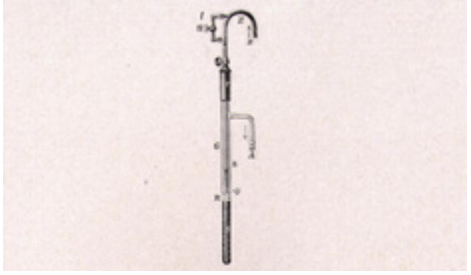


Fig. 1: **Incubator** from the company Lautenschläger



At that time, the Berlin-based company Lautenschläger was the leading manufacturer of **laboratory equipment**. **Incubators** were always operated at a constant **temperature**, since **temperature control** at different temperatures was not yet possible. The "thermostats” were insulated with asbestos or linoleum, **heat transfer** to the interior was provided through a water jacket, heating was done using gas and even double doors, the interior ones made of glass, were already a matter of course. Calibration of the **temperature controller**, however, was significantly more difficult than today. Lautenschläger’s “**thermo regulator**” (fig. 2) consisted of a glas tube [G] closed at the

bottom end around which the water of the **incubator's** water jacket could circulate, a space for regulation [R], an adjustable metal tube [Z] and a glass spiral [S] filled with mercury at the bottom end of the glas tube. The gas was introduced at [B] and discharged at [A]. As mercury expands in direct proportion to the temperature, it rose in the glas tube at increasing temperatures, closed the opening [U] of the inlet tube [Z], so that gas could only be introduced in small amounts through a side tube. If the **temperature** fell below the desired set temperature, this caused the mercury level to sink and the the main gas tube was opened for reheating. "Calibration" of the **temperature control** was done in advance in a **waterbath** with a slightly higher temperature than the desired constant **temperature** in the **incubator**. The inlet tube [Z] was pushed downwards until the gas flame just began to shrink. The water jacket of the **incubator** was filled with water at the **set temperature**. Afterwards, the regulator was introduced into the water in the incubator and connected to the gas supply.

Fig. 2: Lautenschläger's **thermo regulator**

Mechanical temperature controller developed by Willi Memmert

Fig. 3: Aeolus, the first hot air steriliser developed by Memmert

It was an exciting time for **Willi Memmert** when he delivered his first hot air steriliser in 1947. The development of the "Aeolus" marked the beginning of a new passion for the company founder of **Memmert** – the very passion that had already motivated **Robert Koch** still prevails at **Memmert** today: the quest for uniform **temperature** distribution in the working chamber of an **incubator**, **hot air steriliser** or **drying oven**. **Willi Memmert** achieved this with ease and had his ground-breaking invention patented in the early 50s already. Until the early 90s, when **Memmert** as one of the first companies worldwide developed and deployed a PID process controller for **temperature regulation**, this principle of his mechanical **temperature controller** guaranteed unique precision.

The incubator becomes a control element

The greatest inventions are often brilliantly simple. **Willi Memmert** used the fact that metal surfaces – and also the

interior of an **incubator** or **drying oven** - expand due to heat. He installed a heated plate in the back of his appliances, connected to a control rod with a higher heat resistance. If the plate expanded due to the heat, the control rod moved upwards, two contacts installed on a seesaw engaged and a relay was triggered, disconnecting the power supply for the heating unit. This way, the **incubator** or **drying oven** was used as a control element itself. The way from heating unit to the controller was minimised, and the disadvantages of control delay or inaccuracy as a result of temperature sensors in the working chamber, common until then, were overcome

Fig. 4: **Memmert drying** oven from 1950 with hollows in the working chamber

Individual calibration of Memmert appliances

Thanks to a control knob filed for patent by **Willi Memmert** when adjustable **incubators**, **sterilisers** and **drying ovens** were introduced, it was possible to exactly adjust the **temperature** with a precision of less than ± 0.5 °C. Competitors' appliances generally used printed or engraved scales. The disadvantages were obvious: Back then, each appliance was subject to manufacturer tolerances and a fixed temperature scale made it impossible to calibrate it later on. It has always been Memmert's company philosophy never to save money at the expense of precision in manufacturing. This way, each **Memmert** appliance was individually calibrated by hand until the introduction of digital control technology. The **temperature** in the working chamber was measured and then marked on the knob at the corresponding scale position.

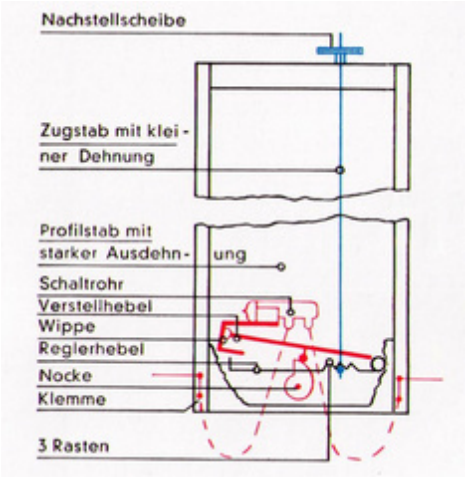


Fig. 4: Scheme of **Willi Memmert's** mechanical controller (dated back to the 60s)

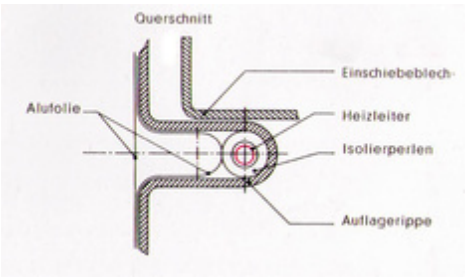


Fig. 5: Cross-section through a hollow in the inner chamber, with integrated heating element

However, **temperature control** only accounted for half the precision of **Memmert's incubators**, **hot air sterilizers** and **drying ovens**. The other half can be attributed to the unique heating concept. In the early 50s, the appliance walls had been equipped with hollows for heating element integration already. These hollows enlarged the surface for heat transfer and additionally made it possible to place shelves on them. The third decisive advantage was the uniform heat distribution from all sides of the interior.

The will to continuously increase his knowledge made **Willi Memmert** a pioneer in temperature control technology and

Memmert the technological leader for temperature control appliances. If you are interested in finding more answers on the question why **Memmert incubators**, **hot air sterilisers** and **ovens** are still of unparalleled precision today, have a look at the **Memmert** homepage.

Picture credit: Lehrbuch der Mikrobiologie, Friedberger und Pfeiffer, 19; German museum of medical history

Autor: Memmert GmbH + Co.KG
