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AN INSTRUMENT FOR MAINTAINING A THERMO- AND HUMIDITY-STABLE ENVIRONMENT

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INTRODUCTION

Precise measurement of weights, volumes and lengths requires standardization of the ambient atmosphere (*Römpp*, 1958), especially of its relative humidity.

In a related investigation (*Glantz*, 1969) it was desired to weigh small amounts of dental plaque with a high degree of precision (about $\pm 1 \times 10^{-6}$ g). But this proved impossible in normal laboratory environments.

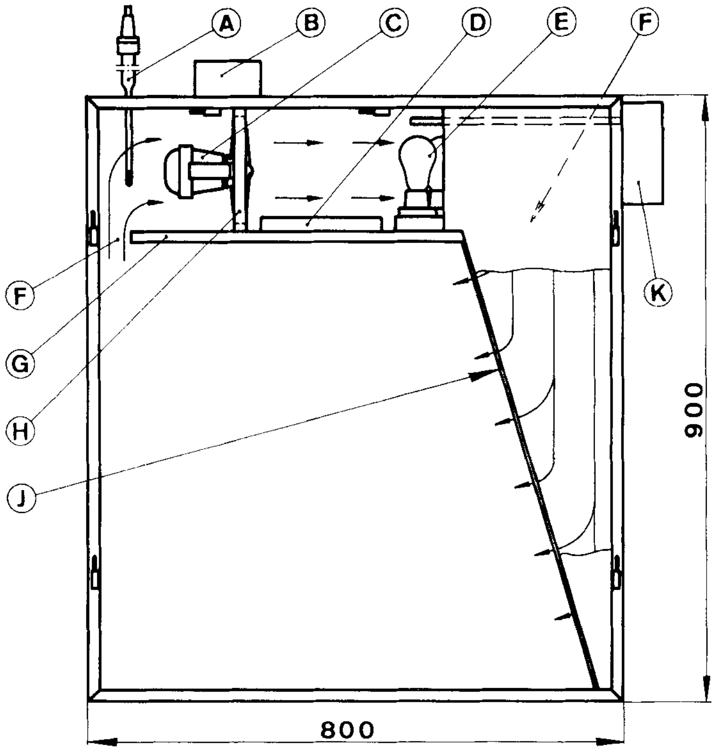
We therefore built a special thermo- and humidity-stable chamber for the balance (Mettler M5SA) used in the experiment.

CONSTRUCTION

The thermo- and humidity-stable chamber was constructed in such a way as to maintain a higher temperature and a lower relative humidity inside a closed box than outside it. The construction is described below.

A chamber, made of wood, was placed on a weighing table. The chamber was 900 mm high and its lid was 600 mm by 800 mm. It had no bottom because the balance was placed directly on the weighing table. The front wall of the chamber had two glass doors with wooden frames, one of which

Received for publication, April 27, 1970.


A
B
C
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G
H
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K
900
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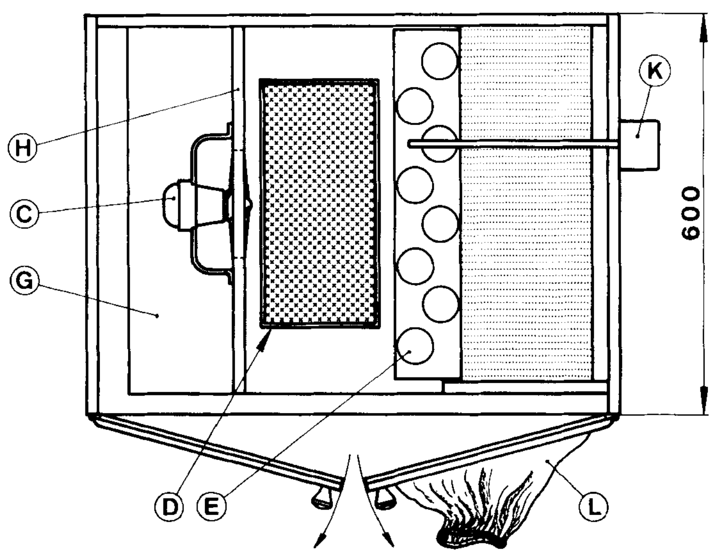
K
H
C
G
600
D
E
L

was also furnished with a cotton sleeve (L in Fig. 1), through which manipulations could be performed inside the chamber while the doors were closed.

The equipment for maintaining constant temperature and relative humidity of the air inside the chamber was housed in a compartment under the lid. The chamber temperature was kept constant by eight 115 W carbon filament lamps (E in Fig. 1) coupled in parallel on the bottom of the compartment (G in Fig. 1). The lamps were regulated by a contact thermometer (Jumo MS D.B.P.) (A in Fig. 1) and a transistorised relay (Jumo Tg U1) (B in Fig. 1), placed outside the chamber. The contact thermometer was placed on the lid of the chamber at a distance of about 400 mm from the carbon filament lamps, and protected from direct radiation from these lamps by a dividing wall (H in Fig. 1). The circuit to the relay by the contact thermometer automatically makes or breaks the supply to the carbon filament lamps.

The relative humidity of the air inside the chamber was kept at a standardized level by placing 570 mm long and 250 mm broad plates filled with silica gel (D in Fig. 1) on the bottom of the compartment close to the carbon filament lamps. The silica gel, which contained a humidity-indicator, was regenerated once every second day.

A fan (Frilec V113-54-1-2) (C in Fig. 1) was mounted on the dividing wall circulating the heated and dried air in the chamber. The fan sucked the air in the chamber through the crevice in the bottom of the compartment (F in Fig. 1) and then forced it over the silica gel and the carbon filament lamps and finally through the perforated masonite-wall (J in Fig. 1), which was placed at a angle of about 15° to the side of the chamber.

Thanks to the high thermal cunductivity of the carbon filament lamps and the high sensitivity of the contact thermometer this system regulates the temperature with a high degree of accuracy.

The dividing wall prevented the air from recirculating and the fan maintained a slightly higher pressure on the right side of the wall. Further, after its passage through the perforated masonite-wall the current of the air was negligible.

Finally, in order to damp the vibrations caused by the fan and to prevent them from being transferred to the weighing table and the balance, a piece

Fig. 1. Construction of thermo- and humidity-stable chamber.

A. Contact thermometer
B. Relay
C. Fan
D. Plate with silica gel
E. Carbon filament lamps
F. Air-inlet
G Bottom of compartment
H. Dividing wall in compartment
J. Air-outlet through perforated wall
K. Thermostat
L. Sleeve

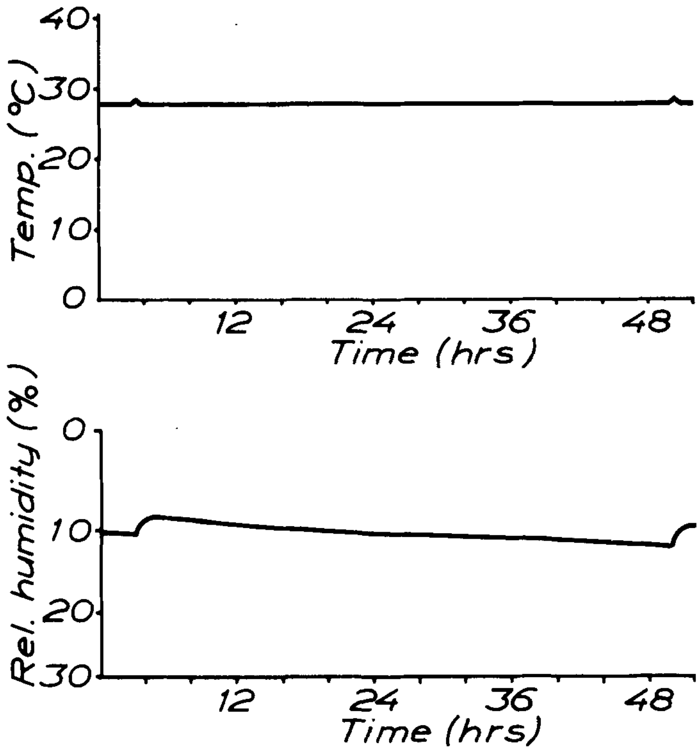

Fig. 2a. Variations of chamber temperature with time.
Fig. 2b. Variations of chamber relative humidity with time.

of 23 mm thick soft industrial felt was placed between the weighing table and theside walls of the chamber.

Precautions

To prevent from overheating of the chamber with the consequent risk of fire the walls of the compartment housing the carbon filament lamps were lined with asbestos-plates.

For the same reason a thermostat (Birka 599 L1) (K in Fig. 1) was placed over the lamps inside the chamber and connected in series with the carbon filament lamps. If, for any reason, the supply to the lamps was not broken at the correct temperature, it was interrupted at predetermined temperature by the thermostat. (The thermostat was adjustable between 30 and 50 centi-degrees).

Table I.

Weights registered with intervals of 30 minutes (g)

Empty gold-bowl	Gold-bowl containing dried dental plaque
5.622046	5.685712
5.622045	5.685712
5.622047	5.685713
5.622047	5.685713
5.622046	5.685714
5.622045	5.685712
5.622045	5.685714
5.622046	5.685712
5.622047	5.685713
5.622046	5.685714
5.622046	5.685714
5.622046	5.685713

Testing of the equipment

The temperature and the relative humidity of the air in the chamber were registered on a thermohygrograph (Lambrecht 252 Pernix) for a period of 15 months. During this period the thermo-hygrograph did not register any variation in the temperature except immediately after the inputs of heated plates with silica gel, which is seen as small steps in the temperature curve of Fig. 2a. Further, during this period the thermo-hygrograph registered a maximum variation in humidity of about 4 per cent. An example of the variations of the temperature and the relative humidity of the air of the chamber is given in Fig. 2a and b respectively. In order to study the temperature of the air in the chamber, a mercury thermometer graduated in centidegrees was also placed on the marble floor of the chamber. Neither with this thermometer was it possible to record any variation of the chamber temperature, except those registered by the thermo-hygrograph.

As indicated above, it had previously been found that weighing with a precision higher than about 1×10^{-4} g was impossible unless, among other things, the air surrounding the balance was thermo- and humidity-stable, and therefore the constance of the temperature and the relative humidity in the chamber was tested by weighing an empty gold bowl 12 times at intervals of 30 minutes. This was repeated with dried dental plaque in the gold bowl. The results are given in Table I.

DISCUSSION

The results of the control weighing given in Table I indicate that the chamber enabled the balance to work with its highest possible precision ($\pm 1 \times 10^{-6}$ g). Further the results showed that the presence action of a rotating fan in the chamber does not interfere with the action of the balance.

The humidity of the chamber used could only be varied within a small range (10 to 15 per cent). But since it is usually desirable to weigh in a dry environment in order to increase the precision of the quantitative determinations by preventing the vapour absorption on the weighing-object, the smallness of this range is seldom a drawback.

Summarizing, in a fairly simple and cheap equipment described it was possible to solve the problems of attaining temperature- and humidity-stable environments for measuring instruments.

SUMMARY

A simple instrument, enabling maintenance of stable temperature and relative humidity is described. In such stable environments it is possible to weigh with a high degree of precision ($\pm 1 \times 10^{-6}$ g).

The instrument has been tested for more than 15 months and proved satisfactory.

RÉSUMÉ

INSTRUMENT POUR MAINTENIR LA STABILITÉ DE TEMPÉRATURE ET D'HUMIDITÉ DU MILIEU ENVIRONNANT

Cet article décrit un instrument simple permettant de maintenir stables la température et l'humidité relative. Dans un milieu d'une telle stabilité, il est possible de peser avec un degré élevé de précision ($\pm 1 \times 10^{-6}$ g).

Cet instrument a été testé pendant plus de 15 mois et s'est montré satisfaisant.

ZUSAMMENFASSUNG

KONSTANTE UMGEBUNGSTEMPRATURE UND -FEUCHTIGKEIT BEI ANWENDUNG EINES EINFACHEN INSTRUMENTES

Eine einfache Apparatur wurde angegeben mit deren Hilfe Präzisionswägungen ($\pm 1 \times 10^{-6}$g) bei konstanter Temperatur und relativer Feuchtigkeit erzielt werden können.

Die Funktion der Apparatur wurde über längere Zeit erprobt.

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