The Universal Dilatometer, Model UBD

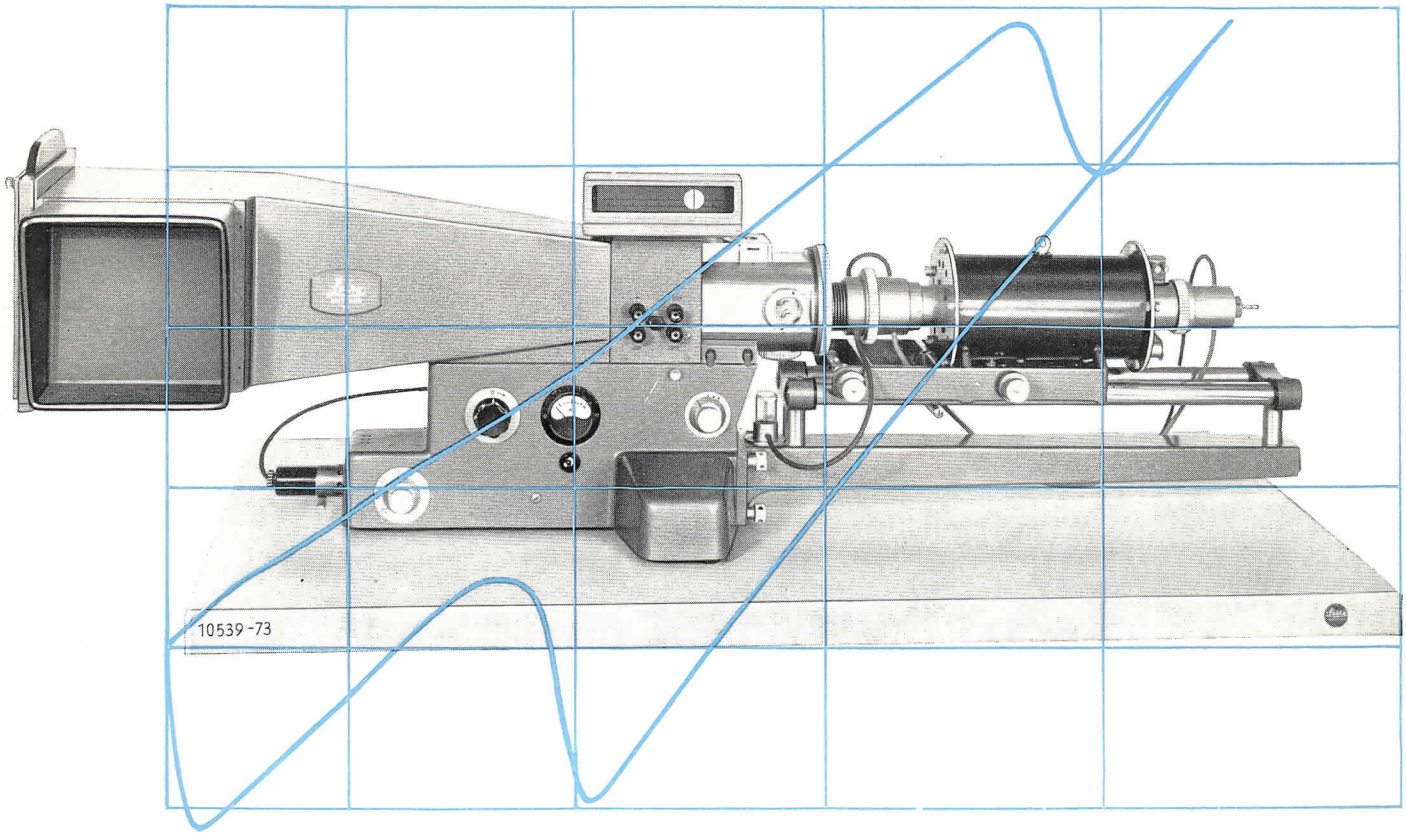


Fig. 1. Universal Dilatometer, Model UBD, with built-in reflecting galvanometer

The dilatometer is an instrument for research into the relationship between temperature and linear heat expansion of solid substances such as metals and alloys, ceramic building materials, glass, minerals, plastics, etc.
The measurements can be carried out during heating or cooling in any atmosphere, such as air, buffer gases, inert gases as well as in a vacuum.
The use of the instrument is not confined to scientific purposes, but also extends to operational control in the factory.

Some applications

Determination of thermal expansion coefficients

Thermo-dilatometric investigations such as: —

Examination of structural changes during heat loss and heat absorption

Examinations of transformations and precipitations

Examination of the temperatures during changes in the lattice structure

Ranges of phase stability in unary and multiple-component systems, decay of mixed crystals, precipitation processes

Examination of recovery and recrystallization after plastic deformation as well as the annealing of systems with suppressed transformation of supersaturated mixed crystals.

The main features of the **Universal Dilatometer, Model UBD** are its compact design and convenient operation. In addition, a number of basic improvements have been introduced: —

The photographic camera is combined with an **observation ground glass screen.** This allows the visual observation of the trace of the curve on the screen while it is recorded by the camera.

The **recording field,** 170×170mm, is utilized from corner to corner.

The **control head,** with push rods mounted on spring-joints, ensures reliable transmission of changes in length.

The very slight **measuring pressure** permits heating of the specimen close to the temperature of solidification or fusion.

The curves are traced **evenly and finely** at all magnifications due to a mechanical transmission on hinged supports.

The **reflecting galvanometer** has a temperature scale replacing a separate reading device.

The **time** is recorded simply by exchanging the reflecting galvanometer against a rotating-mirror housing with variable-speed motor drive.

The **moving spot** can be focused from outside even during vacuum operation.

The furnace is **controlled automatically up to 1150° C** by means of a transformer with variable-speed motor (from 1° C/min. to 5° C/min.). The control is cut out as soon as the desired maximum temperature has been reached.

Devices for high-temperature investigations up to 1600° C as well as a heating and cooling device from −70° C to +250° C are available as accessories.

Fig. 2.
Universal Dilatometer, Model UBD

1 Photographic attachment
2 Moving spot
3 Interchangeable adapter
4 Moving spot adjustment in the abscissa and ordinate axes
5 Control head
6 Socket for reflecting galvanometer and thermocouple
7 Vacuum gasket seating for control head and furnace
8 Furnace
9 Gas inlet nozzle
10 Lamp attachment
11 Stop adjustment for light spot diameters 0.1, 0.3, 0.5, 2.5mm
12 Regulating transformer with limit stop switch
13 Ammeter
14 Control lamp
15 Moving spot focusing head
16 Cooling system inspection window
17 Milled head for movement and lateral adjustment of the furnace

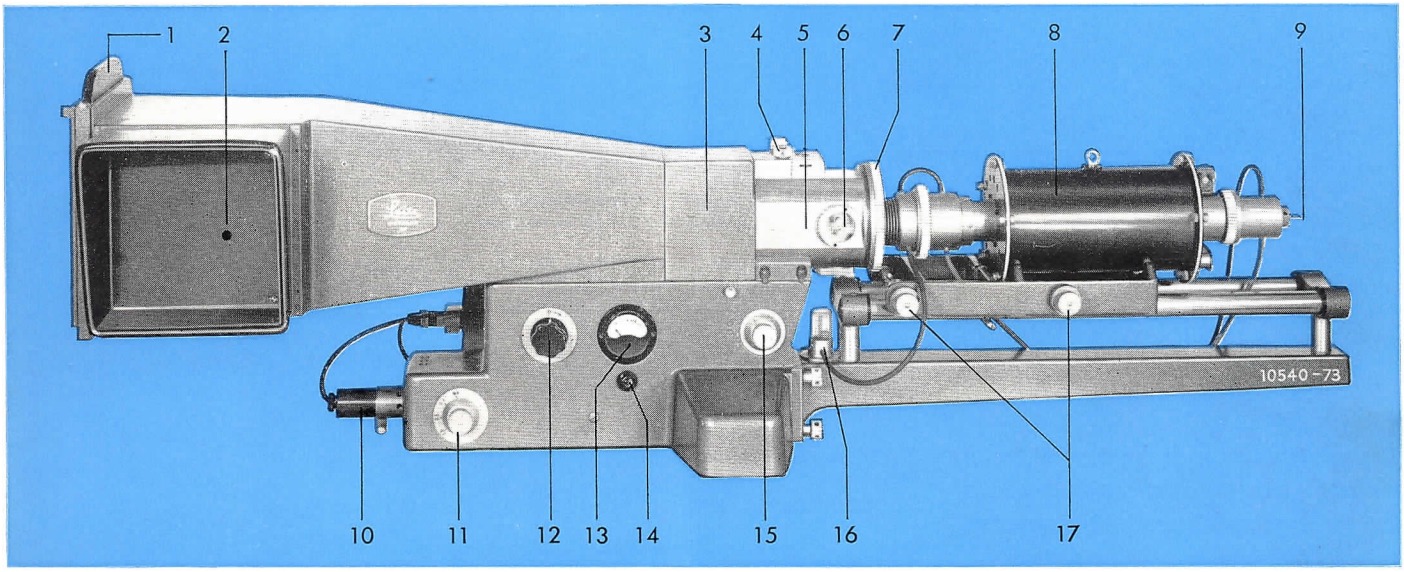


Fig. 2

Technical Details:

Lamp attachment	6 v 15 W low-voltage lamp
Photographic attachment	180×180mm size (effective size 170×170mm)
Observation groundglass screen	180×180mm
Electric furnaces	Maximum temperatures for 1150° C or 1600° C resp.
Heating- and cooling device	−70° C to +250° C
Vacuum device	up to 10^{-4} Torr
Sensitivity of control head	±0.1%
Magnification in the abscissa	mechan. 200 : 1, 400 : 1; optical max. 800 : 1
Magnification in the ordinate	mechan. 50 : 1, 100 : 1, 200 : 1, 400 : 1, 800 : 1; optical max. 1600 : 1
Accuracy of the reflecting galvanometer	±0.5%
Measuring range of the reflecting galvanometer	1600° C / 16.73 mV
Temperature reading ranges	800, 1200, and 1600° C
Scale intervals	10° C
Thermocouple for 1150° C and 1600° C	Pt - Pt Rh with 3.2 Ω lead
Thermocouple for −70° C to +250° C	Cu-const. with 2 Ω lead
Time recording speeds	10, 20, 40, 80, 160mm/h
Outer dimensions of dilatometer	Appr. 1400×320×430mm (4′8″×1′¾″×1′5¼″)
Dimensions of the test rods	diameter appr. 4mm, length 50, 40, 20, or 10mm diameter appr. 8mm, length 50, 40, 20, or 10mm

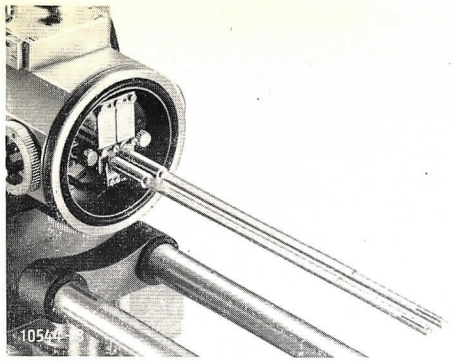


Fig. 3. Control head with quartz tubes in position for specimen and standard rods

Function of the Universal Dilatometer

The specimen rod is placed in a heat-resistant tube of low thermal expansion, such as quartz glass or sintered alumina. An intermediate rod transmits changes in the length of the specimen to the control head which can be mechanically adjusted for transmission ratios of 200:1, 400:1, and 800:1. For an additional 2× magnification a screw-in lens system is supplied. After transmission, these changes in the length of the specimen act on a vertically and horizontally rotating control prism in the path of a light beam. This light beam is reproduced as a spot in the camera and on the groundglass screen. Changes in the length of the specimen are indicated by a movement of this spot in the direction of the ordinate.

The path of the light spot in the ordinate is related to the movement of the light spot in the abscissa depending on the temperature or time. This results in a curve on the photo-sensitive paper after exposure.

The following records can be obtained: —

1. **Expansion/temperature curves**
   a) with standard rods of known temperature coefficients (differential measurement)
   b) with thermocouple and reflecting galvanometer.
2. **Expansion/time curves**
   with time recording device for changes in the volume at constant temperature (A device for logarithmic time recording over several orders is in preparation).

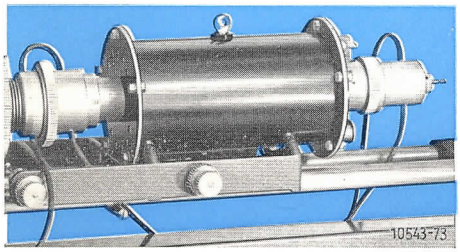
Explanations to

1 a) Control specimens with volume changes known for various temperatures are housed in a second tube with a quartz rod acting on the control prism and thus moving the light spot in the abscissa.

1 b) With a reflecting galvanometer and thermocouple the control specimen becomes unnecessary. The deflection of the light spot in the abscissa is taken over by the mirror in the galvanometer.

2) With the time recording device expansion/time curves are determined, and the light spot in the abscissa is continuously controlled by a mirror in the light path. The mirror can be rotated at several fixed speeds.

Fig. 4. Electric furnace for temperatures up to 1150° C



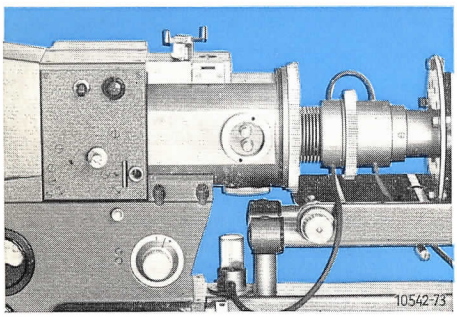


Fig. 5. Control head with attached vacuum device, furnace, and time recording unit in position

Electric furnace with automatic heat regulation

The furnace included in the basic equipment can be heated up to 1150° C. Instruments for temperature/time programme control can be connected to the heating coil.

The furnace up to 1150° C is heated automatically through a transformer and variable-speed motor. The heating-up rate can be adjusted between 1° C/min. and 5° C/min. On reaching the desired temperature the transformer cuts out automatically.

Vacuum device* for the furnace up to 1150° C

In order to avoid the oxidation of certain raw materials such as carbon steel, the heating-up process takes place in vacuo or an atmosphere of buffer gases. The vacuum device forms part of the basic outfit of the Leitz Universal Dilatometer UBD. The light spot can be focused even during vacuum operation.

Test rods

The test rods of 50, 40, 20, or 10mm length (50mm by special order) and 4 or 8mm diameter, can be turned, milled, or ground. Comparison rods are made of electrolytic copper, Vacromium CO, or analytically pure aluminium.

Reflecting galvanometer

The reflecting galvanometer is inserted in place of the adapter or the time recording device and can be used for temperature measurements up to 1600° C.

The galvanometer is also fitted with a projection groundglass screen for direct temperature readings with three measuring ranges, so that a separate reading instrument becomes unnecessary.

* We recommend vacuum pumps made by Messrs. Arthur Pfeiffer GmbH., Wetzlar, E. Leybold's Nachf., Köln-Bayenthal, and Heraeus, Hanau.

Accessories

Time recording device

This instrument is used for the recording of expansion/time curves. It replaces the adapter of the basic outfit or the reflecting galvanometer; the recording light spot is continuously moved in the abscissa at 10, 20, 40, 80, or 160mm/h according to its setting.

Furnace up to 1600° C

For high-temperature investigations the 1150° C furnace can be replaced by a furnace for 1600° C maximum temperature. It is lined with a ribbon element of the precious metal Rhodium and can be placed on the trolley like the normal furnace. The furnace tube, intermediate rod, and adapter are made of sintered alumina. The sample holder is water-cooled and takes samples of up to 8mm diameter; comparison samples are not necessary in this version. The temperature is measured with the thermocouple and the reflecting galvanometer of the standard outfit.
Examinations can be carried out in air or in a buffer gas atmosphere. A special transformer is required for this furnace.

Heating-and cooling device

A heating- and cooling device replaces the furnace for examinations in temperatures from – 70° C to 250° C.
In this device the temperature is measured with a Cu-const. thermocouple and read off the reflecting galvanometer.
The transformer of the basic outfit, if already available, can be used for this device, but for a DILATOMETER to be used with the heating-and cooling device only, we recommend a specially designed transformer, which is considerably less expensive.

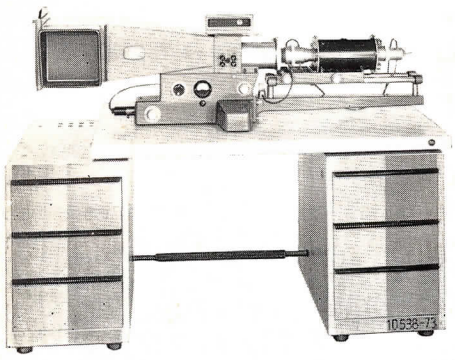


Fig. 6.
Universal Dilatometer Model UBD and
LEITZ instrument table. Price on request.

Expansion/temperature curves of steels, vacuum examinations

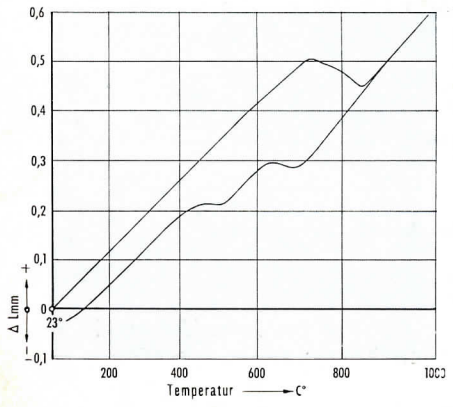


Fig. 7.
Steel containing 0.18% C, 0.46% Si, 2.1% Mn

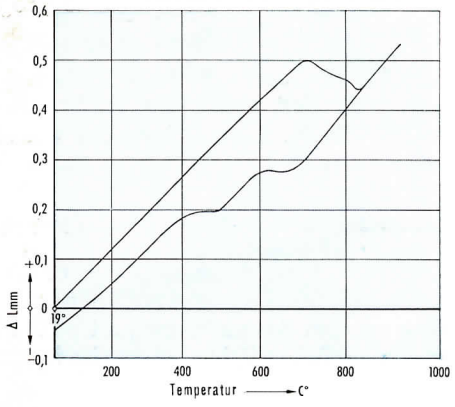


Fig. 8.
Steel containing 0.18% C, 0.46% Si, 2.2% Mn

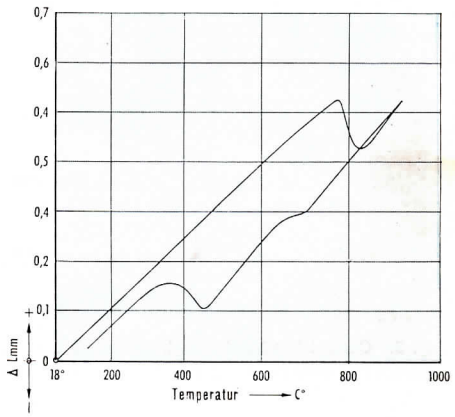


Fig. 9.
Steel containing 0.24% C, 0.29% Si, 0.74% Mn, 2.4% Cr, 0.25% V

* Recordings by Prof. F. Bollenrath,
Inst. f. Werkstoffkunde, T.H. Aachen.
The illustrations are not binding
for all the details of the instrument.

Design subject to alteration without notice.

ERNST LEITZ GMBH WETZLAR GERMANY

Subsidiary: Ernst Leitz (Canada) Ltd., Midland, Ontario

List 73-1b/Engl.

Printed in Germany

VI/64/DLW/SD