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Road vehicles — Braking systems — Temperature measuring methods

Véhicules routiers — Systèmes de freinage — Méthode de mesure des températures

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Foreword

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Attention is drawn to the possibility that some of the elements of this Publicly Available Specification may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/PAS 12158 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 2, *Braking systems and equipment*.

Annexes A and B form a normative part of this Publicly Available Specification.

Introduction

The current European regulations for the type-approval of road vehicle braking systems (ECE Regulation No. 13 [1] and ECE Regulation No. 90 [2]) specify that “the brakes must be cold; a brake is deemed to be cold when the temperature measured on the disc or on the outside of the drum is below 100 °C”.

The proposed harmonized braking regulations (Draft ECE Regulation 13-H and US FMVSS 135 [3]) for application in Europe, USA and Japan specify that “the brakes must be cold; the brakes are deemed to be cold when the temperature measured on the braking path of the disc or drum or inside the brake linings is between 65 °C and 100 °C on the hottest brake under test”.

Vehicle, brake and brake lining manufacturers, as well as independent test institutes, are conscious of the need for a means of measuring and recording brake temperature data during the *whole* test run.

This Publicly Available Specification is aimed at meeting that need, the temperature measuring methods given in its clause 2 having been proven over many years of practical use. It also provides a review of possible temperature measuring methods, which can be used to meet the limited demands of the current European regulations, in Tables A.1 and A.2 of annex A.

Road vehicles — Braking systems — Temperature measuring methods

1 Scope

This Publicly Available Specification presents methods for measuring the temperature of braking systems in road vehicles. It is applicable to both disc and drum brakes fitted on passenger cars and commercial vehicles, and its methods are suitable for either dynamometer tests in the laboratory or vehicle tests on road and track.

2 Continuous temperature measuring methods — Dynamometer and vehicle

2.1 General

Two different, common methods may be used for measuring the temperature of brake discs and drums.

The first is the use of embedded thermocouples in the braking surface of the disc and drum (see Figure B.1). This method generates a need to transfer the signal from rotating to stationary parts by means of slip rings or a power supply (battery) and telemetry. It is used on dynamometers and in vehicles. The signal transfer from rotating to stationary parts is not necessary if the sensors are embedded in the brake linings (see Figures B.2 and B.3).

The second method is the use of rubbing thermocouples (see Figures B.4 to B.7). A rubbing thermocouple consists of a thermo-junction loaded by a low-rate spring against the braking surface of the brake disc or drum and therefore not needing slip ring contacts. The load on the sensor may be up to 1 N but the temperature rise due to self-heating should be less than 15 °C at 50 km/h.

A third method, gaining in popularity, uses an infrared emission sensor operating without any contact between the rotating parts, and measures drum/disc temperatures without resort to slipping contacts or wearing parts.

2.2 Installation

Depending on the measuring task, thermocouples may be installed in each brake to establish the hottest brake temperature and reveal any temperature differentials.

In order that the temperature indicator (nowadays, typically a digital meter) can be placed in a convenient position inside the vehicle, special extension or compensating leads should be used for connecting the measuring thermocouple to this meter.

It is also customary to transfer the cold junction to the meter end. However, modern meters/measuring systems include solid-state cold junction compensation for ambient temperatures between 0 °C and 40 °C — adequate for the vehicle testing required by regulations.

2.3 Calibration

Calibration is effected by adjustment of the circuit resistance (given a constant load), using an external variable resistor. Various proprietary calibrators are available to suit particular thermocouples. These calibrators insert into the circuit a voltage which is the same as that produced by the measuring junction at a specified temperature, thereby allowing the external resistor to be adjusted to give a corresponding temperature reading on the meter.

A typical, practical temperature-measuring installation in which automatic cold-junction compensation is employed has a range of 0 °C to 1 000 °C. Multi-channel recording/logging equipment may be added to the circuits (before calibration) so as to provide a permanent record of the vehicle brake temperatures during subsequent test stages.

3 Other temperature measuring methods

The tables of Annex A summarize a number of different methods that may be used for measuring brake temperatures in order to meet the requirements of the braking regulations mentioned in the introduction.

Annex A
(normative)

Temperature measuring methods

A.1 Temperature measurement on stationary vehicle

See Table A.1.

Table A.1

Method	Valuation criteria
Touch method: — by finger; — by hand.	— subjective; — small measuring range; — poor resolution (cold/warm decision); — applicable mainly to drum brakes, — decision: “brakes deemed to be cold”.
Colour changing method: — measuring strip; — chalk.	— maximum value indicator; — single measurement; — restricted measuring range per measuring strip; — knowledge of temperature range for selection of the suitable measuring strip required; — restricted resolution.
Melting cone	— remaining height is the value for temperature; — temperature at the moment; — single measurement; — application area plain/horizontal; — restricted resolution.
Contact thermometer (thermocouple etc.)	— continuous measurement; — measuring accuracy dependent on handling; — high resolution; — simple handling; — highly practical.

A.2 Temperature measurement on dynamometer or moving vehicle

See Table A.2.

Table A.2

Method	Valuation criteria
Thermocouples installed in brake lining: — contact with rotating surface; — non-contact with rotating surface (recess under lining surface). See documents: US FMVSS 135 [3], US FMVSS 105 [4], US FMVSS 121 [5], Japan JASO C 402 [6] (See Figures B.6 and B.7.)	— brake lining temperature measurement; — no slip ring required; — conforms with ECE Regulation No 13, Annex 15 [a] [b]; — simple installation in drum brakes; — installation on disc brakes depending on design; — high resolution.
Thermocouples installed in/on disc or drum: — contact with rotating surface; — non-contact with rotating surface (recess under disc/drum surface).	— signal transfer from rotating to stationary parts necessary; — much installation required; — high accuracy of measurement; — prior damage of the parts caused by thermocouples possible; — high resolution.
Measurement between rotating and stationary parts: (infrared pyrometer etc.)	— mainly useful on dynamometers; — easy installation (no signal transfer from rotating to stationary parts); — little experience in vehicle tests.

[a] ECE Regulation No. 13 requires disc/drum temperature.

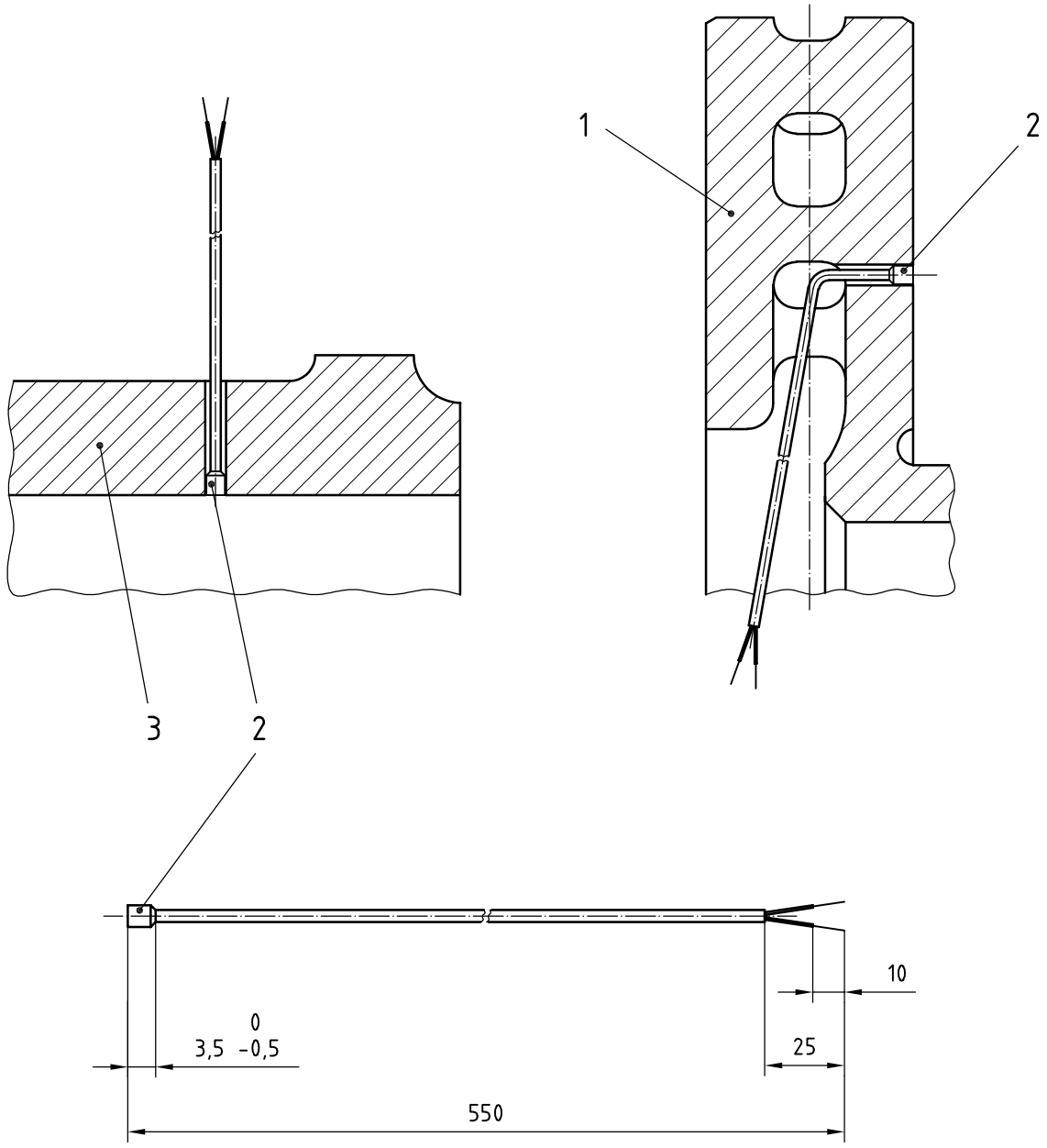
[b] All methods covered in this Publicly Available Specification are suitable for verifying compliance with the requirements of ECE Regulation No. 13 for temperatures $t < 100$ °C for cold brakes.

Annex B
(normative)

Installation examples

Figures B.1 to B.7 show typical test set-ups, which may be used for the test methods given in clause 2.

Dimensions in millimetres

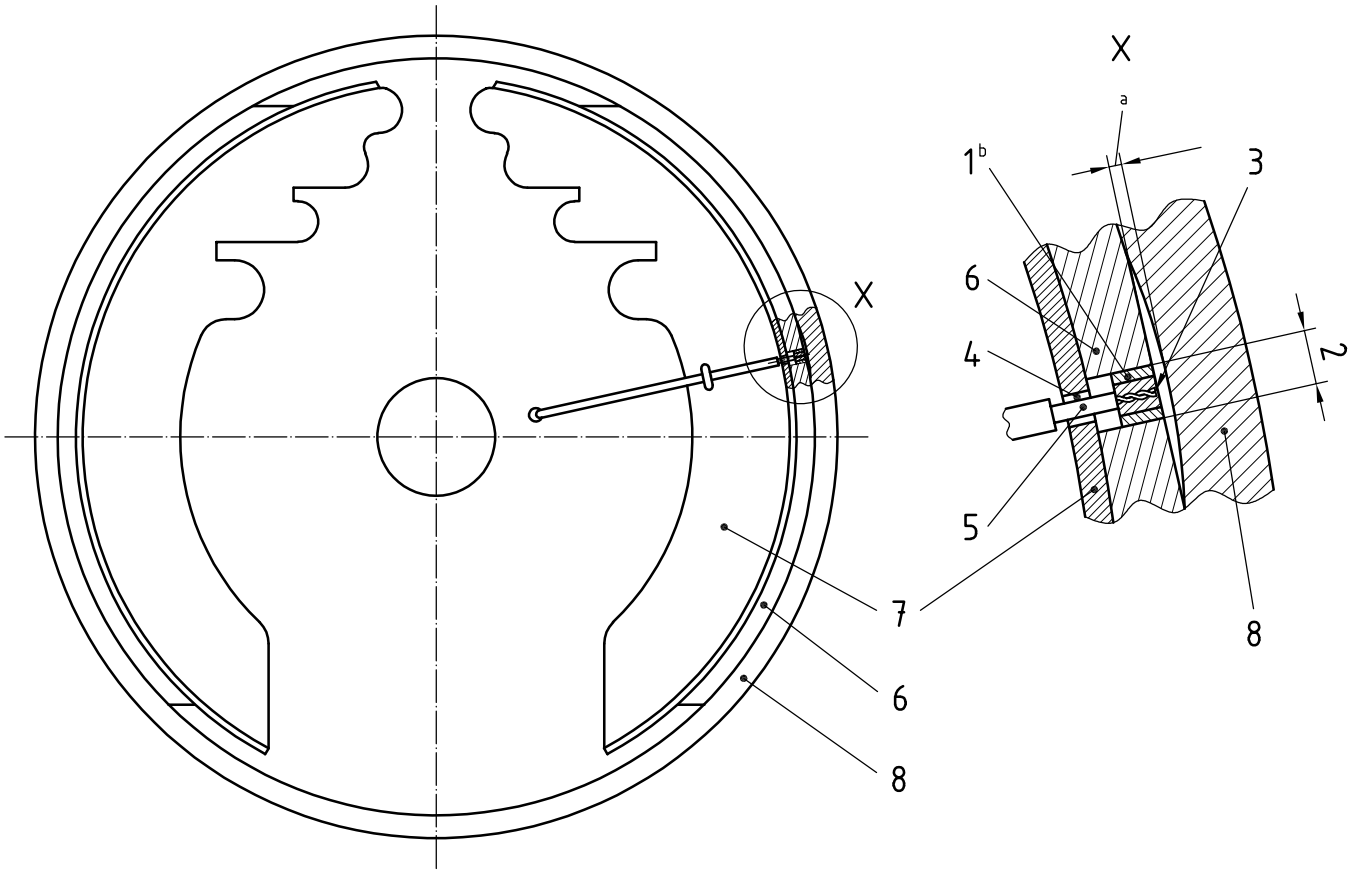


Key

1 Brake disc
2 Embedded thermocouple
3 Brake drum

Figure B.1 — Typical embedded thermocouple installation

Dimensions in millimetres



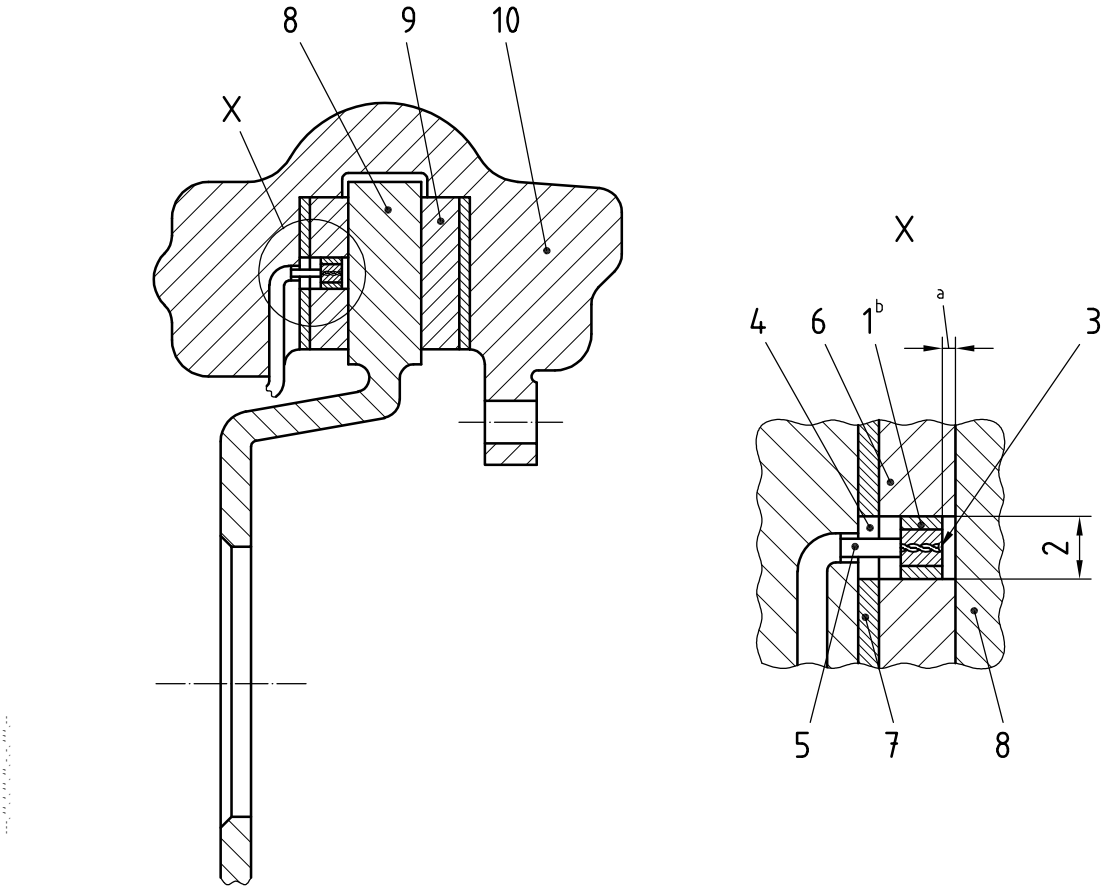
Key

1 Copper tube [outer diameter (OD) = 3,18 mm; inner diameter (ID) = 2,18 mm; initial length = 4,76 mm]
2 Core bore (CB) (diameter = 2,54 mm) in brake lining
3 Silver solder on twisted ends of thermocouple
4 Through hole (diameter = 2,79 mm)
5 Thermocouple table with insulation (duplex wire; inner core diameter = 0,81 mm; resistance = 0,115 Ω/m)
6 Brake lining material
7 Shoe
8 Drum

a Recessed 1,02 mm below ground surface, produced by further grinding.
b Placed on the deinsulated and twisted thermocouple wires before soldering.

Figure B.2 — Typical plug thermocouple installation — Drum brake

Dimensions in millimetres

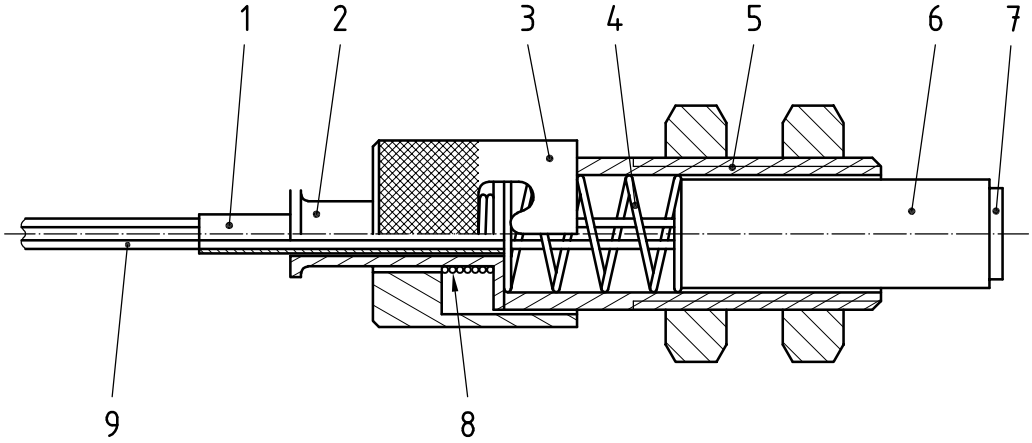


Key

1 Copper tube (see, also, Figure B.2)
2 Core bore CB in lining material (CB diameter = 2,54 mm)
3 Silver solder on twisted end of thermocouple
4 Through hole (diameter = 2,79 mm)
5 Thermocouple cable with insulation
6 Brake lining material
7 Backing plate
8 Disc
9 Disc brake pad
10 Calliper

a Recessed 2,04 mm below ground surface.
b Ground to a length of 3,18 mm after soldering.

Figure B.3 — Typical plug thermocouple installation — Disc brake

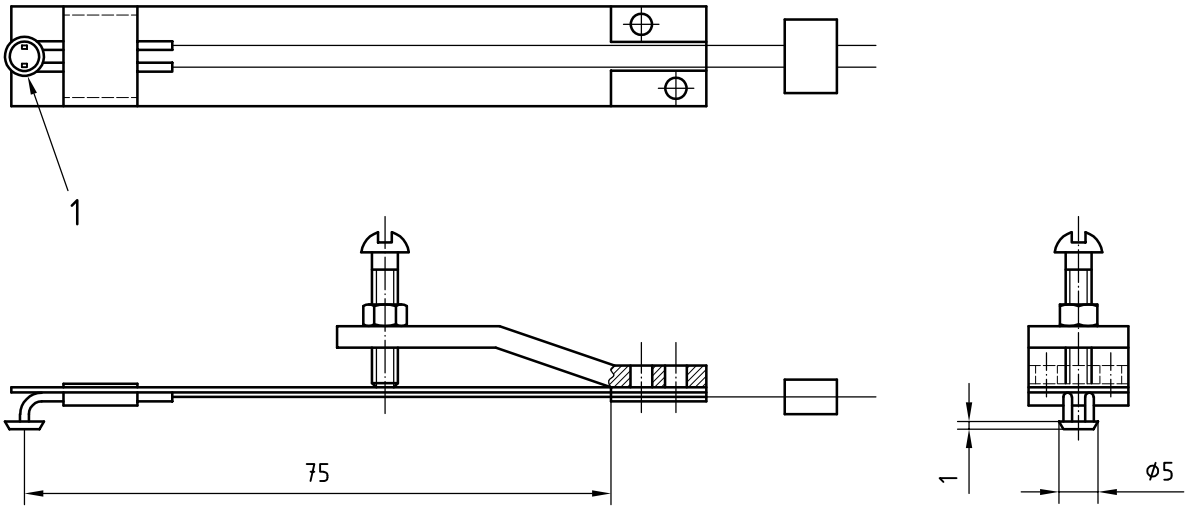


Key

1 Shrinkable tubing
2 Bushing
3 Cap
4 Spring
5 Adapter
6 Insulator
7 Tip plate
8 Spring
9 Thermocouple wire

Figure B.4 — Typical rubbing thermocouple assembly

Dimensions in millimetres

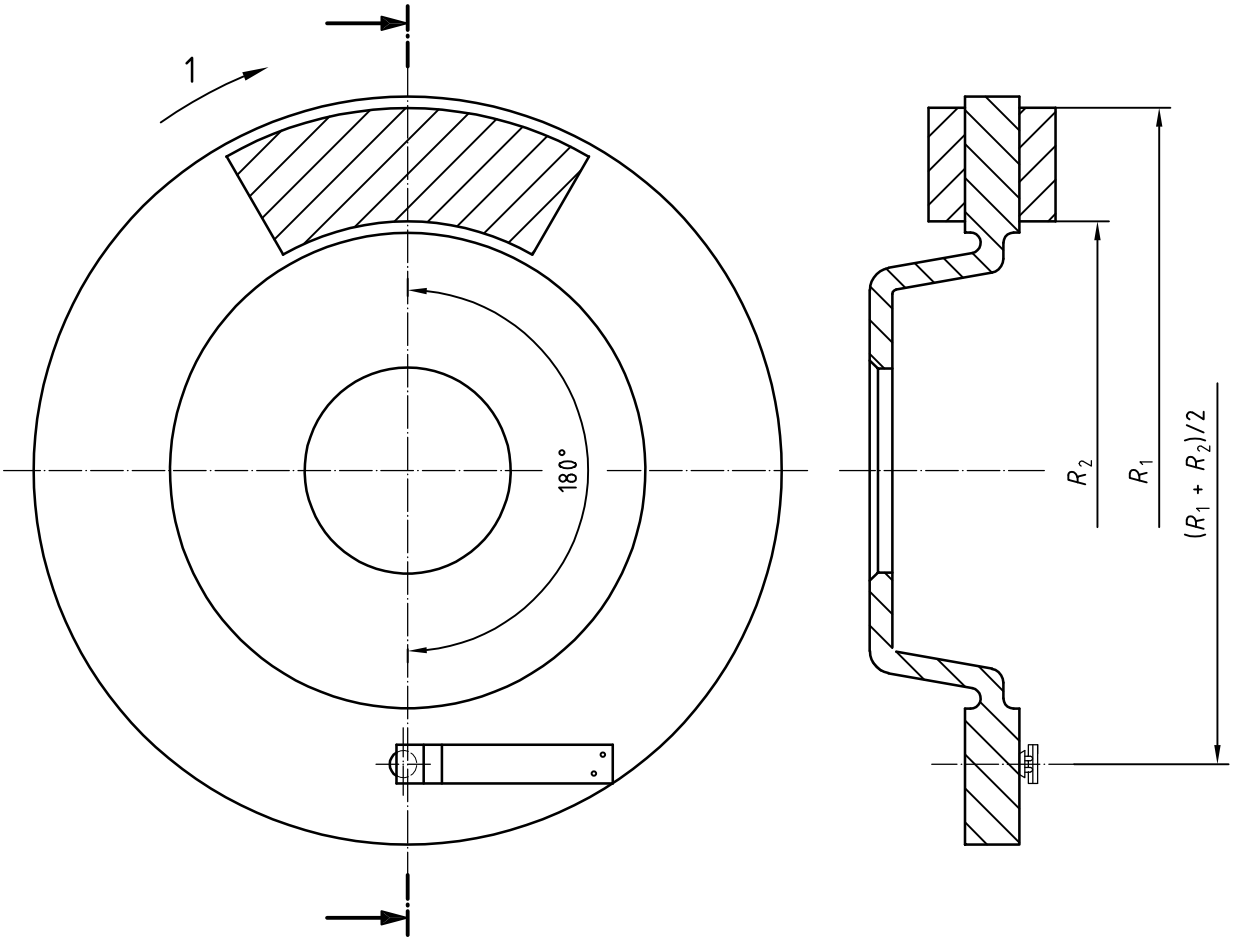


Key

1 Copper button

Figure B.5 — Alternative rubbing thermocouple assembly

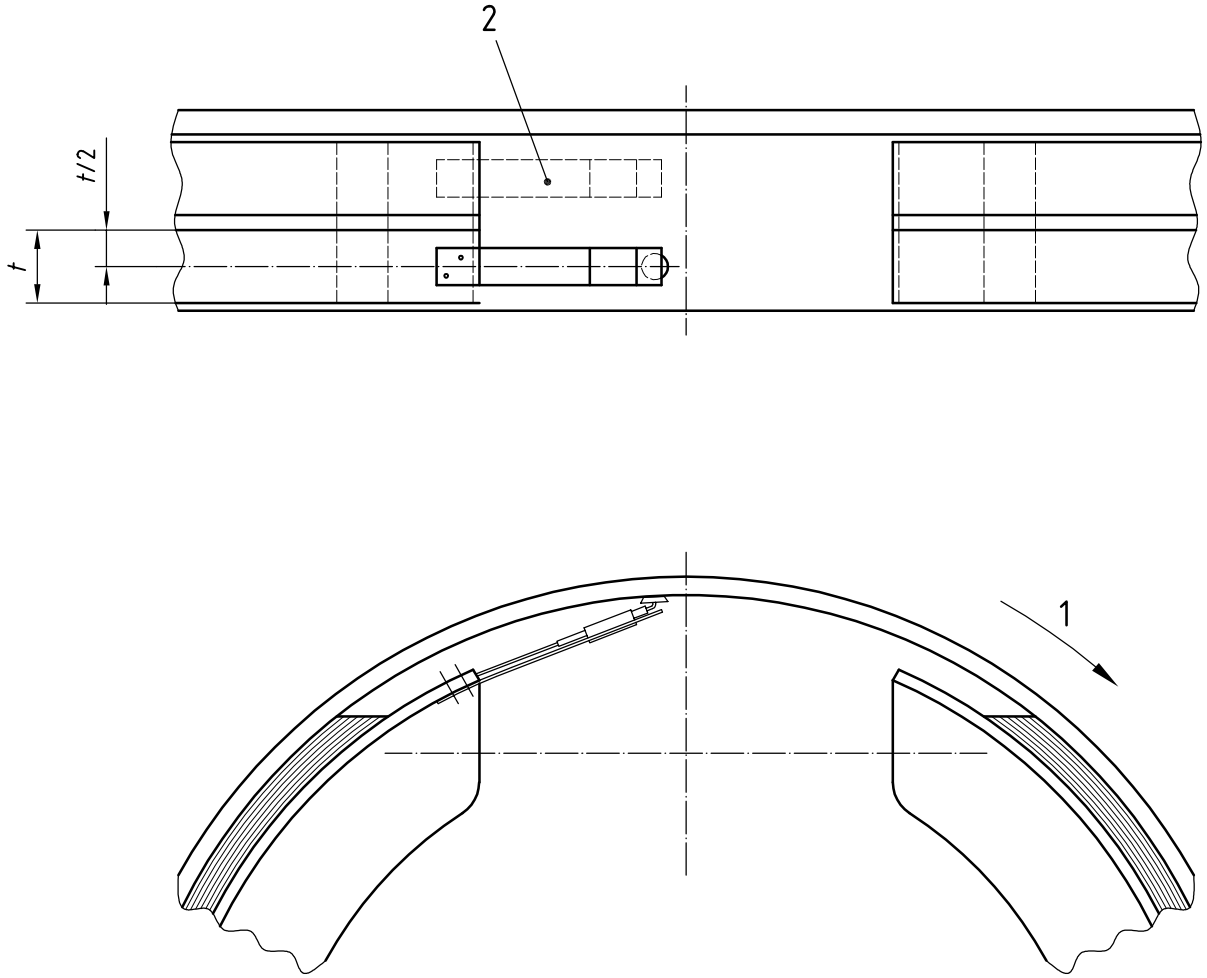
Dimensions in millimetres



Key

1 General rotation

Figure B.6 — Thermocouple position — Disc brake



Key

1 General rotation
2 Alternative position

Figure B.7 — Thermocouple position — Drum brake

Bibliography

[1] ECE [1)] Regulation No. 13, *Uniform provisions concerning the approval of vehicles with regard to braking*

[2] ECE Regulation No. 90, *Uniform provisions concerning the approval of replacement brake lining assemblies for power-driven vehicles and their trailers*

[3] FMVSS 135, *Light vehicle brake systems — Passenger Cars, multipurpose passenger vehicles, trucks and buses*

[4] FMVSS 105, *Hydraulic and electric brake systems — Passenger cars* [2)]

[5] FMVSS 121, *Air brake systems — Trucks, buses, and trailers*

[6] JASO[3)] C 402, *Passenger car — Service brake road test procedure*

1) United Nations Economic Commission for Europe (UNECE).

2) US National Highway Traffic Safety Administration Federal Motor Vehicle Safety Standard (FMVSS).

3) Japanese Automobile Standards Organization (JASO).

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