

# INTERNATIONAL STANDARD

# ISO 14681

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## **Diesel engines — Fuel injection pump testing — Calibrating fuel injectors**

*Moteurs diesels — Essai des pompes d'injection de carburant — Porte-  
injecteurs de carburant complets de calibration*



Reference number  
ISO 14681:1998(E)

## Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 14681 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 7, *Injection equipment and filters for use on road vehicles*.

Annex A of this International Standard is for information only.

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## Introduction

Calibrating fuel injectors are intended to simulate closely the function of fuel injectors in the fuel injection system of a diesel (compression-ignition) engine.

Injection pumps for emission-controlled engines require a new generation of calibrating injectors in order to comply with the higher injection pressures. The field of application is similar to those of the calibrating injectors specified in ISO 7440-1 and of the calibrating nozzle specified in ISO 4010. Compared with calibrating injectors according to ISO 7440-1, the new designs show the following differences:

- change-over from high spring nozzle holder to low spring nozzle holder,
- reduction of masses,
- reduction of dead volumes, e.g. edge filter.

Therefore, the following parts are modified:

- nozzle holder body,
- nozzle retaining nut,
- edge filter,
- spring,
- needle valve assembly and pintle nozzle,
- distance sleeve.

The following parts are not modified:

- the orifice plates with the orifice diameter range from 0,4 mm to 0,8 mm,
- the optional spray damper,
- the distance sleeve of the calibrating fuel injector with the single hole orifice plate.



# Diesel engines — Fuel injection pump testing — Calibrating fuel injectors

## 1 Scope

This International Standard specifies two types of calibrating injectors intended for testing and setting diesel fuel injection pumps on test benches.

It applies to

- a) calibrating injectors for different orifice plates, max. delivery range 400 mm<sup>3</sup>/stroke;
- b) calibrating injectors with pintle type nozzle, max. delivery range 200 mm<sup>3</sup>/stroke.

The field of application is similar to the calibrating injectors specified in ISO 7440-1 and to the calibrating nozzle specified in ISO 4010.

Compared to the calibrating injector specified in ISO 7440-1, the calibrating injectors specified in this International Standard represent an advanced stage of design which is more appropriate to modern high pressure/high performance fuel injection systems.

Specification of the type of calibrating fuel injectors to be used, the appropriate single hole orifice plate size or pintle nozzle (as applicable), high pressure pipes, exact limits, etc. is left to the manufacturer of the injection equipment and/or the manufacturer of the engine.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4010:—<sup>1)</sup>, *Diesel engines — Calibrating nozzle, delay pintle type.*

ISO 4113:1988, *Road vehicles — Calibration fluid for diesel injection equipment.*

ISO 7440-1:1991, *Road vehicles — Fuel injection equipment testing — Part 1: Calibrating nozzle and holder assemblies.*

ISO 7440-2:1991, *Road vehicles — Fuel injection equipment testing — Part 2: Orifice plate flow-measurement.*

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<sup>1)</sup> To be published. (Revision of ISO 4010:1977)

## 3 Requirements

### 3.1 Calibrating fuel injectors

#### 3.1.1 With single hole orifice plate

The two alternative designs of the calibrating fuel injectors with the single hole orifice plate specified in figure 11 are shown in figure 1.

#### 3.1.2 With delay pintle type nozzle

The two alternative designs of the calibrating fuel injectors with the delay pintle type nozzle specified in figure 14 are shown in figure 2.

### 3.2 Components

The calibrating fuel injectors consist of the components specified in 3.2.1 to 3.4.2 with their functionally critical dimensions.

#### 3.2.1 Holder body

The holder body may include two spill tubes:

- one tube for the leakage fuel passing the needle valve assembly in the direction to the spring housing;
- another tube (optional) used with vented holder only.

The holder body is shown in figure 3.

#### 3.2.2 Spring

The spring is shown in figure 5. It is designed for low stress in order to prevent fatigue.

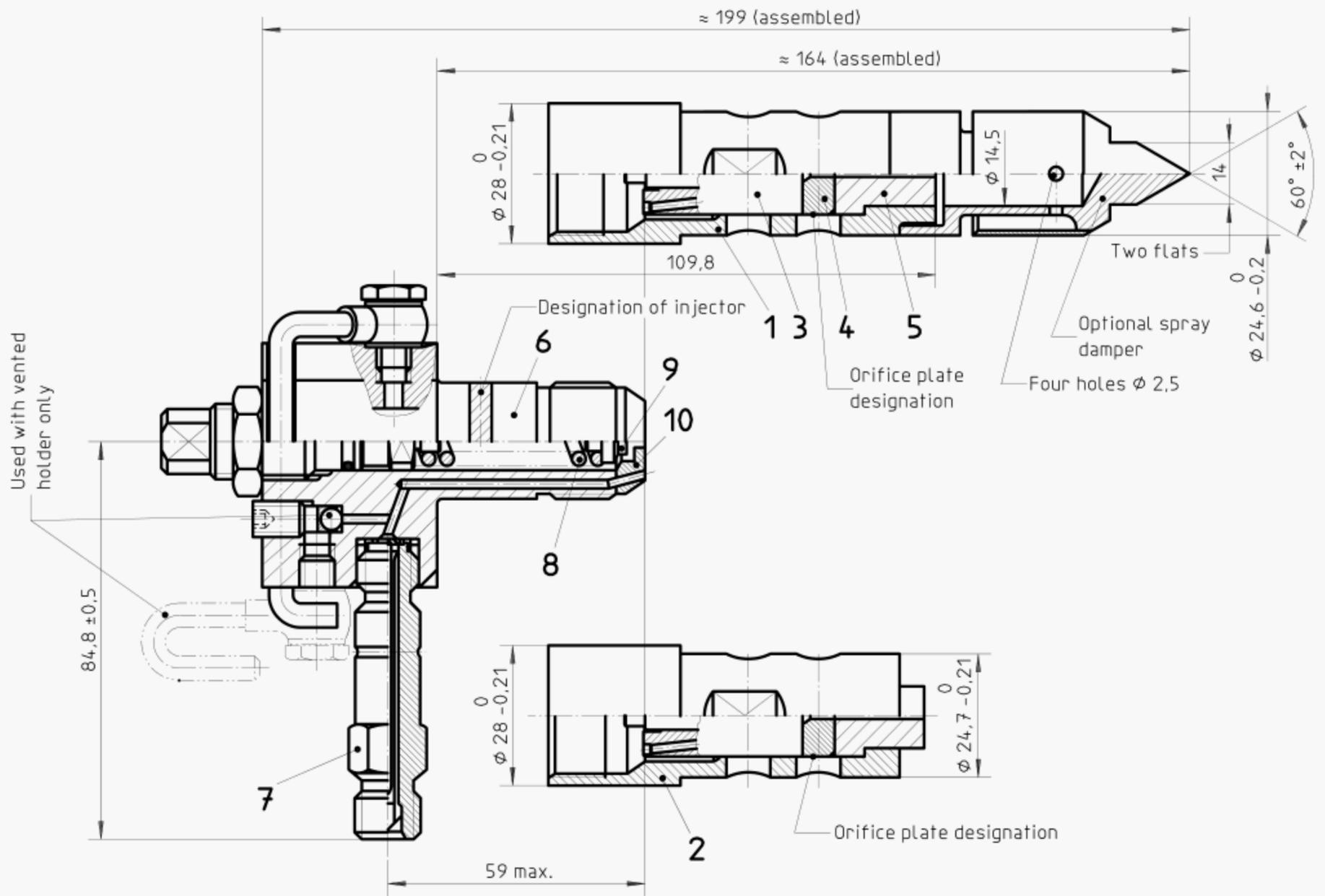
#### 3.2.3 Spring seat

The spring seat, which provides the connection of the low situated spring with the needle, is shown in figure 6.

#### 3.2.4 Inlet stud with edge filter

The inlet stud with edge filter is shown in figure 7. It may be flow-tested as shown in figure 8. The outlet of the fixture (within dotted lines) shall be ambient pressure.

Dimensions in millimetres



Alternative 1: Preferably for use with calibrating test benches having open spray chamber

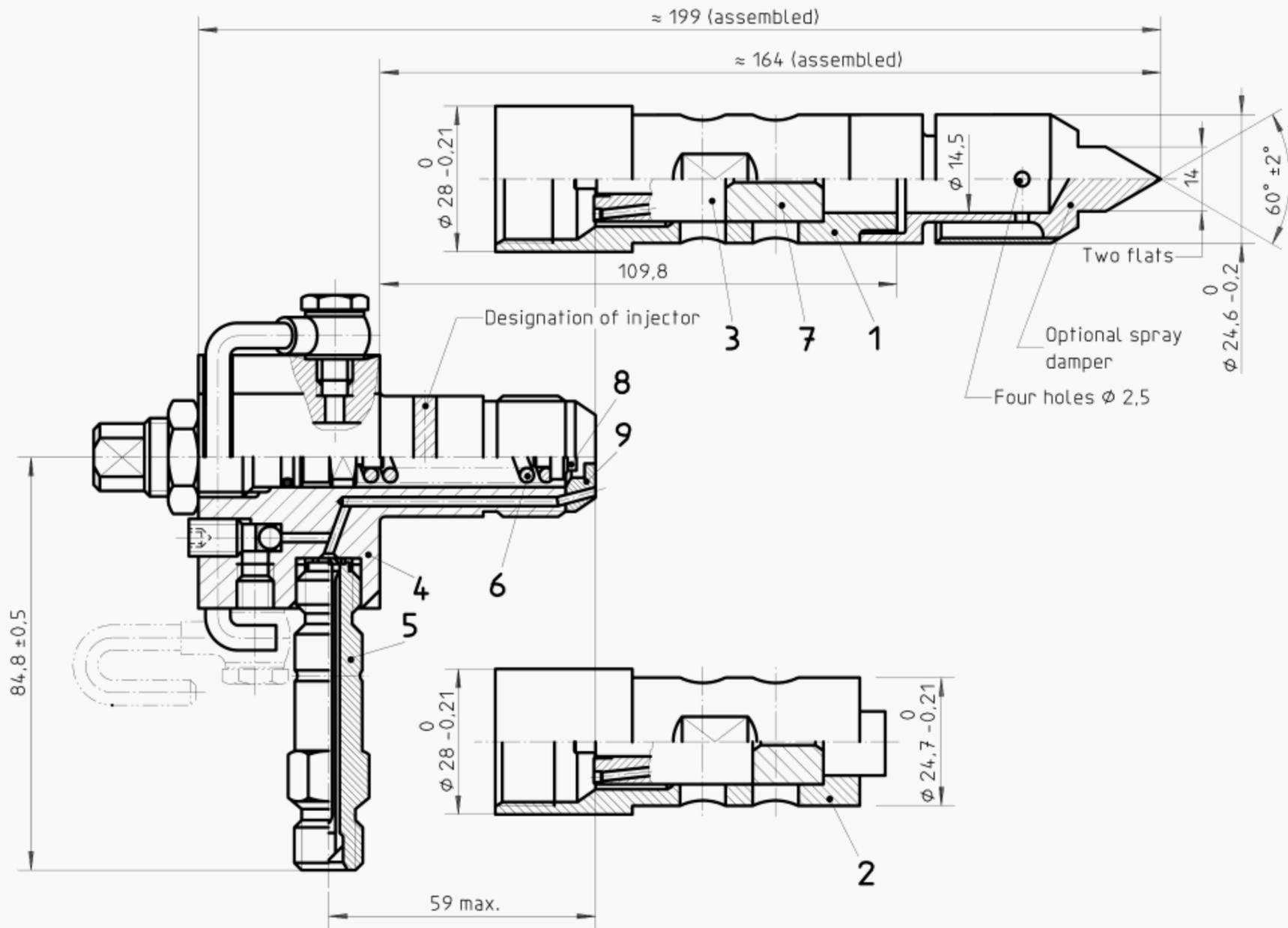
Alternative 2: Preferably for use with calibrating test benches having closed spray chamber

**Key**

- 1 Retaining nut, alternative 1
- 2 Retaining nut, alternative 2
- 3 Needle valve assembly
- 4 Single hole orifice plate
- 5 Distance sleeve
- 6 Holder body
- 7 Inlet stud with edge filter
- 8 Spring
- 9 Spring seat
- 10 Adaptor plate

**Figure 1 — Calibrating fuel injector with single hole orifice plate**

Dimensions in millimetres



Alternative 1: Preferably for use with calibrating test benches having open spray chamber

Alternative 2: Preferably for use with calibrating test benches having closed spray chamber

**Key**

- 1 Retaining nut, alternative 1
- 2 Retaining nut, alternative 2
- 3 Delay pintle type nozzle
- 4 Holder body
- 5 Inlet stud with edge filter
- 6 Spring
- 7 Distance sleeve
- 8 Spring seat
- 9 Adaptor plate

**Figure 2 — Calibrating fuel injector with delay pintle type nozzle**

Dimensions in millimetres

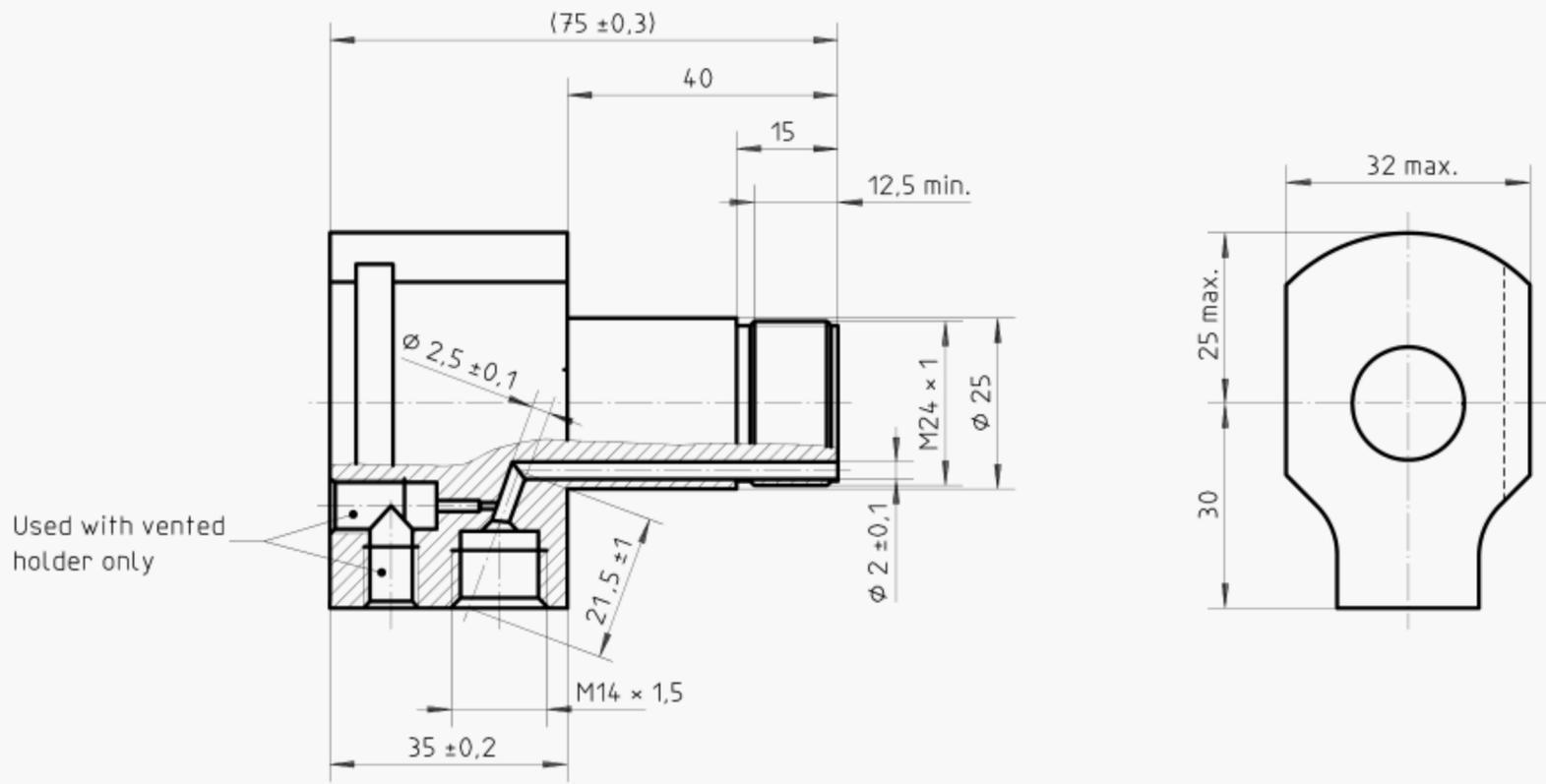


Figure 3 — Holder body

Dimensions in millimetres

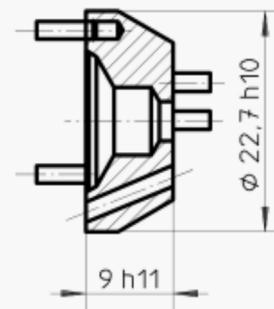


Figure 4 — Adapter plate

Dimensions in millimetres

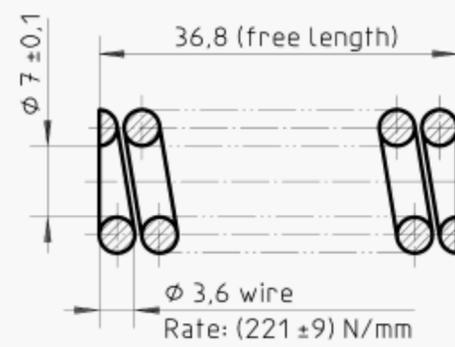


Figure 5 — Spring

Dimensions in millimetres

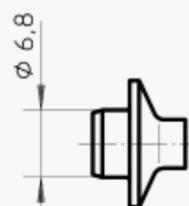
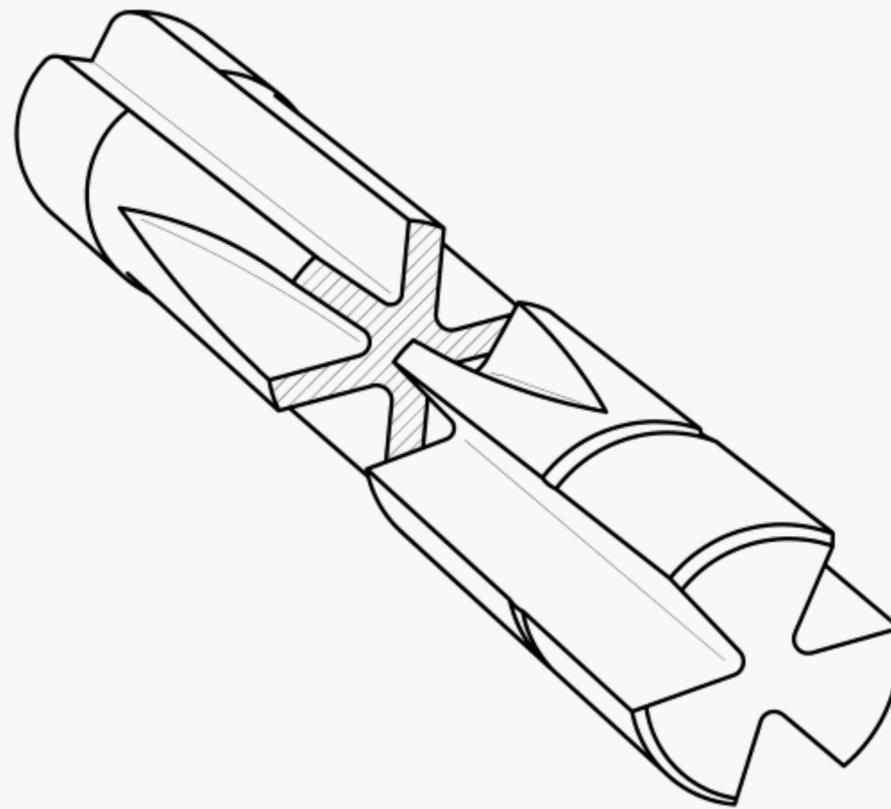
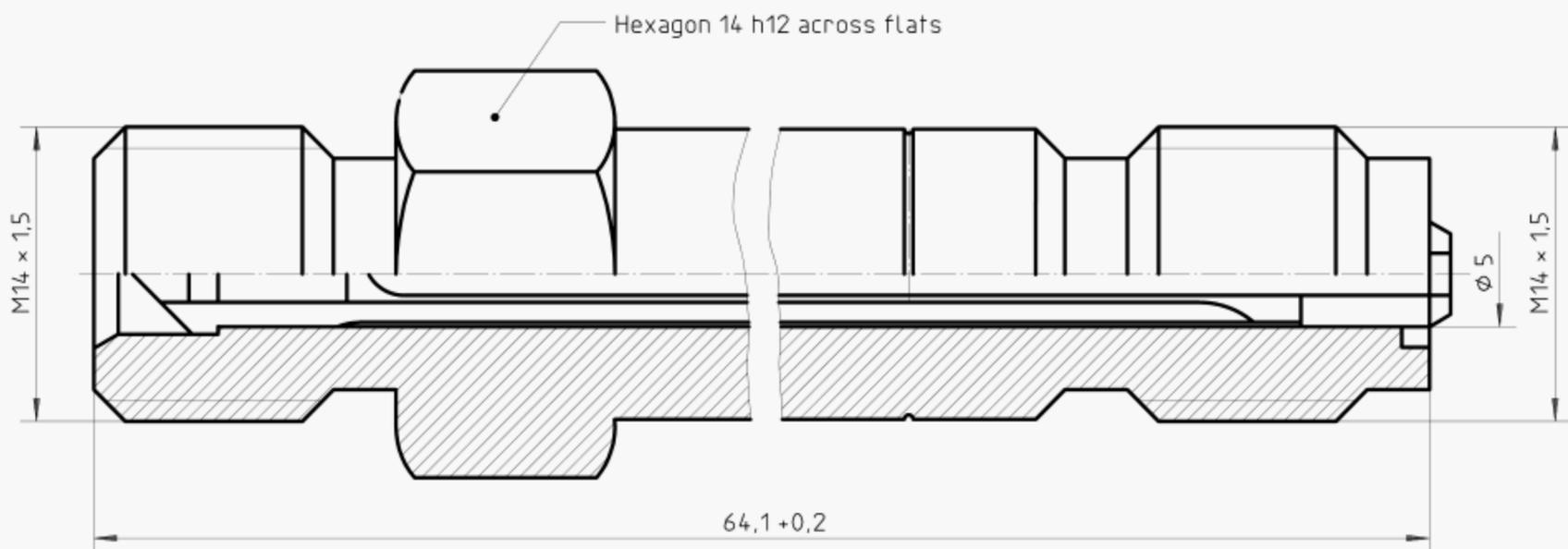


Figure 6 — Spring seat

Dimensions in millimetres



a) Edge filter with flutes (schematic)



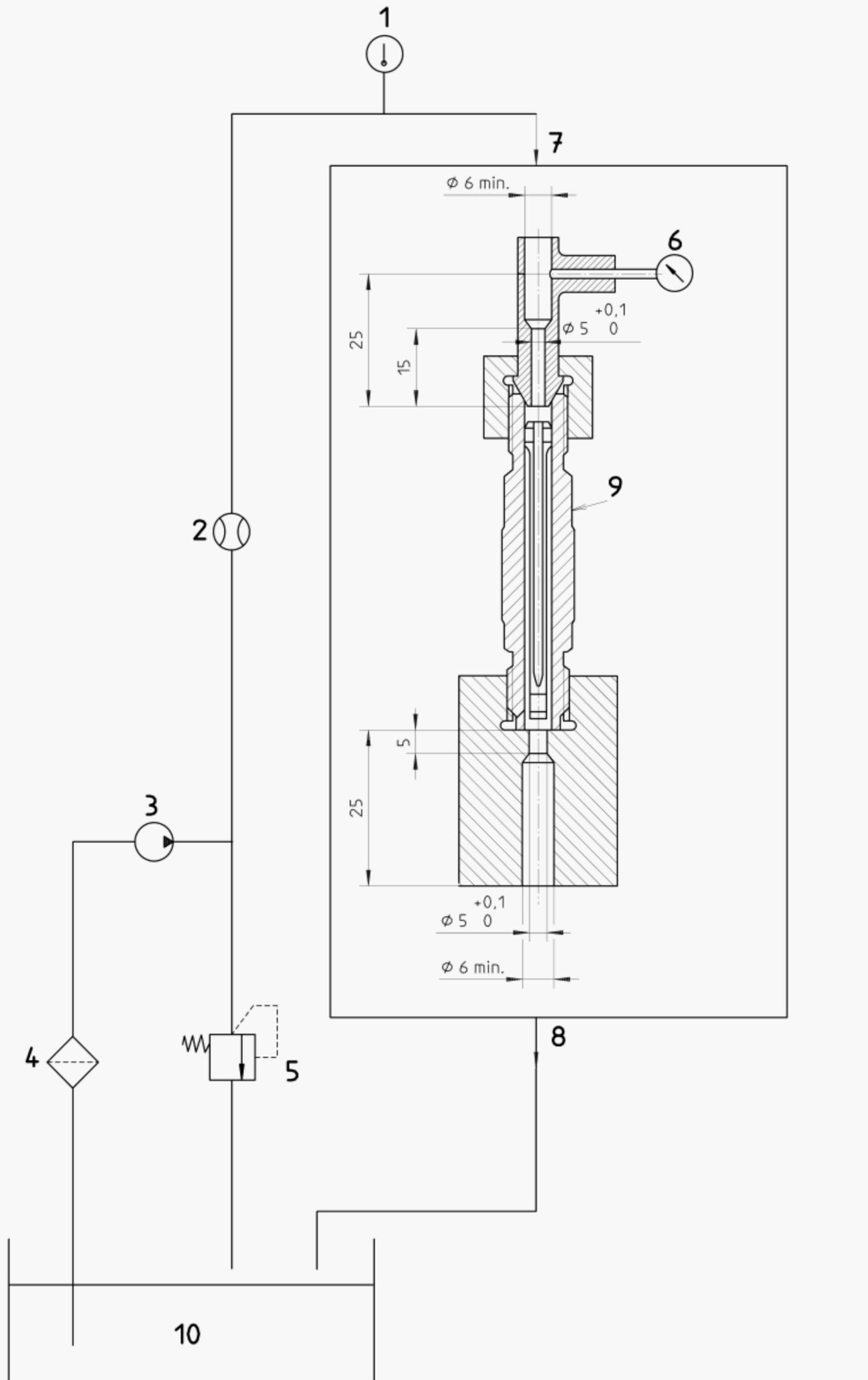
b) Inlet stud with edge filter

Characteristic	Value
Filter clearance (radial)	0,02 mm to 0,031 mm
Filter clearance area	6 mm <sup>2</sup> min.
Flow area for three flutes [see figure 7a)]	5,2 mm <sup>2</sup>
Internal volume	700 mm <sup>3</sup> ± 20 mm <sup>3</sup>
New filter flow at 0,3 MPa (3 bar) pressure <sup>1)</sup>	2800 cm <sup>3</sup> /min to 4600 cm <sup>3</sup> /min
Minimum flow of assembled holder body with inlet stud and edge filter at 0,3 MPa (3 bar) pressure <sup>1)</sup>	2000 cm <sup>3</sup> /min
Minimum acceptable flow in service of the edge filter (to replace) at 0,3 MPa (3 bar) pressure <sup>1)</sup>	2500 cm <sup>3</sup> /min

<sup>1)</sup> These tests shall be made using calibration fluid as specified in ISO 4113 at 40 ± 1°C and the tolerance of the supply pressure shall be ± 0,03 MPa (0,3 bar).

Figure 7 — Characteristic dimensions and values of the inlet stud with edge filter

Dimensions in millimetres



**Key**

- |                  |                      |                               |
|------------------|----------------------|-------------------------------|
| 1 Temperature in | 5 Pressure regulator | 8 Outlet                      |
| 2 Flowmeter      | 6 Pressure in        | 9 Inlet stud with edge filter |
| 3 Pump           | 7 Inlet              | 10 Tank                       |
| 4 Filter         |                      |                               |

**Figure 8 — Inlet stud flow measuring system**

### 3.2.5 Retaining nut

Figure 9 shows the retaining nut. This nut is used for both types of calibrating injectors, the orifice plate and the delay pintle type nozzle design. The different lengths of the two types, i.e. the needle valve assembly together with the orifice plate and the delay pintle type nozzle, are covered by using different distance sleeves.

Dimensions in millimetres

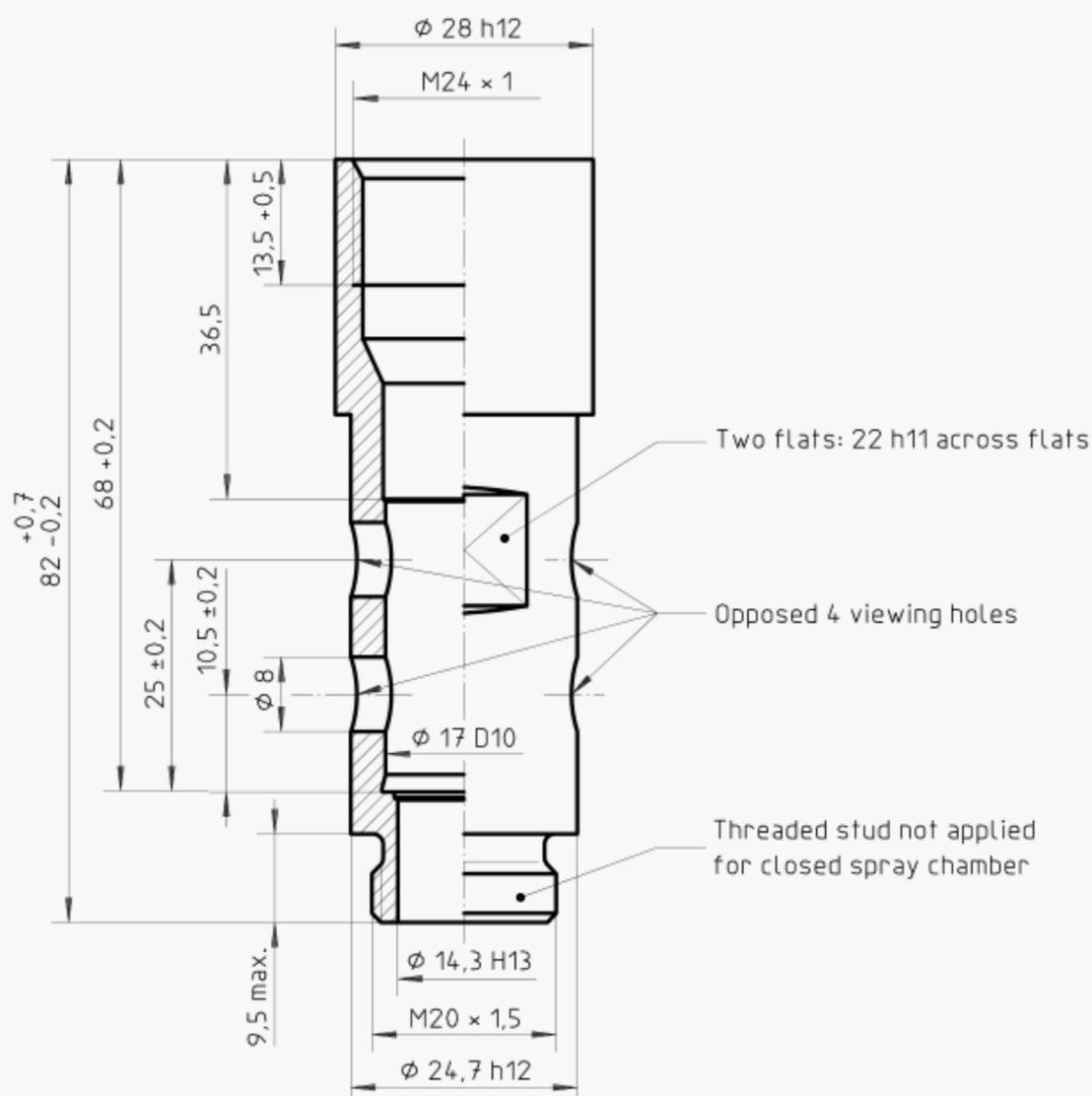


Figure 9 — Retaining nut

## 3.3 Special components for orifice plate design

### 3.3.1 Needle valve assembly

Figure 10 shows the needle valve assembly.

Dimensions in millimetres

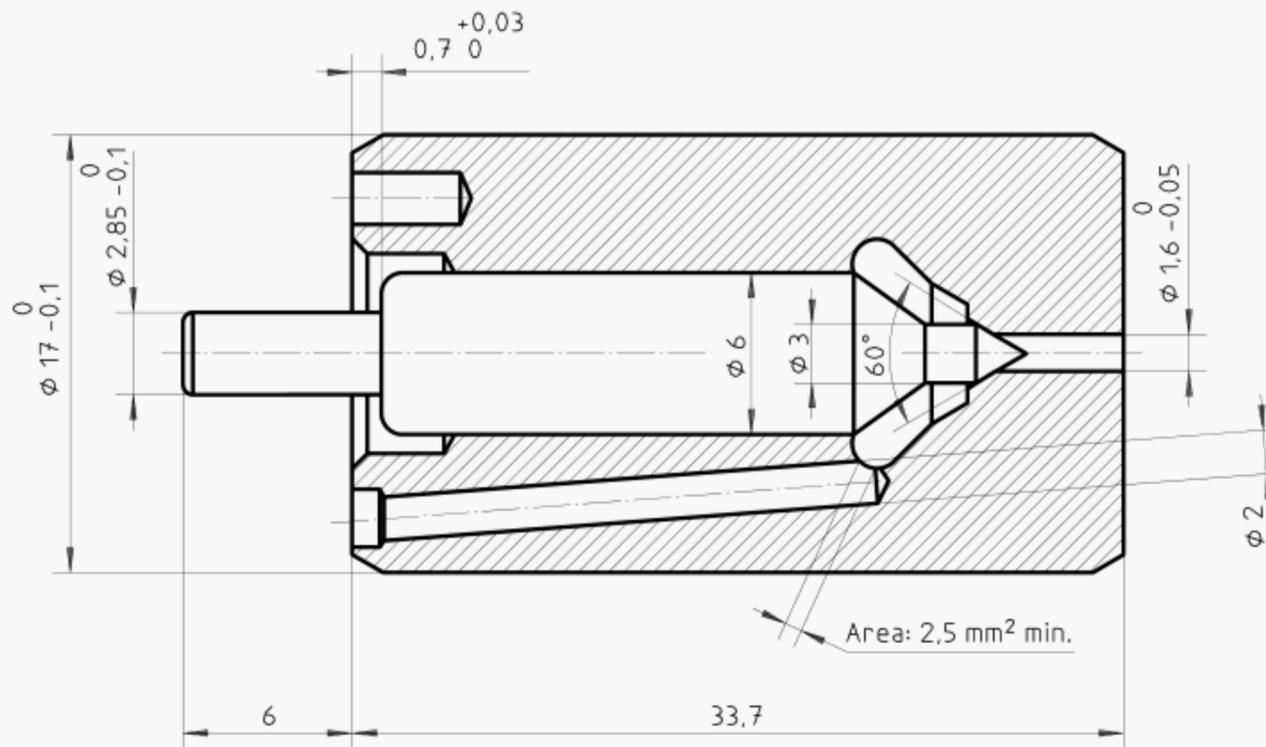
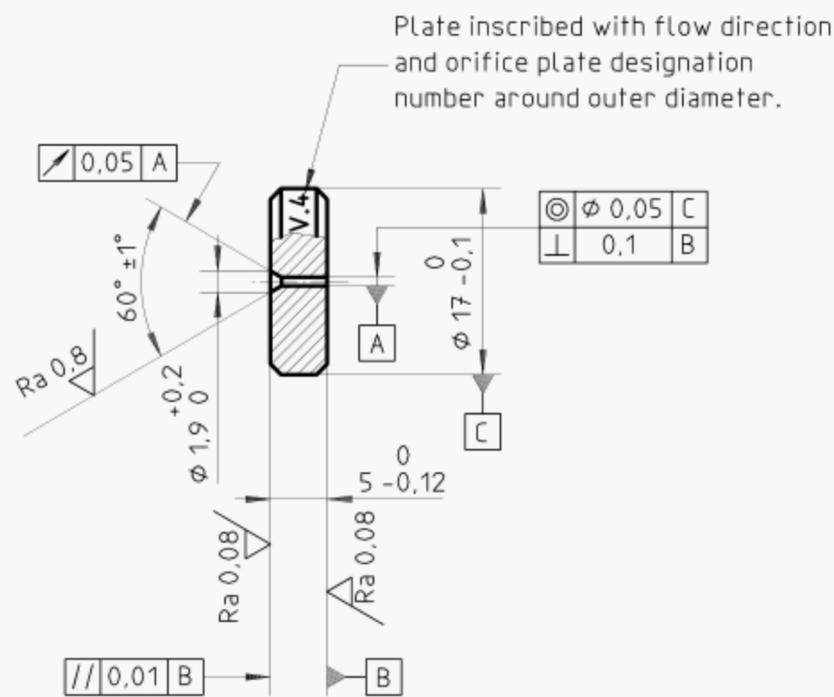


Figure 10 — Needle valve assembly

### 3.3.2 Single hole orifice plate

Figure 11 shows the orifice plate(s) and the corresponding high pressure flow range(s). The orifice plates are also specified in ISO 7440-1.

Dimensions in millimetres



Orifice plate no.	.4	.5	.6	.7	.8	
Orifice diameter, mm $\pm 0,05^1$ )	0,4	0,5	0,6	0,7	0,8	
Flow, cm <sup>3</sup> /min	min.	964	1 528	2 190	3 024	3 948
	max.	1 014	1 606	2 302	3 180	4 150

1) Tolerance of orifice hole is only a guide for manufacturing. Its purpose is to assist in meeting the final static flow limits specified in the table when flow-tested under the test conditions specified in ISO 7440-2.

Figure 11 — Single hole orifice plate

### 3.3.3 Distance sleeve

Figure 12 shows the distance sleeve, which corresponds to the orifice plate design. This distance sleeve is also specified in ISO 7440-1.

Dimensions in millimetres

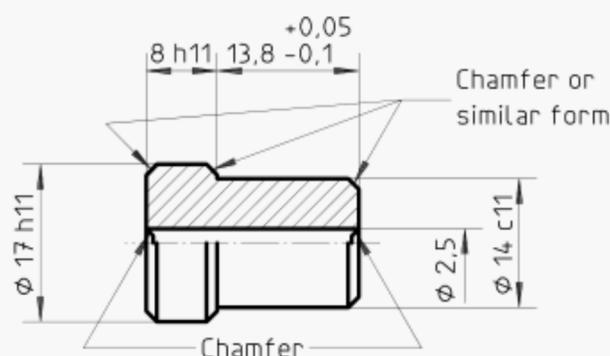


Figure 12 — Distance sleeve

## 3.4 Special components for injectors with delay pintle type nozzle

### 3.4.1 Delay pintle type nozzle

Figure 14 shows the delay pintle type nozzle. Its design is different from the design given in ISO 4010. Therefore the control values when measuring the flow characteristics should be in accordance with table 1.

Table 1 — Control values of air flow at different needle lifts

Needle lift mm	Air flow	Pressure below ambient pressure kPa
0,1	310 ml/min to 330 ml/min	80
0,57	520 ml/min to 550 ml/min	80
end of lift	282 l/h to 288 l/h	60

NOTE — The values indicated in this table are based on  
 — an ambient pressure of  $p_a = 98$  kPa (0,98 bar),  
 — an ambient air temperature of  $t_a = + 20$  °C.

A characteristic course of the air flow versus the needle lift is shown in figure 13. The measuring device for air flow shall be according to 5.1.3 of ISO 4010:—.

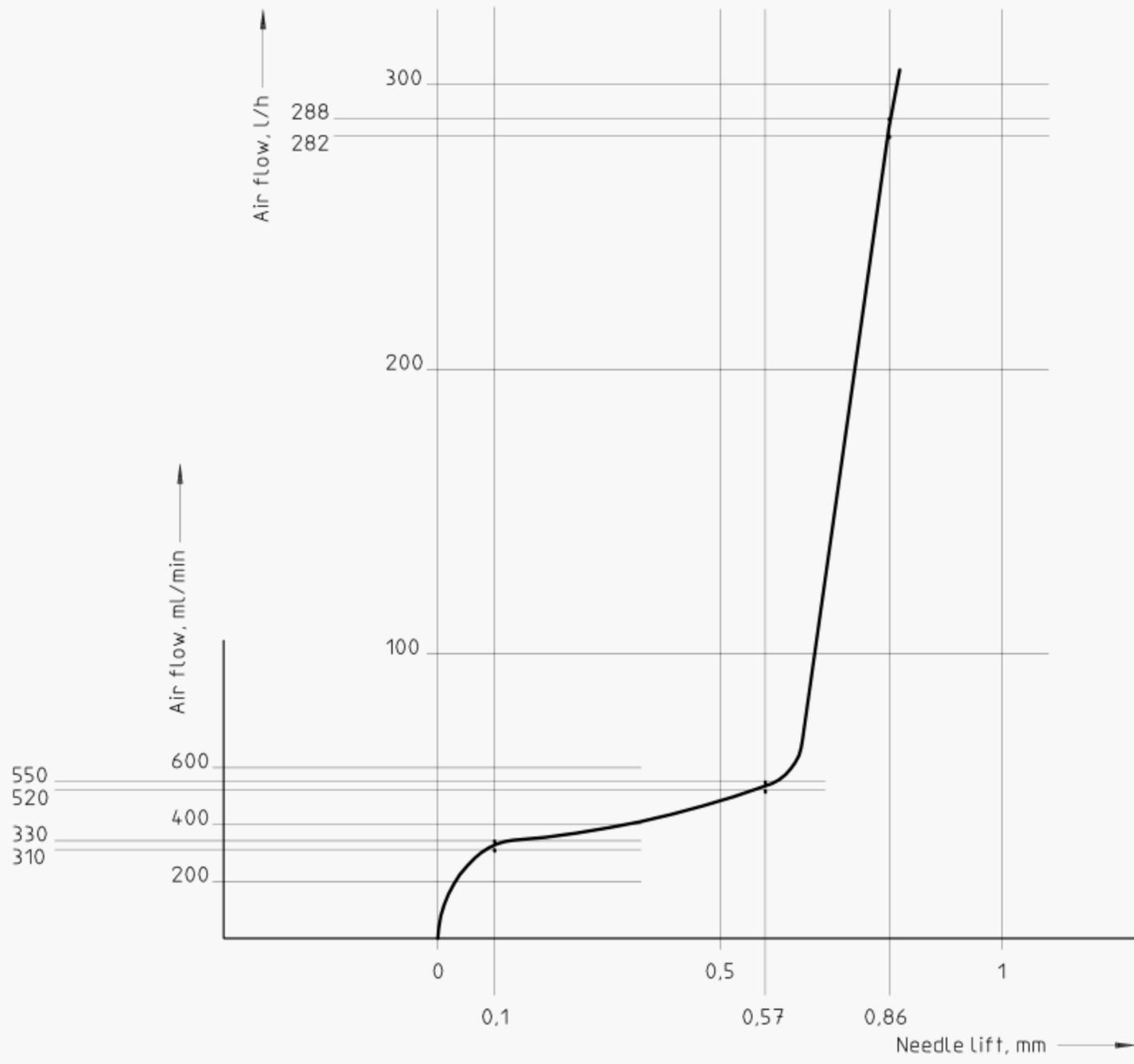


Figure 13 — Flow diagram

Dimensions in millimetres

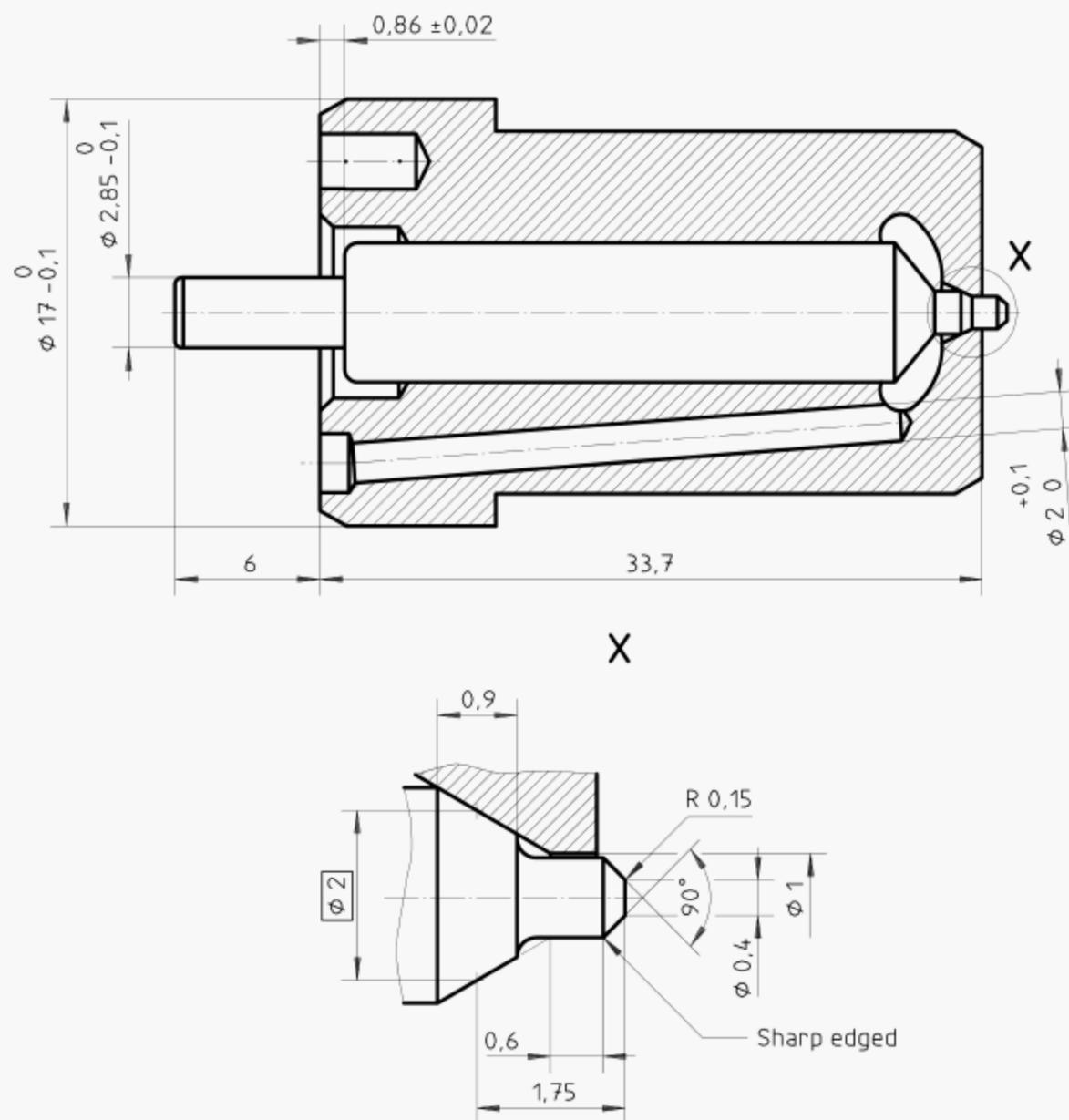


Figure 14 — Delay pintle type nozzle

### 3.4.2 Distance sleeve

Figure 15 shows the distance sleeve, which is used together with the delay pintle type nozzle.

Dimensions in millimetres

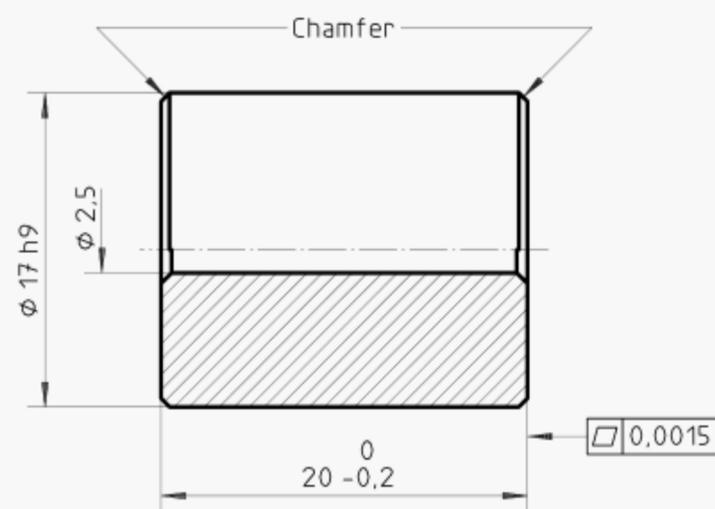


Figure 15 — Distance sleeve

## 4 Designation

### 4.1 General

The various alternatives of nozzle, nozzle holder, nozzle retaining nut and nozzle opening pressure result in many possible combinations of component content and adjustment. To facilitate concise specification of any particular form of calibrating fuel injector,

- a) required by the injection pump test schedule, or
- b) requiring purchase, either in whole or in part, by the operator,

the range of calibrating fuel injectors shall be designated in code form as specified in 4.2 and illustrated in the following example.

#### EXAMPLE

ISO 14681 A13 - 207

### 4.2 Composition

#### 4.2.1 First element: International Standard number

The first element is the number of the International Standard which specifies the calibrating fuel injectors.

In the example: ISO 14681

#### 4.2.2 Second element: letter code

In the example: A

This single letter code allows extension of the present A code system if and when all the possibilities of the code tables (see 4.2.3.2) are filled by new or modified orifice plates, nozzle types and/or holder bodies; then the letter 'A' shall be changed to 'B', etc.

This presupposes that additional 'B' code tables will be established.

In the 'B' system the meaning of either one of the digits may, however, retain the same meaning as in the 'A' code but this shall be duplicated in the 'B' code tables.

#### 4.2.3 Third element: component content

##### 4.2.3.1 Significance

This two-digit code defines the component content according to the structure specified in 4.2.3.2.

In the example: 13

where

1— (tens-digit code) indicates delay pintle type nozzle as specified in figure 14,

—3 (units-digit code) indicates vented holder body, as specified in figure 3 with a retaining nut, without a threaded stud, as specified in figure 9.

##### 4.2.3.2 Structure

The logic structure of the code defining the combination of components of the various calibrating fuel injectors as specified in this International Standard is given in table 2 for the tens and in table 3 for the units digit.

Table 2 — Tens-digit for A code

Code	Type of nozzle or orifice plate
0–	Not fitted
1–	Delay pintle nozzle type (see figure 14)
2–	—*
3–	—*
4–	Orifice plate no.: .4
5–	Orifice plate no.: .5
6–	Orifice plate no.: .6
7–	Orifice plate no.: .7
8–	Orifice plate no.: .8
9–	—*

NOTES

- The orifice plate numbers are as defined in figure 11.
- The codes where spaces are marked with an asterisk (\*) are at present undefined and are available for future definitions.
- Code 0– refers to a nozzle holder suitable for accepting either type of nozzle.
- Codes 4–, 5–, 6–, 7– and 8– refer to orifice plate only.

Table 3 — Units-digit code

Code	Type of fuel injector	
	Holder body with vent	Nozzle retaining nut for spray chamber
–0	—*	—*
–1	not specified	not specified
–2	yes	not specified
–3	yes	closed
–4	yes	open
–5	—*	—*
–6	no	not specified
–7	no	closed
–8	no	open
–9	—*	—*

NOTES

- Figure 3 illustrates nozzle holder bodies with a vent and without a vent.
- Alternative nozzle retaining nuts are as shown in figure 9.
- The codes where spaces are marked with an asterisk (\*) are at present undefined and are available for future definitions.

#### **4.2.4 Fourth element: nozzle opening pressure**

These three digits define the nozzle opening pressure setting in  $10^5$  Pa (bar).

In the example: 207

where 207 specifies 207 bar nozzle opening pressure.

## **Annex A**

(informative)

### **Bibliography**

- [1] ISO 4093:1986, *Road vehicles — Fuel injection pumps — High-pressure pipes for testing.*
- [2] ISO 8984-1:1993, *Diesel Engines — Testing of fuel injectors — Part 1: Hand-lever-operated testing and setting apparatus.*
- [3] ISO 8984-2:1993, *Diesel Engines — Testing of fuel injectors — Part 2: Test methods.*

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**ICS 43.060.40**

**Descriptors:** road vehicles, internal combustion engines, diesel engines, injection pumps, tests, test equipment, fuel injectors, specifications, form specifications, dimensions, designation.

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