Sac-hole nozzle with cylindrical sac hole and conical tip (6b):
This type of nozzle is used exclusively with spray-hole lengths of 0.6 mm. The tip's conical shape enables the wall thickness to be increased between the throat radius and the nozzle-body seat with an attending improvement of nozzle-tip strength.

Sac-hole nozzle with conical sac hole and conical tip (Fig. 6c):
Due to the conical shape of this nozzle's sac hole, its volume is less than that of a nozzle with cylindrical sac hole. The volume is between that for a seat-hole nozzle and a sac-hole nozzle with cylindrical sac hole. In order to achieve uniform tip-wall thickness, the tip's conical design corresponds to that of the sac hole.

Fig. 5

**Sac-hole nozzle**

**1** Pressure shaft, **2** Needle-lift stop face,
**3** Inlet passage, **4** Pressure shoulder,
**5** Needle shaft, **6** Nozzle tip,
**7** Nozzle-body shaft, **8** Nozzle-body shoulder,
**9** Pressure chamber, **10** Needle guide,
**11** Nozzle-body collar, **12** Locating hole,
**13** Sealing surface,
**14** Pressure-pin contact surface.

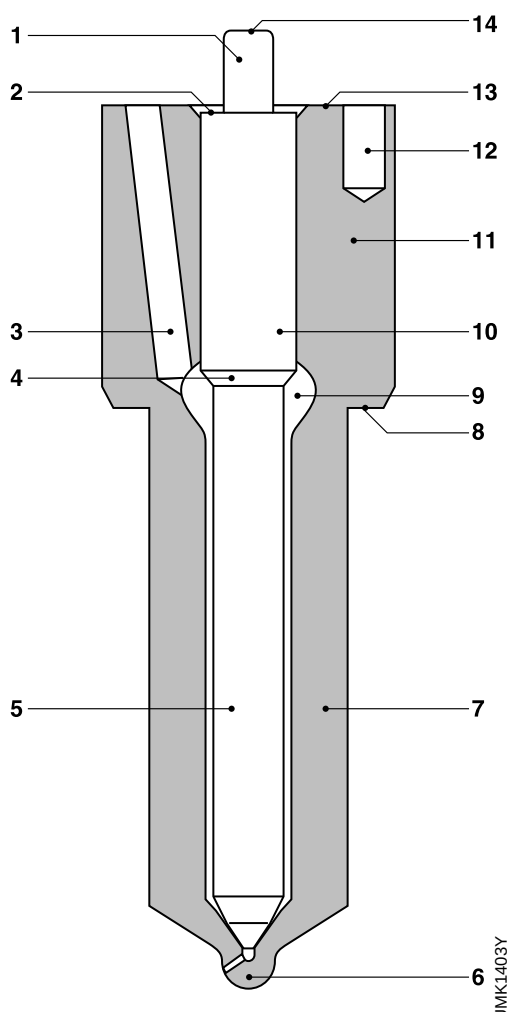
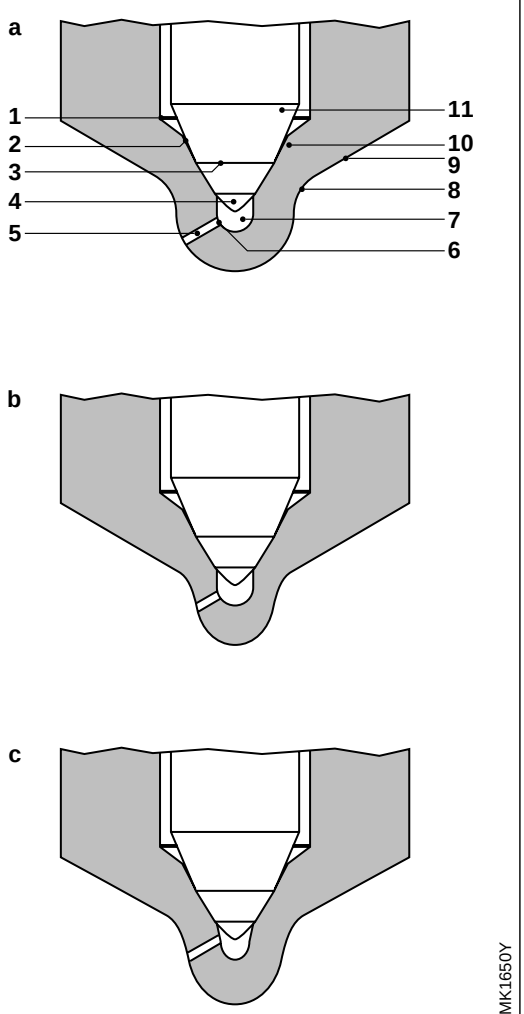



Fig. 6

**Sac-hole shapes**

**a** Cylindrical sac hole with round tip,
**b** Cylindrical sac hole with conical tip,
**c** Conical sac hole with conical tip.
**1** Shoulder, **2** Seat entrance, **3** Needle seat,
**4** Needle tip, **5** Injection orifice,
**6** Injection-orifice entrance, **7** Sac hole,
**8** Throat radius, **9** Nozzle-tip cone,
**10** Nozzle-body seat, **11** Damping cone.



Seat-hole nozzle

In order to minimise the residual volume – and therefore the HC emissions – the start of the spray hole is located in the seat taper, and with the nozzle closed it is covered almost completely by the nozzle needle. This means that there is no direct connection between the sac hole and the combustion chamber (Figs. 7 and 8). The sac-hole volume here is much lower than that of the sac-hole nozzle. Compared to sac-hole nozzles, seat-hole nozzles have a much lower loading limit and are therefore only manufactured as Size P with a spray-hole length of 1 mm.

For reasons of strength, the nozzle tip is conically shaped. The spray holes are always formed using e.c.m. methods.

Fig. 7

**Seat-hole nozzle**

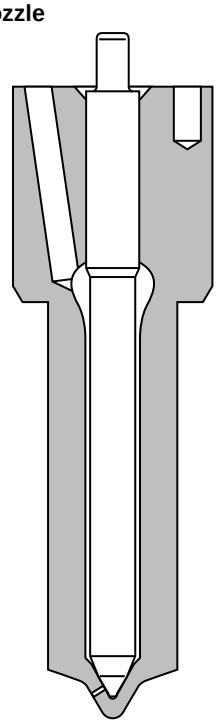


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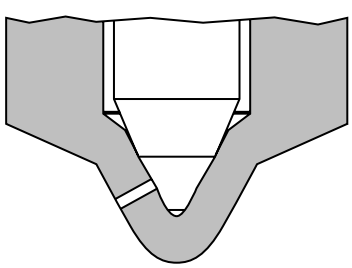
Fig. 8

**Seat-hole nozzle: Tip shape**



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# Standard nozzle holders

**Assignments and designs**

Nozzle holders with hole-type nozzles in combination with a radial-piston distributor injection pump are used on DI engines.

With regard to the nozzle holders, one differentiates between

– Standard nozzle holders (single-spring nozzle holders) with and without needle-motion sensor, and
– Two-spring nozzle holders, with and without needle-motion sensor.

**Application**

The nozzle holders described here have the following characteristics:

– Cylindrical external shape with diameters between 17 and 21 mm,
– Bottom-mounted springs (leads to low moving masses),
– Pin-located nozzles for direct-injection engines, and
– Standardised components (springs, pressure pin, nozzle-retaining nut) make combinations an easy matter.

**Design**

The nozzle-and-holder assembly is composed of the injection nozzle and the nozzle holder.

The nozzle holder comprises the following components (Fig. 9):

– Nozzle-holder body,
– Intermediate element,
– Nozzle-retaining nut,
– Pressure pin,
– Spring,
– Shim, and
– Locating pins.

The nozzle is centered in the nozzle body and fastened using the nozzle-retaining nut. When nozzle body and retaining nut are screwed together, the intermediate element is forced up against the sealing surfaces of nozzle body and retaining nut. The intermediate element serves as the needle-lift stop and with its locating pins centers the nozzle in the nozzle-holder body.

The nozzle-holder body contains the
– Pressure pin,
– Spring, and
– Shim.

The spring is centered in position by the pressure pin, whereby the pressure pin is guided by the nozzle-needle's pressure shaft.
The nozzle is connected to the injection pump's high-pressure line via the nozzle-holder feed passage, the intermediate element, and the nozzle-body feed passage. If required, an edge-type filter can be installed in the nozzle holder.

**Method of operation**
The nozzle-holder spring applies pressure to the nozzle needle through the pressure pin. The spring's initial tension defines the nozzle's opening pressure which can be adjusted using a shim.
On its way to the nozzle seat, the fuel passes through the nozzle-holder inlet passage, the intermediate element, and the nozzle nody. When injection takes place, the nozzle needle is lifted by the injection pressure and fuel is injected through the injection orifices into the combustion chamber. Injection terminates as soon as the injection pressure drops far enough for the nozzle spring to force the nozzle needle back onto its seat.

## Two-spring nozzle holders

**Application**
The two-spring nozzle holder is a further development of the standard nozzle holder, and serves to reduce combustion noise particularly in the idle and part-load ranges.

**Design**
The two-spring nozzle holder features two springs located one behind the other. At first, only one of these springs has an influence on the nozzle needle and as such defines the initial opening pressure. The second spring is in contact with a stop sleeve which limits the needle's initial stroke.

Fig. 9
**Standard nozzle holder**

**1** Edge-type filter, **2** Inlet passage,
**3** Pressure pin, **4** Intermediate element,
**5** Nozzle-retaining nut, **6** Wall thickness,
**7** Nozzle, **8** Locating pins, **9** Spring,
**10** Shim, **11** Leak-fuel passage,
**12** Leak-fuel connection thread,
**13** Nozzle-holder body, **14** Connection thread,
**15** Sealing cone.