

Air diffusion systems

**Variable air pattern
swirl diffusers
type VD
sizes Ø 315 & Ø 400**

General

The VD range of variable air pattern swirl diffusers meets the need for supplying high flow rates and changes in supply air temperature from cooling to heating modes combined with high mounting installation levels. They are intended for supplying air for ventilation of air conditioning applications for both comfort and industrial installations. The units operate between 83 and 970 l/s (300 and 3500 m³/h) at mounting heights from 3 m to 12 m and with temperature difference between the supply and the room air of up to 12K for cooling and 15K for heating.

Function

The very high induction rates of the VD diffusers are achieved by means of eight specially designed blades. The supply air is projected to any direction between horizontal and vertical by means of varying the route of the air flow within the diffuser.

The main advantages of the VD variable air pattern swirl diffusers are:

- Infinite positioning of the air flow between horizontal and vertical.
- Minimal change in pressure loss between horizontal and vertical air patterns.
- Strong vertical penetration of the warm air at high mounting heights.
- Minimum energy loss of the jet in the heating mode at high mounting heights due to the swirling air stream being surrounded by a non-swirling air stream.
- No ceiling effect needed to maintain the horizontal air pattern in cooling mode.

Sizes and operation

The VD variable air pattern swirl diffusers are available in two sizes: Ø 315 and Ø 400. Change of the air flow direction can be achieved by one of the following means:

- Manual setting.
- Self actuating piston in response to supply air temperature.
- Servo-motor, Electric

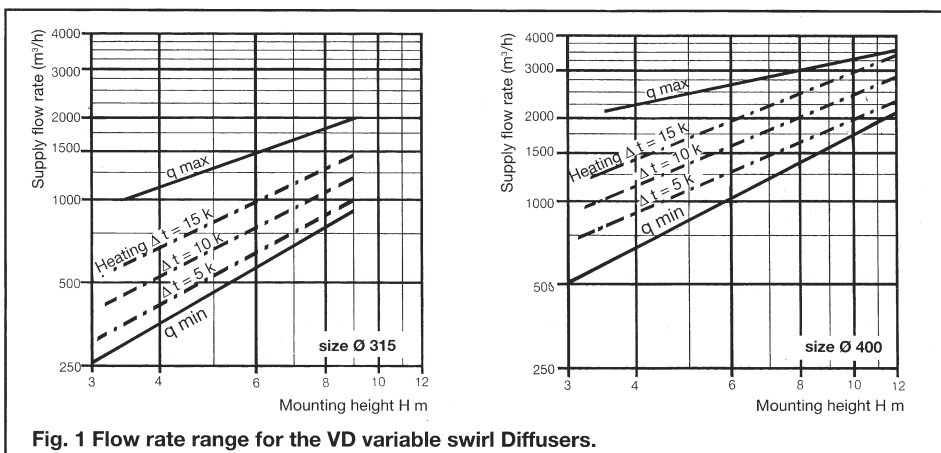
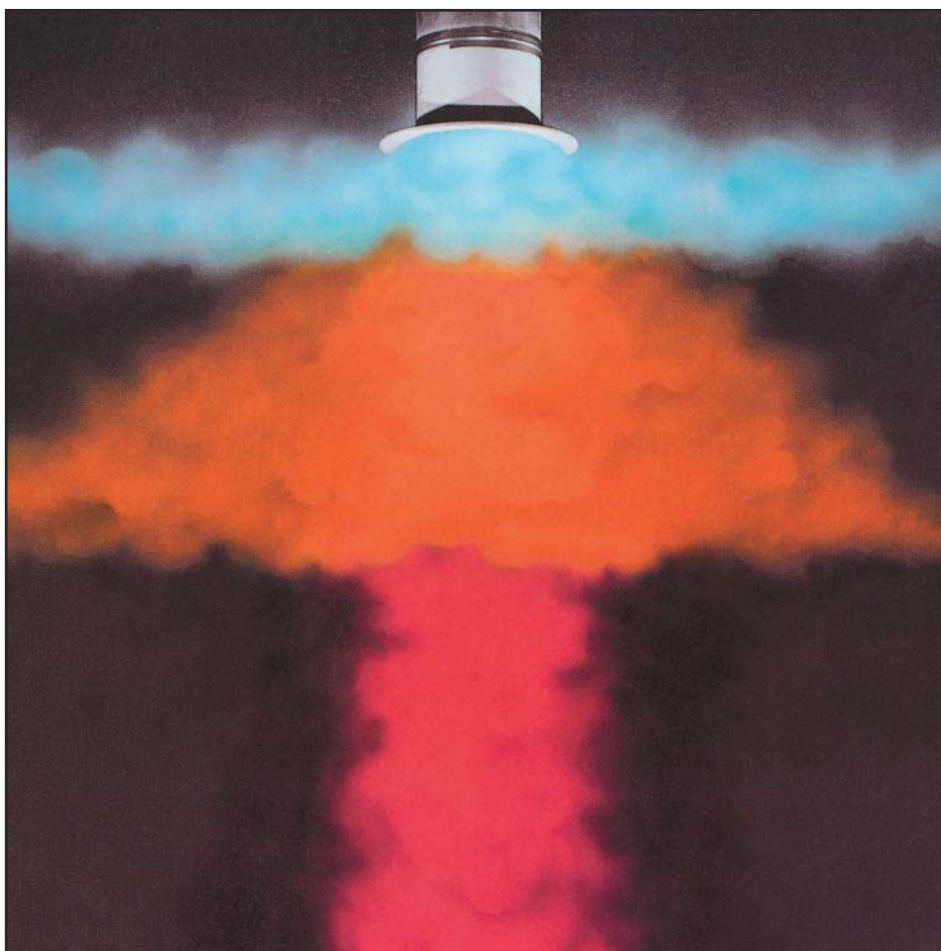


Fig. 1 Flow rate range for the VD variable swirl Diffusers.

Variable air pattern swirl diffusers type VD sizes Ø 315 & 400

Applications

- Production areas
- Storerooms and warehouses
- General purpose halls
- Sports halls
- Airports
- Business premises

Content

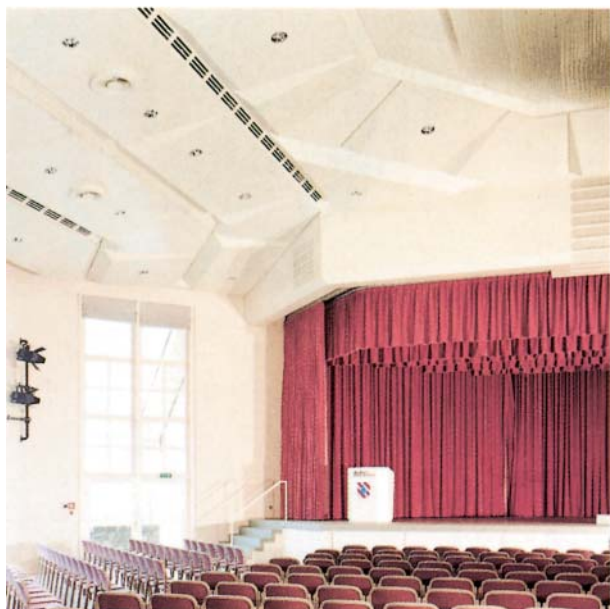
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Production: Sutter printing shop, Essen



General purpose hall: Kehl-Kork



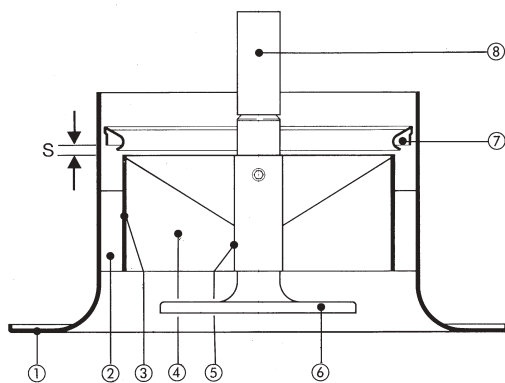
Town hall: Ransbach - Baumbach



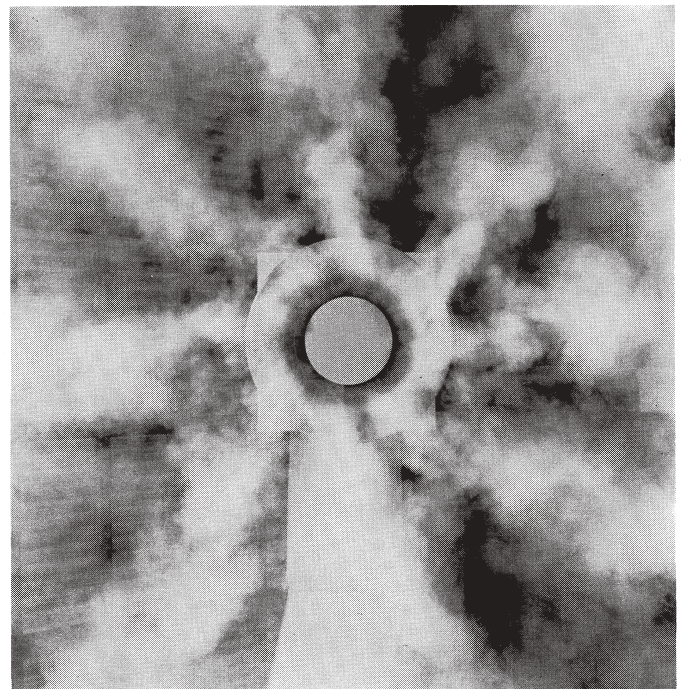
Control room: König Brewery, Duisburg

**Variable air pattern
swirl diffusers
type VD,
sizes Ø 315 & Ø 400**

Construction and function



- ① Outer cylinder with face flange
- ② Corrugated cylinder air straightener
- ③ Inner cylinder
- ④ Swirl blades
- ⑤ Central column
- ⑥ Air deflection plate
- ⑦ Control ring
- ⑧ Positioning device



Horizontal air pattern smoke test

Construction

The variable pattern swirl diffuser type VD is constructed from aluminium and consists of an outer cylinder ① and an inner assembly ③ to ⑤ which comprises the swirl blades ④. Between the outer cylinder and the inner cylinder ③ there is space which houses a corrugated cylinder ② which acts as an air straightening device. The deflection plate ⑥ and the control ring ⑦ are connected to each other through the central column, vertical movement of the deflection plate and the control ring changes distance "s" between the upper edge of the inner cylinder and the control ring seal which in turn changes the direction of the air flow pattern.

Function

The supply air passes through the swirl diffuser either totally between the central column and the inner cylinder, that is through the blades, or partly through the blades and partly between the outer and inner cylinders. The percentage ratio passing through each path is governed by distance "s". The more air passes between the outer and the inner cylinders the more vertical the air pattern becomes.

**Variable air pattern
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Function

Dimensions

Adaption of the swirl diffuser to thermal loads

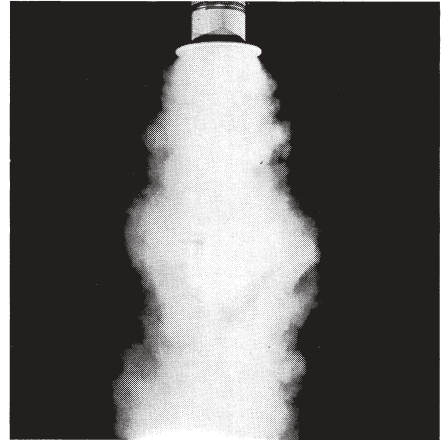
Maximum cooling position



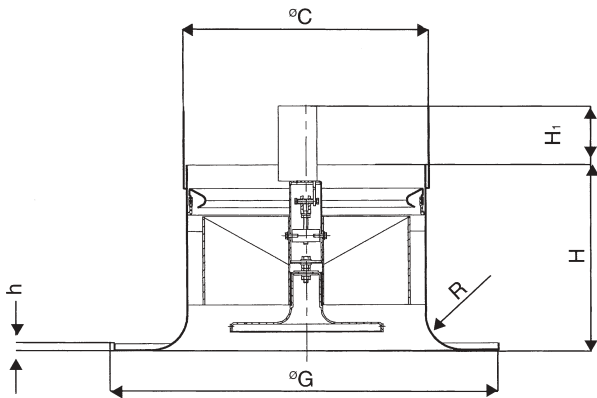
Mid- temperature position



Maximum heating position



Diffuser dimensions



Dim. mm	Nominal size	
	315	400
Cø	312	397
Gø	500	625
H	260	300
h	10	10
R	50	58
H1 (DE) *	31	24
H1 (ME) **	93	86

* Self actuating piston

** Electric actuator

Variable air pattern swirl diffusers type VD, sizes Ø 315 & Ø 400

Positioning methods

Positioning methods

The special characteristics of the VD range of variable air pattern swirl diffusers lie in the change of air projection direction of the swirling air flows, this is achieved by a change in position of the control ring and the positioning plate.

There are three different means by which this change of position can be achieved:

- **Manual positioning** Fixed position at a predetermined projection angle.
- **Self actuating piston** Projection angle determined as a function of the supply air temperature.
- **Servo motor (electric or pneumatic)**

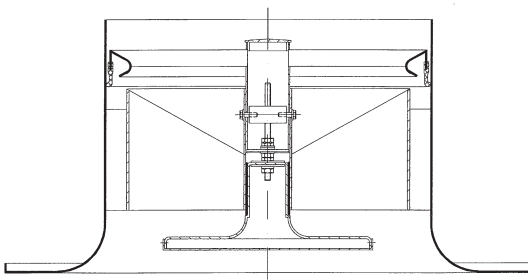
Choice of positioning method

Depending on the desired operational performance of the diffuser e.g. rapid heating and draught free room air movement, there is a certain required projection angle of the supply air, this is determined by the respective application data.

- Supply - room air temperature difference
- Mounting height
- Air flow rate per diffuser

The selection of the suitable positioning method should follow the following criteria.

Manual positioning



Variable air pattern swirl diffuser with manual setting

By manually rotating the directional plate, the vertical position of the directional plate and the control ring is changed. Clockwise rotation produces a more vertical projection (heating) and anti-clockwise a more horizontal projection (cooling).

With manual setting the projection angle is predetermined and cannot take into account subsequent changes in conditions without again manually re-setting.

Criteria for manual positioning

- | | |
|---|---|
| Low mounting heights:
(up to 4 m) | Cooling to heating of $\Delta t \leq 6$ K |
| Medium mounting heights:
(from 4 to 6 m) | Cooling and heating with relatively small changes of temperature differences ($\Delta t \leq \pm 3$ K) |
| High mounting heights: | Only with determined thermal loads e.g. cooling, heating or isothermal with constant air flow rates. |

Data for determining the projection depending on:

- Temperature difference of supply to room air
- Mounting height
- Air flow rate

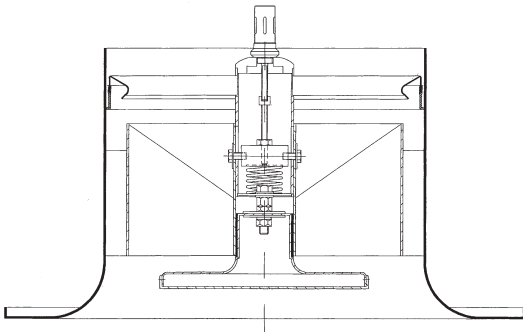
is given in Figs. 6 and 7 of the technical data sheets.

The data is based on a room air velocity of 0,2 m/s at 1,8 m above the floor level and beneath the diffuser.

Variable air pattern swirl diffusers type VD, sizes Ø 315 & Ø 400

Positioning methods

Positioning by self actuating piston



Variable air pattern swirl diffuser with self actuating piston

The self actuating piston consists of a metal cylinder filled with wax. The wax responds to temperature changes and by expansion and contraction creates a linear piston action, this linear action dictates the movement of the control ring and the direction plate which in turn changes the direction of the air projection.

With the self actuating piston the air projection direction is determined purely by the supply air temperature.

Working range of the self actuating piston:

The operating range of the self actuating piston is from 16 - 28 °C with a minimum linear displacement of 19 mm to a maximum of 22 mm.

At supply air temperature of $\leq 16^{\circ}\text{C}$ the air projection is horizontal.

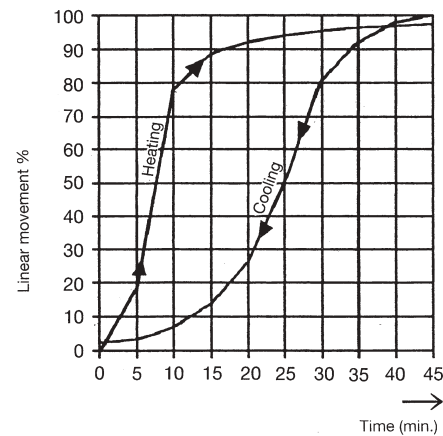
At supply air temperature of $\geq 28^{\circ}\text{C}$ (t max + 50°C) the air projection is vertical.

Between 16°C and 28°C supply air temperature the air projection changes with the temperature.

The response time of the self actuating piston is related to the temperature change rate of the metal cylinder and of the wax it contains, the response time is illustrated in the graph opposite.

The graph shows the time taken for a percentage linear movement of the linear action, it is based on a supply air temperature change of from 15° to 30°C for heating and from 30° to 15°C for cooling.

It can be seen therefore that for heating there will be 90% of the piston movement after 17 minutes and for cooling 90% of movement after 33 minutes.



Control response of a self actuating piston

Application considerations for positioning by self actuating piston

Efficient room air movement in heating and cooling modes for high mounting heights (above 4 m).

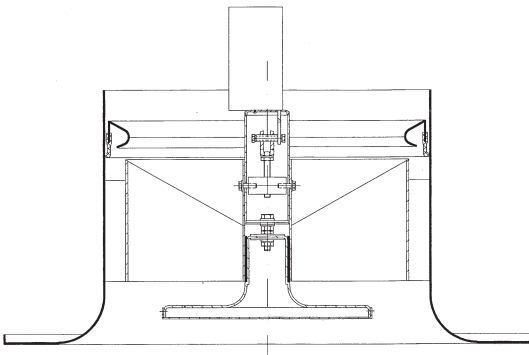
The advantages over manual positioning of the air projection lie in the reduction of excessive air velocities in the cooling mode and in the improvement of the vertical throw in the heating mode.

Important: The definitive room air velocity in the occupied zone cannot be guaranteed with the use of a self actuating piston.

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Positioning methods

Positioning by electric servo-motor



Variable air pattern diffuser with electric servo-motor

The electric servo-motor offers the best method of achieving a change in direction of the the air projection.

Its application is equally valid with respect to the air movement in the occupied zone for both comfort and industrial applications.

To maintain the required room air movement it is necessary for the change in air projection direction to be related to the temperature difference between the supply air and the room air. The normal buoyancy of the warm or cold air can therefore be compensated for by the different projection angles so that in the occupied zone or working zone, the required air movement can be maintained almost constant at different thermal loads.

Types of motors available

Variation I: Motor with 3 set points (ME-3)
Operating current 24V or 220V

If a closed loop is required, the positioning servo-motor must be furnished with a feed back potentiometer through which a signal can be sent to determine the position of the motor.

Variation II: Motor (proportional)
Operating current 24V (AC)
Control current 0 - 10V (DC)
or 0 - 20V cut phase
(SCS controller)

Application considerations for positioning by electric servo-motor

Universal application for optimum control of all thermal loads, air flow rate and mounting height conditions.

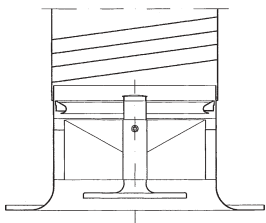
Essential if air velocities in specified zones are to guaranteed.

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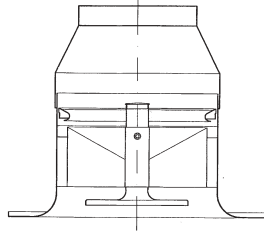
Connection methods

Connection methods

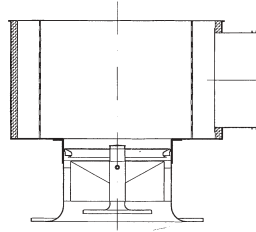
The variable air pattern swirl diffusers can be furnished with the following connection methods:



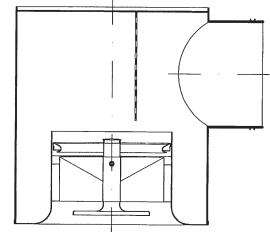
Direct duct connection



Connection cone



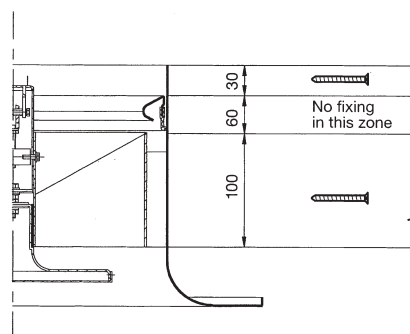
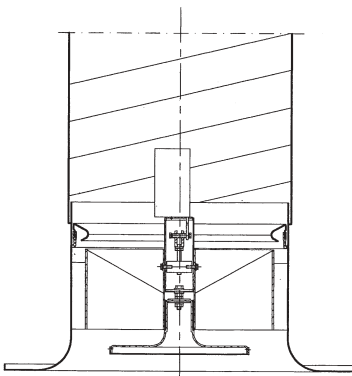
Rectangular plenum box



Circular plenum box

Direct duct connection

For direct duct connection the duct should be same nominal size as the diffuser



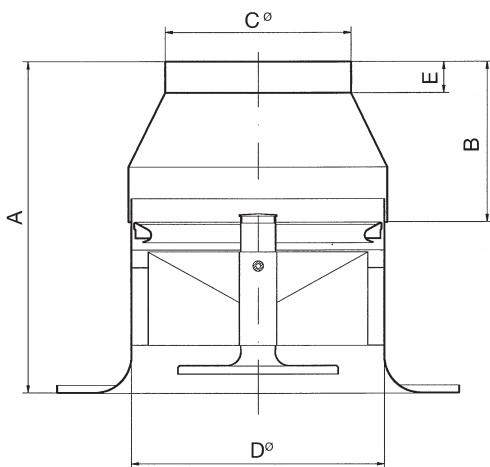
Swirl diffusers VD must only be screwed at these zones

Installation - fixing instruction

**Variable air pattern
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Connection methods

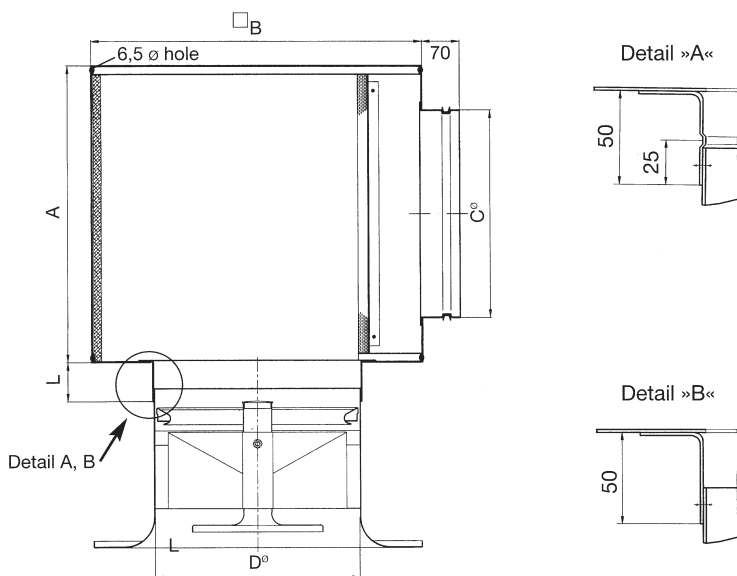
Connection cone



Nom. size Ø mm D	Dimensions mm			
	A	B	C Ø	E
315	215	155	250	50
400	240	163	355	57

The connection cone is only recommended for applications with low air flow rates.

Rectangular connection plenum box



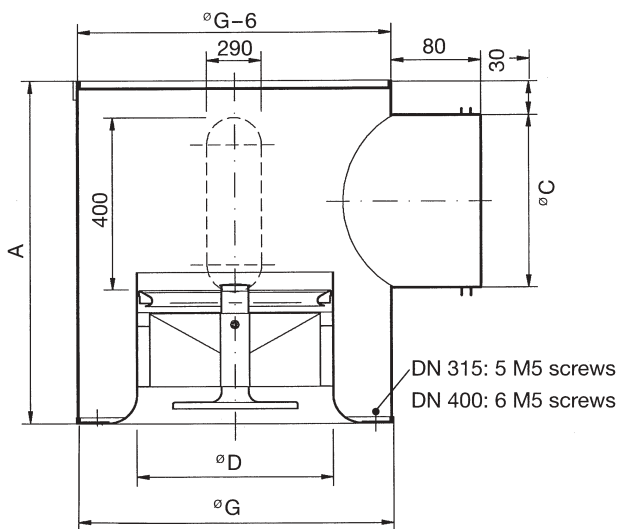
Nom. size Ø mm D	Dimensions mm			
	A	B sq.	C Ø	L
315	450	500	250 or 315	50
400	500	650	355 or 400	50

Connection plenum box from zinc plated steel. Acoustic insulation applied to only vertical walls.

**Variable air pattern
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**Connection plenum
with access**

Connection plenum, circular



Nom. size \varnothing mm	Dimensions mm		
	A	C \varnothing	G \varnothing
315	500	315	500
400	550	400	625

Connection plenum from zinc plated steel with or without internal acoustic insulation and with access door.

**Variable air pattern
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Technical data

**Cooling
Heating**

Air flow rate sizing for cooling mode

For stable horizontal air jets from the swirl diffuser in the cooling mode the minimum air flow rates are:

VD 315: $q_v = 70 \text{ l/s (250 m}^3\text{/h)}$
 VD 400: $q_v = 166 \text{ l/s (600 m}^3\text{/h)}$

For better room air movement in the cooling mode as well as for isothermal, it is necessary for the air direction to change to a vertical projection characteristic. See also the setting values of "s" as set out in Figs. 6 & 7 on page 12.

Air flow rate sizing for heating mode

In order to efficiently and rapidly warm a room with heated supply air it is necessary to have an intensive projection towards the floor.

Figs. 4 & 5 show the air flow rates at different temperature differentials necessary to achieve a projection intensive enough to achieve a mean air velocity of 0,25 m/s at 0,5 m above the floor level

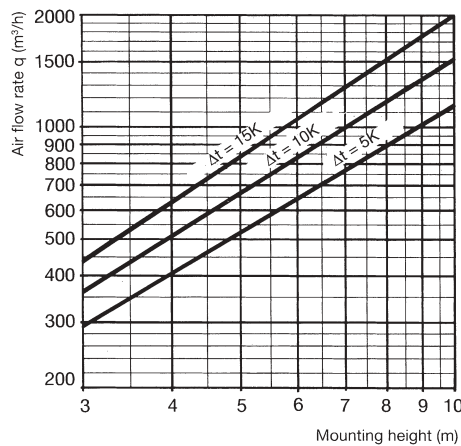


Fig. 4 Swirl diffuser VD 315
Minimum air flow rates for the heating mode

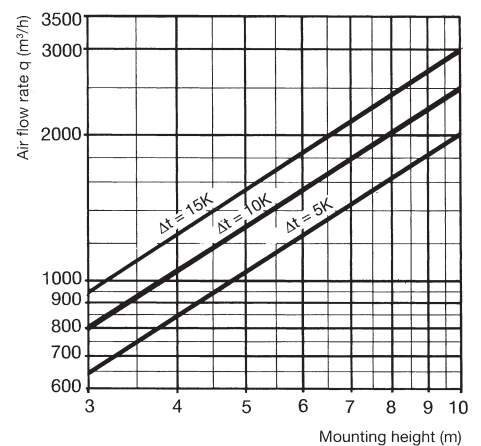


Fig. 5 Swirl diffuser VD 400
Minimum air flow rates for the heating mode

**Variable air pattern
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Technical data

**Determination of the
dimension "s"**

Determination of dimension "s"

(the dimension "s" is the distance between the control ring and the fixed collar, see drawing below)

Dimension "s" determines the angle of the swirl air pattern created by the diffuser as a function of the following:

- Air flow rate
- Mounting height
- Thermal load (heating or cooling)

Dimension "s" can be derived from figures 6 and 7 relative to the above parameters.

With the values given in figures 6 or 7 a room air velocity of 0,2 m/s at 1,8 m above the floor level will be achieved.

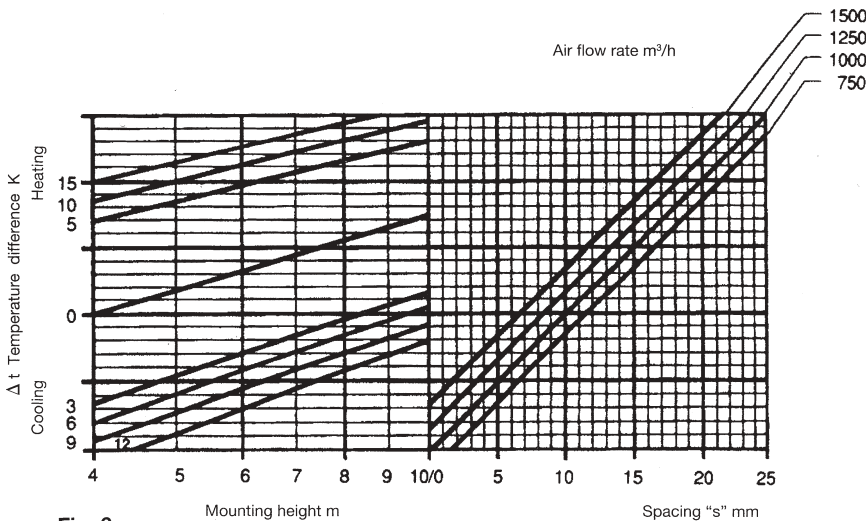


Fig. 6

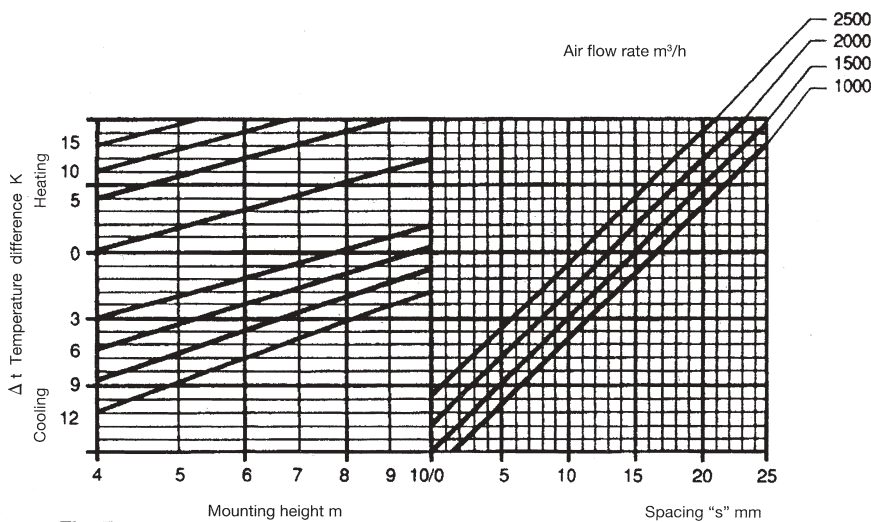
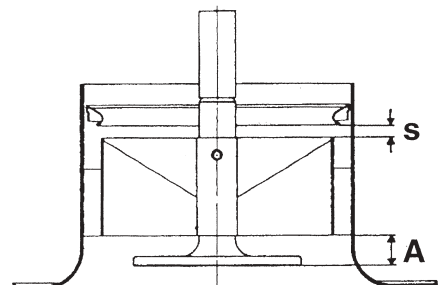


Fig. 7

Verification of "s" for installed diffuser.

VD 315 s = 56 - A mm
 VD 400 s = 64 - A mm
 (A = physically measured dimension)



Variable air pattern swirl diffusers type VD, sizes Ø 315 & Ø 400

Technical data

**Distance between diffusers
Pressure loss
Noise level**

Minimum distance between diffusers

When ceiling diffusers with horizontal cooling air projection are positioned too close to each other the air streams can converge and be deflected downwards, this can cause undesirable air movement in the occupied zone. Fig. 8. shows the minimum centreline distance between diffusers relative to the air flow rate and the mounting height.

The minimum distance to a wall should be half of the derived distance.

The following formula can also be used to determine the minimum centreline distance between diffusers.

$$t_{min} = \sqrt{(q_v \cdot 0,3 / H)}$$

where

- q_v = air flow rate l/s
- t_{min} = minimum centreline distance between diffusers (m)
- H = mounting height (m)

or

$$t_{min} = \sqrt{(q_v / 12 \cdot H)}$$

where

- q_v = air flow rate m³/h

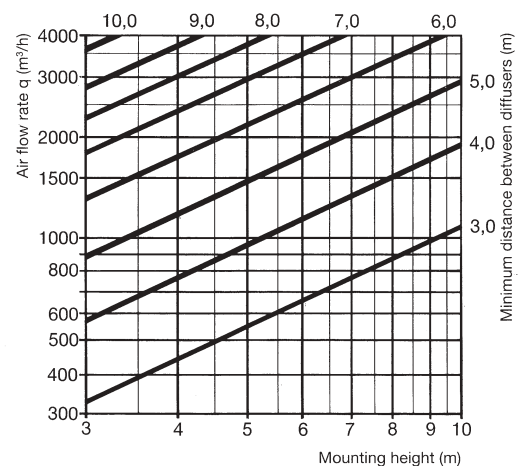


Fig. 8: Minimum centreline distance between diffusers

Pressure loss and Noise levels of variable air pattern diffusers VD

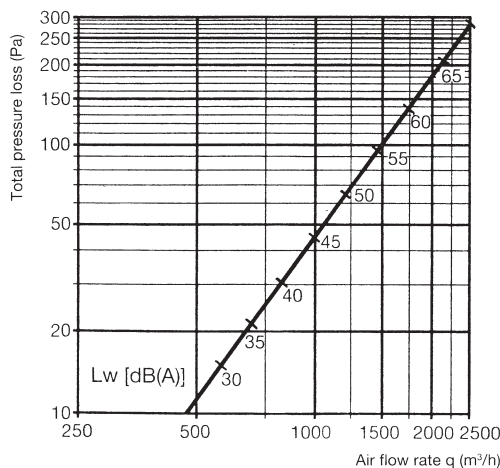


Fig. 9: Total pressure loss and noise level of variable air pattern swirl diffuser VD 315 (cooling)

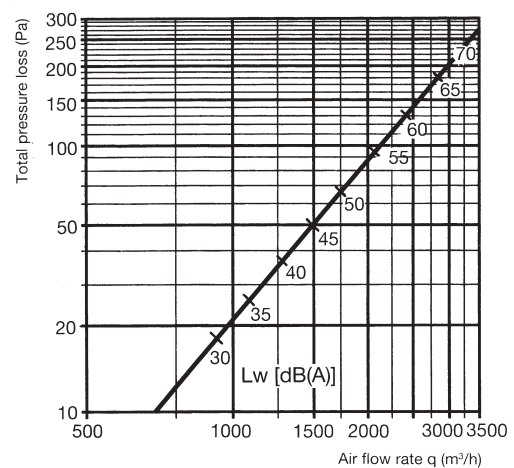


Fig. 10: Total pressure loss and noise level of variable air pattern swirl diffuser VD 400 (cooling)

The pressure loss is the same at any setting position at equal air flow rate whilst the noise level is 4 to 6 dB higher at heating position than for cooling.

**Variable air pattern
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Technical data

**Sound power levels
per octave band**

Sound power levels per octave band

The sound power level per octave band can be calculated from the corrections given in Figs. 13 and 14 and the following formula:

$$L_{wo} = L_{wa} + K_o$$

where

L_{wo} = Sound power level per octave band dB

L_{wa} = Noise levels derived from Figs. 9 and 10 (dB(A))

K_o = Octave band correction factor dB

Example

Given $L_p = 41$ dB(A) cooling

Required L_{wo} at 1000 Hz

then from Fig. 13

$$L_{wo1000} = 41 + (-13) = 28 \text{ dB(A)}$$

Hz	63	125	250	500	1000	2000	4000	8000
Ko	-21	-14	-8	-6	-4	-9	-16	-21

Fig. 11. Table of third octave band correction factors - cooling

Hz	63	125	250	500	1000	2000	4000	8000
Ko	-32	-29	-23	-10	-3	-5	-11	-21

Fig. 12. Table of third octave band correction factors - heating

**Variable air pattern
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**Variable air pattern diffusers
Special designs**

**VD-QR
VD-AK/Q
VD-AK/QR**

Special forms of variable air pattern diffusers

The special diffusers described below have been developed to meet the following specific requirements:

- Increase in air flow rate
- Reduction in noise level at equal air flow rates
- Reduction in the required distance between diffusers without increasing the air velocity in the occupied zone

VD-QR

Variable air pattern swirl diffuser with cylindrical diffusion face

VD-AK/Q

Variable air pattern swirl diffuser with rectangular plenum and diffusion face

VD-AK/QR

Variable air pattern swirl diffuser with cylindrical plenum and diffusion face



VD-AK/Q: Production hall, Fa. Mommers, Echt (NL)



VD-AK/QR: Production area, Fa. Mommers, Echt (NL)



VD-QR: Production area, Fa. Siemens, Berlin (D)

Variable air pattern swirl diffusers type VD, sizes Ø 315 & Ø 400

Variable air pattern diffusers Special designs

VD-QR

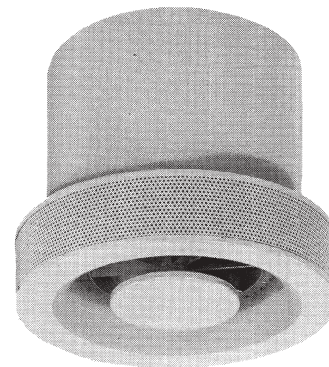
Variable air pattern swirl diffuser VD-QR with cylindrical diffusion face

Connection method

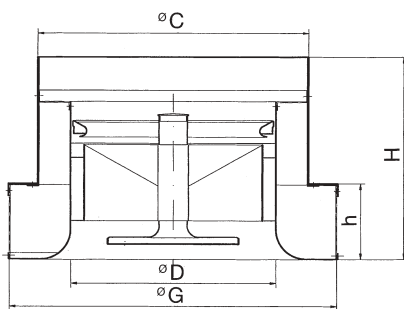
Duct connection

Function, Technical features

- 60% of the supply air passes through the swirl diffuser and 40 % passes directly through the displacement element.
- Increase of air change rate from 14· h⁻¹ to 25·h⁻¹, reduction of the minimum distance between diffusers by 30%.



Dimensions

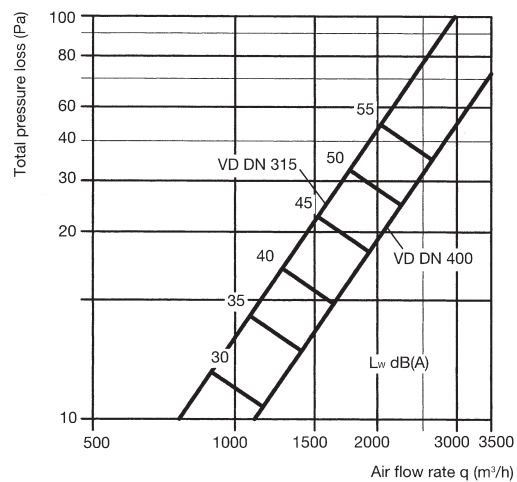


Nom. size D ø	Dimensions mm			
	C ø	G ø	H	h
315	400	500	360	100
400	500	625	400	150

Positioning

The positioning of the air pattern setting can be by one of the following methods:
Manual, self actuating piston or electric servo-motor.
(see pages 5-7)

Pressure loss and noise level



The VD-QR is set using the same parameters for temperature difference and mounting height as for the standard diffuser, however for the flow rate, only the amount passing through the swirl element is considered.
(See page 11)

Variable air pattern swirl diffusers type VD, sizes Ø 315 & Ø 400

Variable air pattern diffusers Special designs

VD-AK/Q

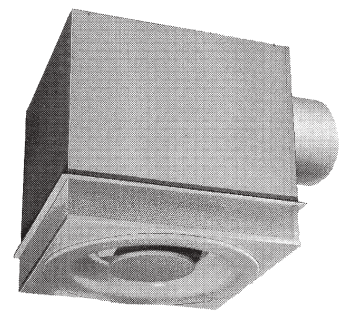
Variable air pattern swirl diffuser VD-AK/Q with rectangular plenum and diffusion face

Connection method

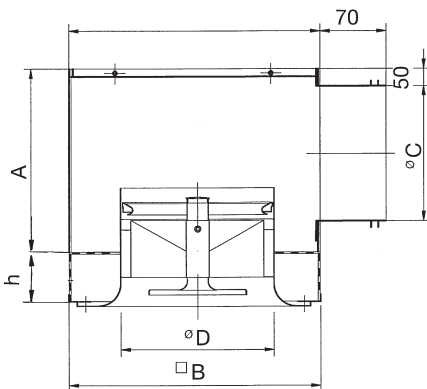
Plenum box with side entry spigot

Function, Technical features

The VD-AK/Q has the same functions and technical features as the VD-QR but combined with a plenum box and a side entry inlet.

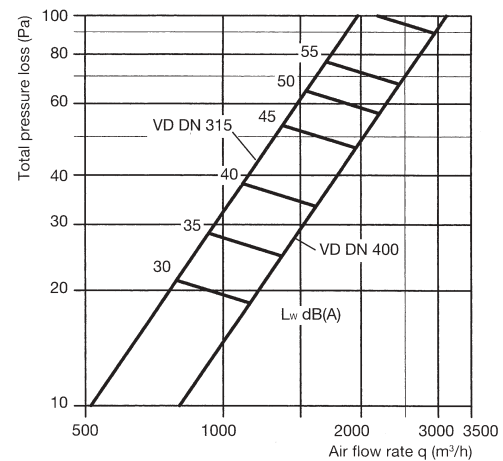


Dimensions



Nom. size D ø	Dimensions mm			
	A	B sq	C ø	h
315	580	550	315	80
400	680	650	400	120

Pressure loss and noise level



Positioning

The positioning of the air pattern setting can be by one of the following methods:
Manual, self actuating piston or electric servo-motor.
(see pages 5-7)

The VD-AK/Q is set using the same parameters for temperature difference and mounting height as for the standard diffuser, however for the flow rate, only the amount passing through the swirl element is considered.
(See page 11)

**Variable air pattern swirl diffusers
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**Variable air pattern diffusers
Special designs**

VD-AK/QR

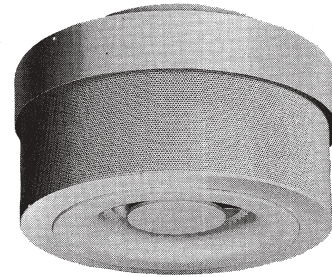
Variable air pattern swirl diffuser VD-AK/QR with cylindrical plenum and diffusion face

Connection method

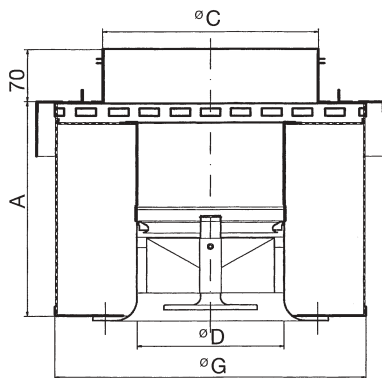
Plenum box with top entry spigot

Function, Technical features

- 50 - 70% of the supply air passes through the swirl diffuser and 30 - 50 % passes directly through the displacement element.
- Increase of air change rate from 14· h⁻¹ to 25·h⁻¹, reduction of the minimum distance between diffusers by 30%.

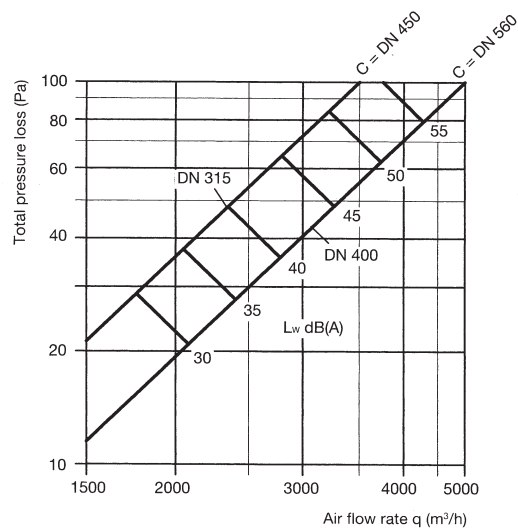


Dimensions



Nom. size D Ø	Dimensions mm		
	A	C Ø	G Ø
315	300-500	450	650
400	400-600	560	800

Pressure loss and noise level



Positioning

The positioning of the air pattern setting can be by one of the following methods:
Manual, self actuating piston or electric servo-motor.
(see pages 5-7)

The VD-AK/QR is set using the same parameters for temperature difference and mounting height as for the standard diffuser, however for the flow rate, only the amount passing through the swirl element is considered.
(See page 11)

**Variable air pattern
swirl diffusers
type VD
sizes Ø 315 & Ø 400**

**Weights
Selection example**

Weights

Component		Weight (kg)	
		Ø 315	Ø 400
VD	Variable air pattern diffuser, Manual setting	6,0	7,5
U	Cone connection without perforated plate	1,5	2,0
AKH	Plenum box connection (square form) having extended spigot	16,0	21,5
AK	Plenum box connection (round form)	10,5	13,5
DE	Self actuating piston	0,3	0,3
ME	Electric servo-motor	0,5	0,5
VD-QR	Variable air pattern diffuser with cylindrical diffusion face for direct duct connection	11,5	15,0
VD-AK/Q	Variable air pattern diffuser with square plenum and diffusion face	17,5	22,5
VD-AK/QR	Variable air pattern diffuser with cylindrical plenum and diffusion face	16,0	20,5

Selection example

Given:

Room size: 24 m L x 8 m W
 Mounting height of diffuser: 4,75 m
 Total air flow rate to room: 4800 m³/h
 Temperature difference – cooling: 8 K
 Temperature difference – heating: 15 K
 Maximum allowable noise level: 40 dB(A)
 Required diffuser size: Ø 315

Required:

Necessary number of diffusers and the associated air flow rates, noise level, pressure loss, minimum distance between diffusers and the setting value »s«.

Method:

From Fig. 9 it can be seen that the maximum flow rate for heating at 40 dB (A) is 850 m³/h which in considering the total flow rate of 4800 m³/h would mean 6 diffusers handling 800 m³/h each.

Fig. 8 shows that for a flow rate of 800 m³/h at 4,75 m mounting height the minimum distance between the diffusers should be 3,75 m. Therefore the six diffusers can be positioned in the room of 24 m x 8 m at centres of 4 m.

Check for flow rate – cooling:

The flow rate of 800 m³/h is in excess of the minimum stated on page 11 for stable conditions.

Check for flow rate – heating:

Fig. 4 shows that for heating at 800 m³/h per diffuser and 15 K temperature difference the air stream at maximum vertical projection reduces to 0,25 m/s at 0,5 m from floor level. In this case it may be desirable to set the air projection at a medium position.

At 800 m³/h acceptable room air movement conditions can be achieved for both the heating and cooling modes.

Result:

6 variable air pattern swirl diffusers type VD 315 with servo-motor control having the following characteristics would be suitable:

Flow rate per diffuser: 800 m³/h
 Noise level: 38 dB(A)
 Total pressure loss: 40 Pa

From Fig. 6 the minimum centreline distance between diffusers at mounting height of 4,75 m can be established as 3,75 m.

From Fig. 15 the values »s« can be established as 22 mm for heating and 4 mm for cooling.

Tender text

Position	Description	No. of units	Unit price	Extended price
	<p>Supply air swirl diffusers for applications requiring even air diffusion and the minimum possible temperature gradient. The air pattern depending on the thermal loads and mounting height is from horizontal to vertical. Constant pressure loss in heating and cooling mode.</p> <p>The diffuser consists of an outer cylindrical housing with outlet flange for stabilising the air flow enclosing the diffuser components, formed swirl diffusion elements are attached to an inner cylinder, an air straightening element consisting of a “corrugated” cylinder is positioned between the inner and an outer cylinder. By the vertical movement of a directional element, a control ring opens or closes the air entry to the air straightening element and the swirl diffusion elements.</p> <p>Diffuser material: Aluminium</p> <p>Swirl diffuser:</p> <p>Nom Diameter</p> <p><input type="checkbox"/> 315 Ø</p> <p><input type="checkbox"/> 400 Ø</p> <p>Face flange form:</p> <p><input type="checkbox"/> Circular flange with returned edge (standard)</p> <p><input type="checkbox"/> Rectangular dimensions</p> <p><input type="checkbox"/> Special design</p> <p>Directional control:</p> <p><input type="checkbox"/> Manual HV</p> <p><input type="checkbox"/> Self actuating piston DE Only recommended for industrial applications</p> <p><input type="checkbox"/> Electric servo-motor ME-S (24 V ~ 0-10 V control signal)</p> <p><input type="checkbox"/> Electric servo-motor ME-3 (3 point control, 24 V –or 200 V)</p> <p>Finish</p> <p><input type="checkbox"/> primed</p> <p><input type="checkbox"/> enamelled to RAL</p> <p>Installation method:</p> <p><input type="checkbox"/> Connection cone</p> <p><input type="checkbox"/> Connection plenum box from zinc plated steel and with perforated directional plate to ensure an equal distribution of air at the diffuser.</p> <p style="padding-left: 20px;"><input type="radio"/> plenum circular</p> <p style="padding-left: 20px;"><input type="radio"/> plenum rectangular</p> <p>Swirl diffuser with displacement:</p> <p><input type="checkbox"/> VD-QR</p> <p><input type="checkbox"/> VD-AK/Q</p> <p><input type="checkbox"/> VD-AK/QR</p> <p>Air flow rate l/s or m³/h</p> <p>Max. noise level NR or dB (A)</p> <p>Max. pressure loss Pa</p> <p>Manufacturer: STRULIK</p> <p>Type: VD</p>			