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Aldes ME Flash

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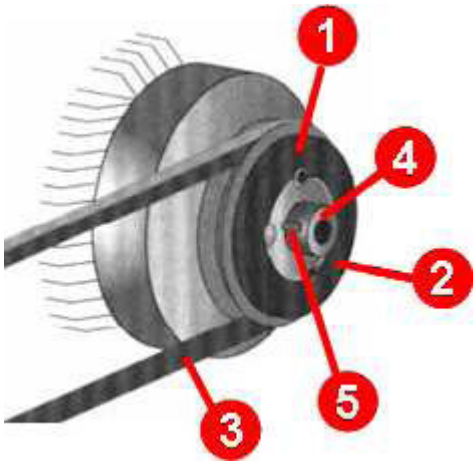
Technical Information

Belt Drive

Introduction

Belt drive is often used for centrifugal fans. It is necessary to know this belt drive's composition and functioning to carry out the commissioning or to define a new fan operating point.

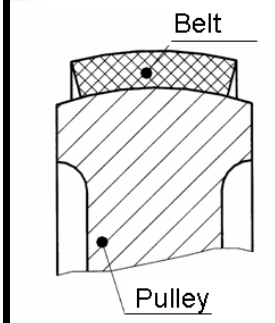
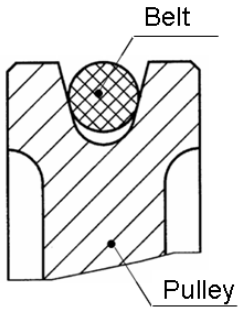
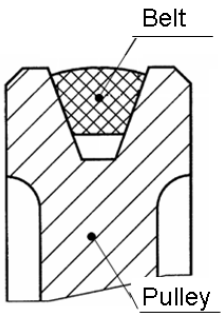
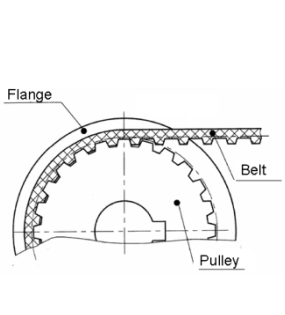
A belt drive is composed of 4 elements: pulley, belt, key, and sometimes hub.



1. Pulley
2. Hub
3. Belt
4. Shaft
5. Key

Kinds of belts

Several types of belts do exist:

Flat belt	Round belt	V-type belt	Synchronous belt
			

- **Flat belt** can relay high power. It is recommended for high speed applications (for paper industry for instance).
- **Round belt** is flexible and often used for small mechanisms.
- **V-type belt** – on which this newsletter will focus – is especially used in ventilation, thanks to the full contact with pulley.
- **Synchronous belt** is a flat belt with gear teeth, that works without slipping and often used for low speed installations.

"V-type" name comes from the belt shape. Most of the time, the « narrow V-belt » are the V-belts used in ventilation according to different profiles: SPZ, SPA and SPB. These profiles are standardized and defined according to the DIN7753/1 European standard. "Classical V-belt" (Z, A, B and C profiles, according to the DIN2215 standard) or American (3V 5V profiles, according to the RMA – MPTA) are also used.

The belt

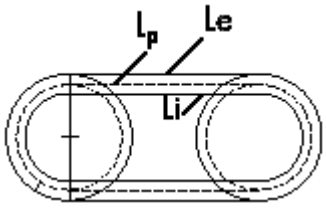
A belt is characterized by :

❶ Its standardized profile: SPZ, SPA, SPB or SPC for narrow belts. The choice of profile depends on the transmitted power.

	Width mm	Height mm
SPZ	10	8
SPA	13	10
SPB	16	13
SPC	22	18

❷ Its length of reference or pitch length. 3 types of lengths do exist:
- “Le” outside length
- “Li” inside length
- “Lp” pitch length

The pitch length is not always in the half-way between Le and Li, as it depends on the belt profile (V-type, flat, synchronous type…), on the substance or on the internal framework type. In any case, the indicated length is the pitch length. It is standardized according to defined pitches.

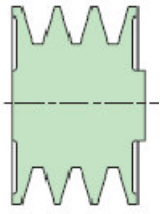


For example, “SPZ 1437” is a narrow V-belt of SPZ profile, with a pitch length of 1437 mm.

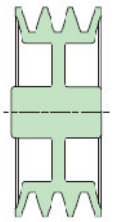
The pulley (1)

A **pulley** is a circular piece, allowing the movement transmission to the shaft. It is used with a belt or any other rope. In our case, the pulley carries out the contact between the belt and the hub or directly to the shaft. Three types of pulley are available: solid pulley, web pulley or arm pulley.

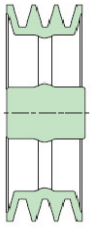
Solid



Web



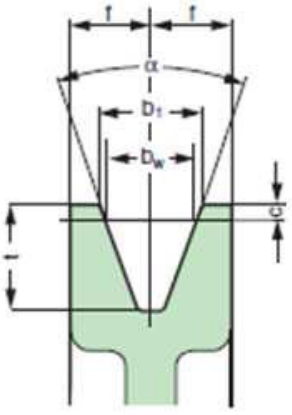
Arm



The pulley is characterized by 3 main parameters:

❶ Its **outside diameter** (called pitch diameter): the dimension is standardized according to defined pitches. (56,60,63,67,71…1600 mm)

❷ Its **associated type of belt** and **the number of grooves**: both parameters are defined according to the DIN2211 standard with dimensional characteristics linked with the associated belt types (SPZ, SPA or SPB for example). The motor and fan pulleys have a similar construction



Sections	SPZ [mm]	SPA [mm]	SPB [mm]
bw [mm]	8,5	11	14
b1 [mm]	9,7	12,7	16,3
c [mm]	2	2,8	3,5
e [mm]	12±0,3	15±0,3	19±0,4
f [mm]	8±0,6	10±0,6	12,5±0,8
t [mm] min.	$11^{+0,6}$	$13,8^{+0,6}$	$17,5^{+0,6}$

The pulley (2)

❸ The matched hub type (for pulley with removable hub), which is qualified by a number with several figures (between 4 and 6 figures) (see part *Removable hub*). It is normalized according to a pulley diameter, a belt profile and with different groove numbers.

A pulley will thus be indicated as for example :
* **"3*SPZ - 90 – 1610"** corresponding to a pulley with 3 grooves, for a SPZ belt, with a 90mm pitch diameter, mounted with a 1610 removable hub.
* **"2*SPA – 140"** corresponding to a pulley without hub, with 2 grooves, for a SPA belt, with a 140mm pitch diameter.

The removable hub

The **removable hub** (also called "Taper Lock") is the piece connecting the shaft (motor or fan) to the pulley. Thanks to its cone-shape, it is easy to string together and to dismantle the pulley. It is mounted on the pulley with 2 screws. If the hub is used on one side (motor side usually), it can be absent on the other side.

Its dimensions are normalized and characterized by:

❶ The reference normalized figures: from 1008 to 200170.

❷ Its bore, corresponding to the inside dimension.

A removable hub is calling, for instance:
"Hub 3535-90", which corresponds to a 3535 removable hub for a 90mm bore.

Ø pulley (in mm)	hub reference	Ø bore (in mm)	Grooves number
425	3535	90	3
			4
			5
	4040	100	6
	4545	110	8
	7540	75	2
	9560	95	3
			4
	10095	100	5
			6
	115105	120	8
			10
			12

An example of pulley diameter and associated hubs

The key

The **key** is a piece that allows the connection between two pieces in rotation. It is designed to break down if the torque is too high. It will be used as the link between the hub and the shaft or directly between the pulley and the shaft in case of pulley without hub.

Several types of key exist but most often, "parallel" or "disk" keys are used in ventilation.

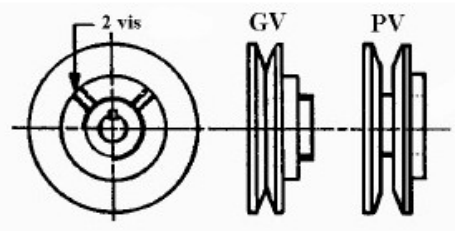
Disk key

Parallel key

Change of the drive (1)

The fan velocity is the result of the multiplication between the motor velocity and the drive factor. It is thus necessary to modify the drive if the goal is to change the operating point.

In some cases, fan or motor pulley can be adjustable. Such pulley has an attached flange and a loose flange. The distance between both flanges can be changed so that the pulley can go up or down in the groove. A change of the pulley diameter leads to a change of the fan velocity.

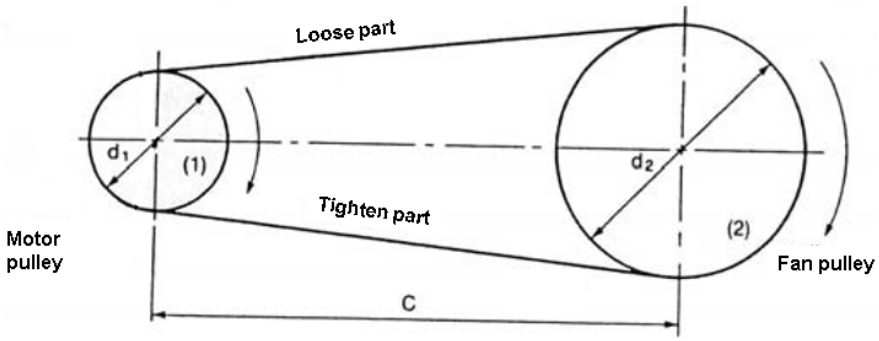


If this modification is not enough or if the pulley is not adjustable, a new design of the drive will be necessary (pulley modification and even sometimes belt modification).

Through a concrete example, steps for a new drive design are described below:

The fan casing operating point is 5000m3/h for 675 Pa as global pressure (static + dynamic) (point A) but the required operating point is 11000 m3/h for 800 Pa (point B) (see curve on page 5).

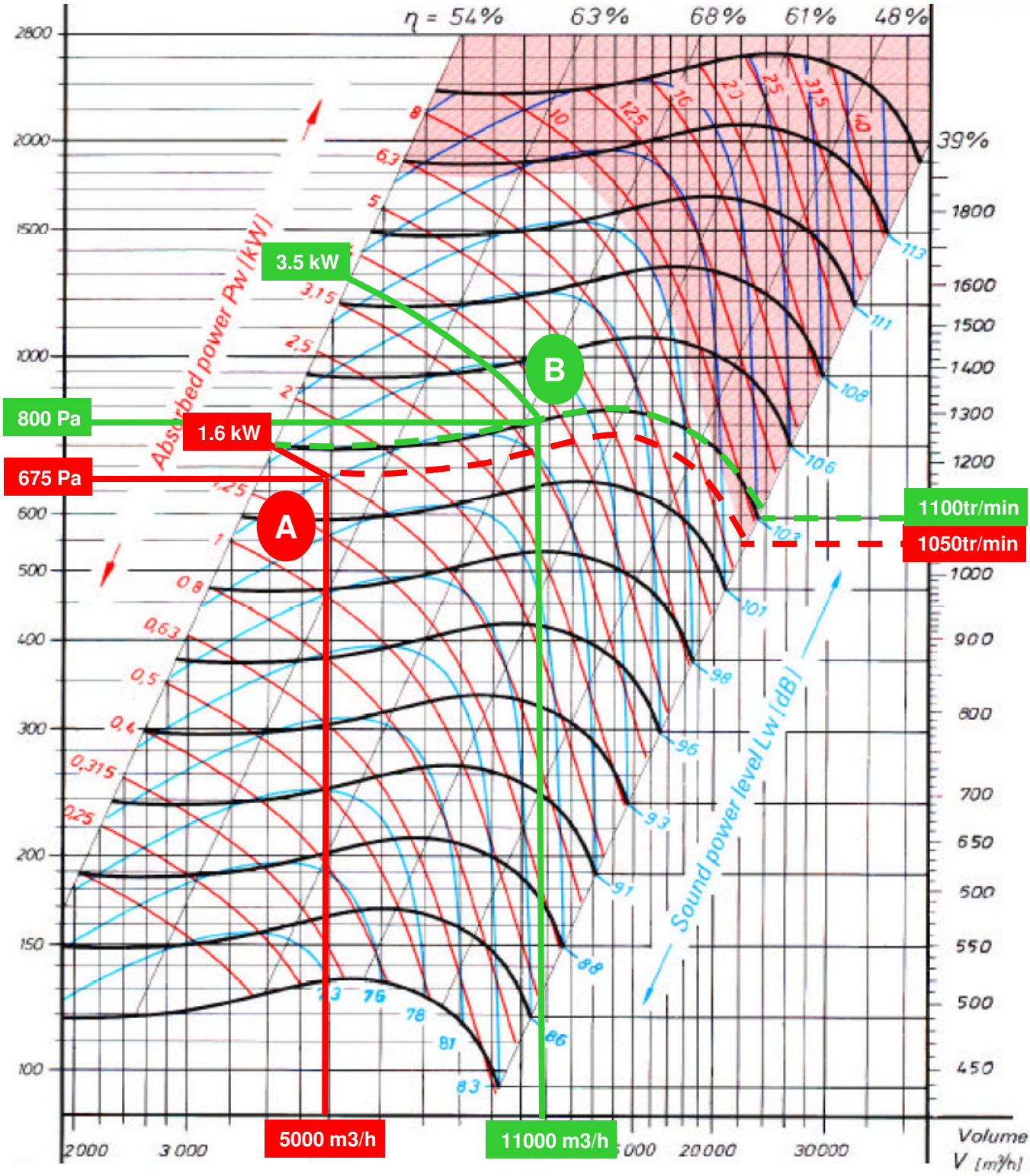
Below are the fan technical characteristics:
- Motor pulley 2xSPA - 132 => motor pulley diameter: d1 = 132mm
- Fan pulley 2xSPA - 180 => fan pulley diameter: d2 = 180mm
- Interaxial distance between both pulleys: C = 970mm.
- Belt SPA Lp = 2430mm
- Motor velocity: Vm = 1430tr/min
- Motor power: Pm = 4kW
- Fan velocity: V1 = 1050tr/min



❶ Place the new operating point (B point) on the supplier fan curve
Please, check on the Aldes ME Flash 10 (October, 2010 - *How to read a fan curve*) to support you on this step.

❷ Read the absorbed mechanical power
Read on the curve the absorbed mechanical power on the fan shaft.
In this example, the value is 3.5 kW.

Change of the drive (2)



Change of the drive (3)

❸ Compare with the indicated mechanical power of the motor

The absorbed power corresponds to the mechanical energy transmitted form the motor to the fan, through the belt drive. Because of the drive, energy losses are observed between the motor and the fan.
This energy loss is defined by the drive factor.

According to the motor power, the drive factor is approximately :

Pmot < 7,5 kW : 90 %
7,5 kW < Pmot < 11 kW : 92 %
11 kW < Pmot < 22 kW : 94 %
22 kW < Pmot < 30 kW : 95 %
30 kW < Pmot < 55 kW : 96 %
55 kW < Pmot < 75 kW : 97 %
75 kW < Pmot < 100 kW : 97.5 %

Thanks to the drive factor, determine the minimum mechanical power supplied by the motor. Check that this power is not over the motor indicated mechanical power. In this case, the minimum mechanical power is 3.8 kW (3.5/0.9 = 3.8), value under the motor power (4kW). So the current motor is adapted to the new operating point.

❹ Read the new fan velocity on the curve.

In this example, the result is: V2 = 1100tr/min

❺ Determine the new fan pulley diameter

With the new V2 velocity and the following formula $\frac{V2}{Vm} = \frac{d1}{d2}$, the new fan pulley diameter is d2 = 171.6mm.

Always choose the closest standardized diameter; here: d2 = 170mm.

❻ Determine the fitted length of the belt

While d2, d1 and C are known, it is possible to calculate the belt length as per the following formula:

$$L \approx 2*C + \frac{\Pi}{2}*(d2+d1) + \frac{(d2-d1)}{4*C}$$

In this example, L = 2415mm.
Always choose the closest standardized length above or beneath the calculated value. In this case, the belt SPA 2400mm should be selected

In summary, the new belt drive is :
- Motor pulley: 2xSPA – 132 (unchanged)
- Fan pulley : 2xSPA - 170
- Belt SPA: Lp = 2400mm
- Interaxial distance: C = 970mm (unchanged)
- Motor velocity: 1430 tr/min (unchanged)
- Fan velocity: 1100 tr/min

Belt drive maintenance

A belt drive needs an adapted setting while the first use as well as a regular maintenance in order to keep the best performances.

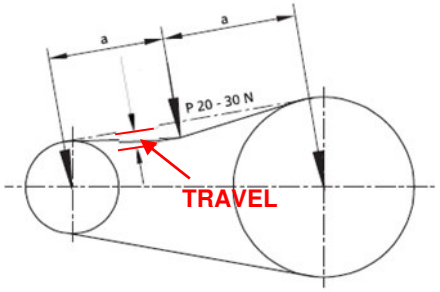
Several checks have to be done :

❶ **Control the aligning of both pulleys**, which can run out the belt if this is not correct.

PARALLEL NON ALIGNMENT | ANGULAR NON ALIGNMENT | ANGULAR AND PARALLEL NON ALIGNMENT

❷ **Control the belt tension**.

- A too low tension can cause a temperature rise of the belt and an early run out.
- A too high tension increases the stress on the bearings.



Use a dynamometer that measures the applied force and the associated travel in the belt center. Check that the travel is not over 15mm for a 20-30N applied force.

On some belts, 2 printed lines on the belt are used as measurement reference points. Dynamometer use can be avoided. The tension setting will be done by measuring the distance between both lines (this is the case for Aldes CYCLONE fans). This distance should correspond to the length value printed on the belt.
If the measured distance is too small, that means the belt is not tight enough.
If the measured length is too high, the belt has to be released.

How to dismantle & assemble a pulley and a removable hub

To dismantle a pulley :

- Release the belt.
- Get it out from the pulley groove.
- Take off both screws (2) which held the pulley on the hub.
- Insert one screw (or both) in the pulley free bore (1) and tight it, until the pulley moves away from the hub.
- Remove the hub and the pulley from the shaft.

To assemble a pulley :

- Insert the pulley and the hub on the shaft.
- Assemble the pulley with its hub. Align both holes (hub and pulley) and put the screw in the hole without tightening it.
- Move the hub and the pulley to the closest shaft from the motor or from the fan (in order to avoid the lever stress) and align them.
- Tighten screws in a regular way and fix them.