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Informa Manual

The flat belt drive compared to the V-belt drive

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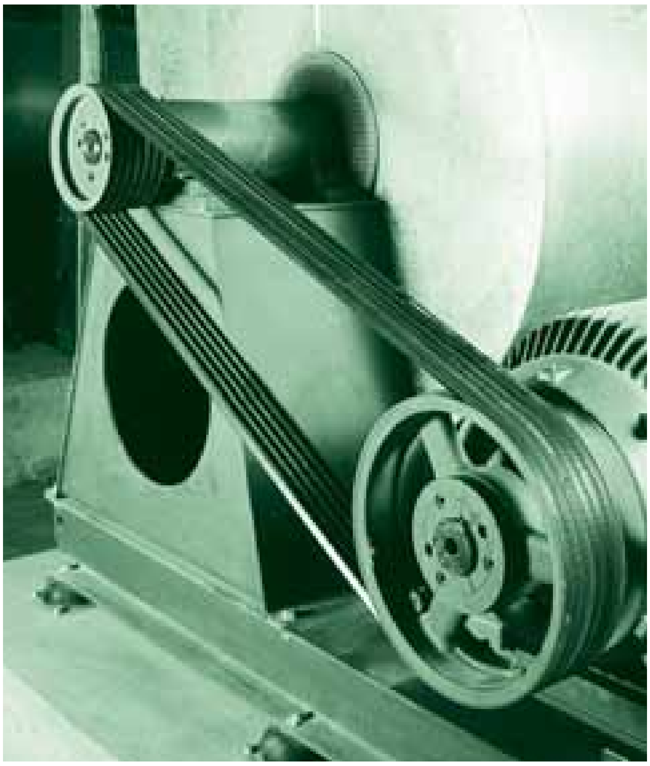
The flat belt drive

The V-belt drive



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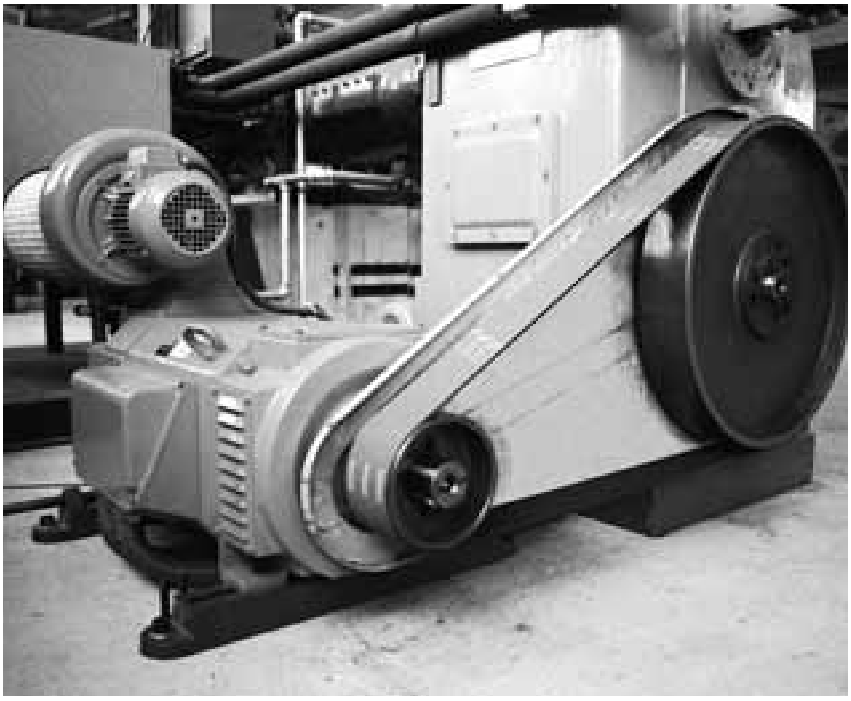
Introduction
Belt drives have always provided the simplest means of transmitting power over long center distances.

In former times
In the 19th Century, when power from a single energy source (such as a steam engine) had to be transmitted to many smaller users, i.e. machines, the line shaft was the best solution.

Today
Nowadays, single drives are primarily used since small, high performance motors are readily available.



The same enormous progress made by drive units in the past one hundred years has also been made by the power transmission element, the flat belt. There are many different types of belts available today, and among them, **the modern, fully synthetic, Habasit flat belts**.
Comparing the leather flat belt of the 19th century with today's high efficiency or Armid flat belt is like comparing the solid rubber tires of that era with today's high performance racing tires.

1. The Habasit flat belts

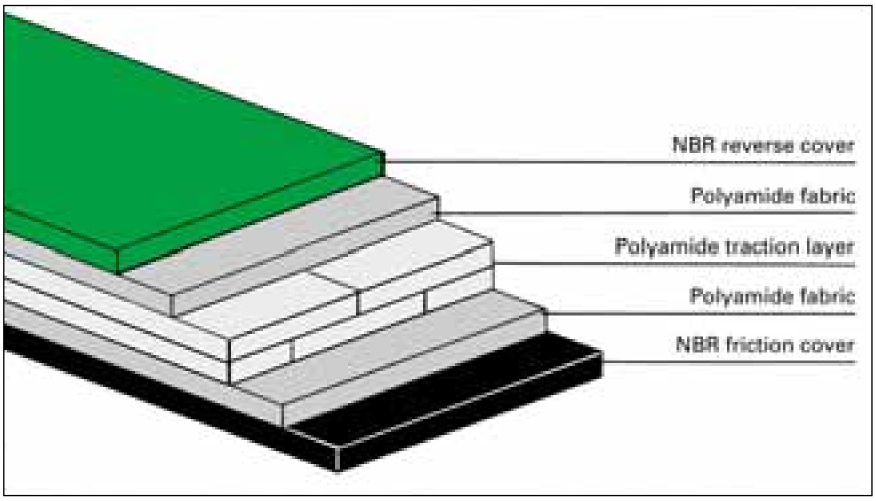
1.1 The polyamide high efficiency flat belt

The polyamide flat belt used today is a highly developed drive element manufactured with state-of-the-art-technology, suitable for applications in all areas of mechanical engineering. Its high performance capability is derived from the superior properties of modern synthetics.

1.1.1 Belt design

The Habasit polyamide high efficiency flat belt has a traction layer made of highly oriented polyamide with two covers of elastomer (NBR = acrylo-nitrile-butadiene rubber) and one intermediate layer of polyamide fabric on each side. The traction layer absorbs the forces exerted on the belt when power is transmitted.

The friction cover ensures that the peripheral force acting on the belt pulleys is transmitted to the belt and vice-versa.

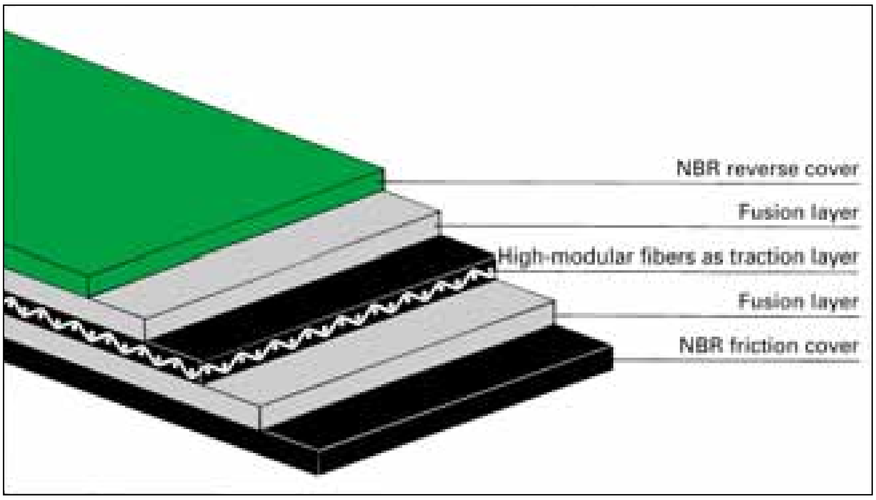


1.2 Belts with traction layer made of high-modular fibers

Armid and TC-belts have been developed for meeting specially high requirements and they supplement the polyamide flat belt. They are designed for use where small pulley diameters are a must, it runs smoothly, with precise angular velocity, under extreme climatic conditions (great temperature and relative humidity of air fluctuations), and with controlled and average starting behavior.

1.2.1 Belt design

The traction layer of Habasit Armid and TC flat belts is made of a high-modular fiber fabric (Aramid, Polyester) of extremely high tensile strength. This fabric is imbedded in a thermoplastic layer and covered by two layers of NBR elastomer – similar to the polyamide flat belt design.



1.3 Chemical and electrical properties

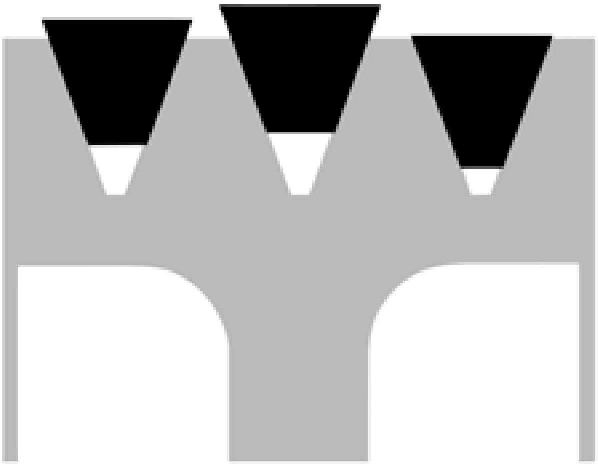
Thanks to the completely synthetic construction, Habasit flat belts are resistant to oil, fats and most chemicals used in industry.

Habasit flat belts are antistatic and almost all belt types comply with the stringent safety requirements for operation in explosive environments.

2. Fundamental differences between the V-belt drive and the flat belt drive

The differences between the V-belt drive and the flat belt drive are shown schematically in the illustrations below.

The V-belt drive

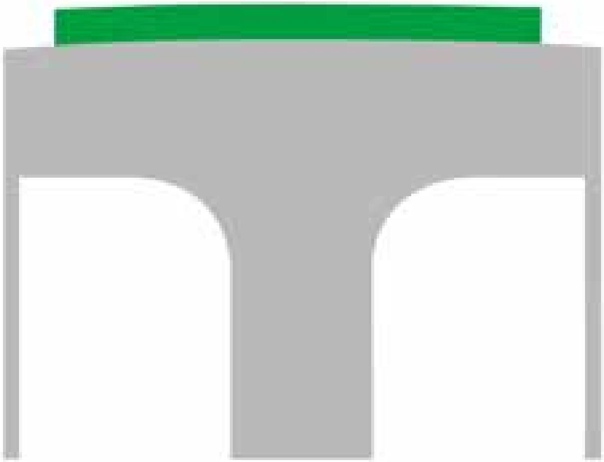


☐ Frictional engagement between the lateral wedge surfaces of the belt profile.

☐ Large bending cross-section, large mass.

☐ Different effective diameters and thus varying speeds of individual belts.

The flat belt drive



☐ Frictional engagement on the outer pulley diameter.

☐ Small bending cross-section, small mass.

☐ Precisely defined effective diameters across the belt width and therefore exact speeds.

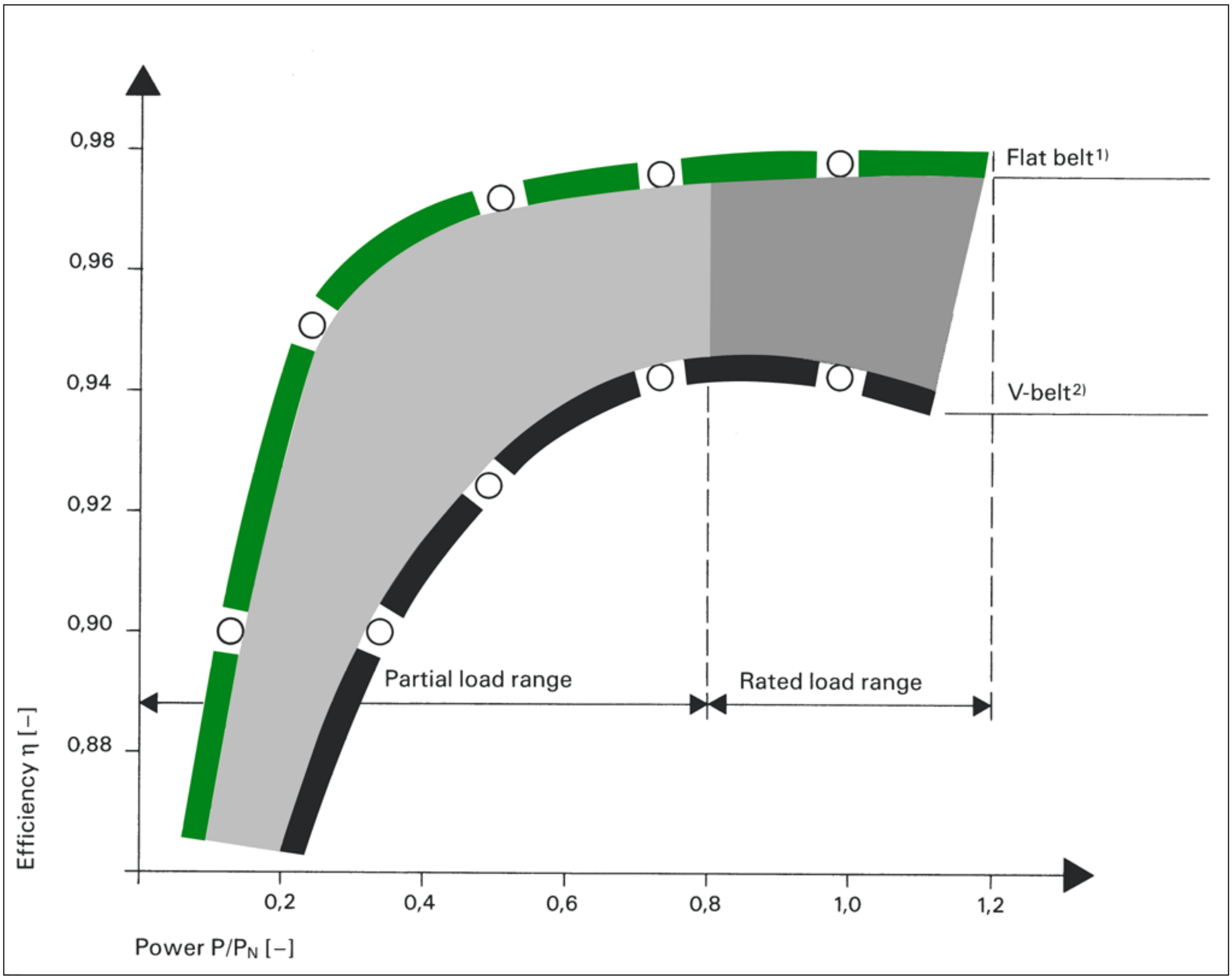
These system-based differences result in some advantages in favor of the flat belt drive which we shall discuss hereafter.

3. The advantages of the flat belt drive compared to the V-belt drive

3.1 Efficiency and energy savings

The small bending cross-section of the flat belt causes little bending loss and only slight deformation work (flexing work). This fact, together with even running and the absence of pulley wedge effects, leads to a higher flat belt efficiency as opposed to the open-flank, toothed spacesaver V-belt, in spite of the fact that the spacesaver belt referred to herein is the most efficient among the various types of V-belts.

Measurements taken at the Federal Corporation for Material Research and Testing in Berlin (BAM) in this context showed the following relationships:



[1] Armid flat belt TP-22 and polyamide flat belt S-140H, both pulleys d = 80 mm
[2] 4 SPA belts, both pulleys d = 80 mm

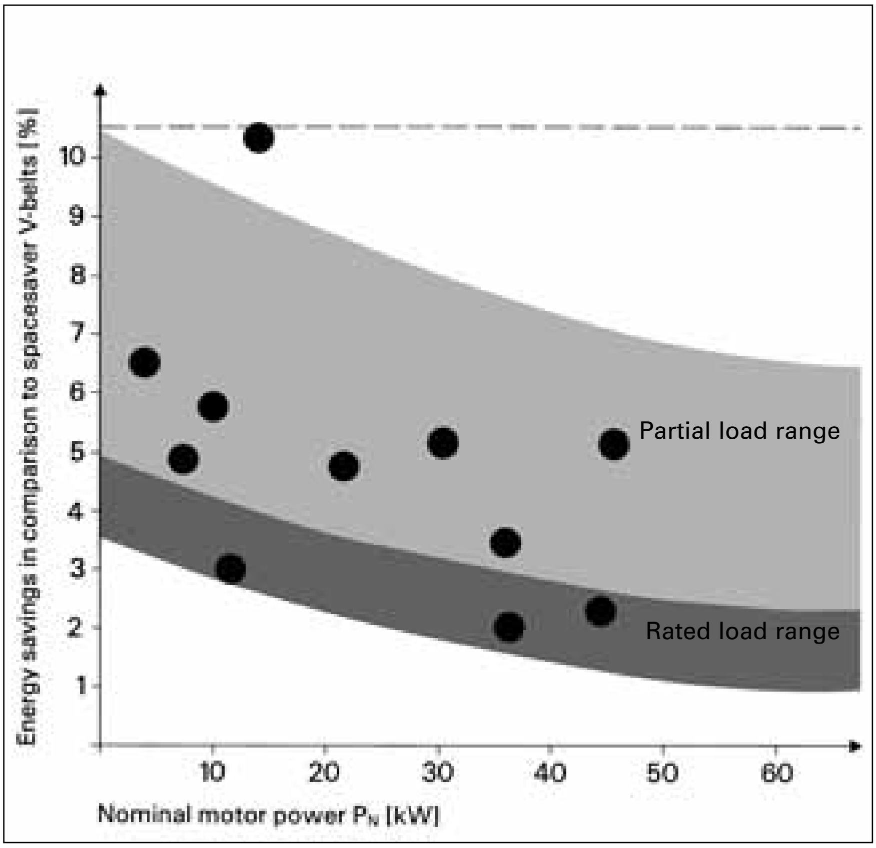
This illustration shows a significantly higher flat belt efficiency across the entire operating range than that of the narrow V-belt. The maximum efficiency attained by the flat belt is 98%.

As the load decreases, there is an increasingly marked difference in efficiency in favor of the flat belt which is about 3.5% in the rated load range and may be as high as 10% in the partial load range.

This gain in efficiency also leads to corresponding savings in energy compared to the spacesaver V-belt - a fact that has been proven during practical trials with fan belts. For details, see the illustration on the right.

The percentage of energy savings achieved during practical trials fairly match the gain in efficiency represented in the previous graph. As pulley diameters tend to increase with increasing capacity, the bending losses of V-belts decrease and the percentage of energy savings declines. As a prerequisite for these field trials the fan speed of the test installations had to be exactly maintained for both the V-belt drive and the flat belt drive.

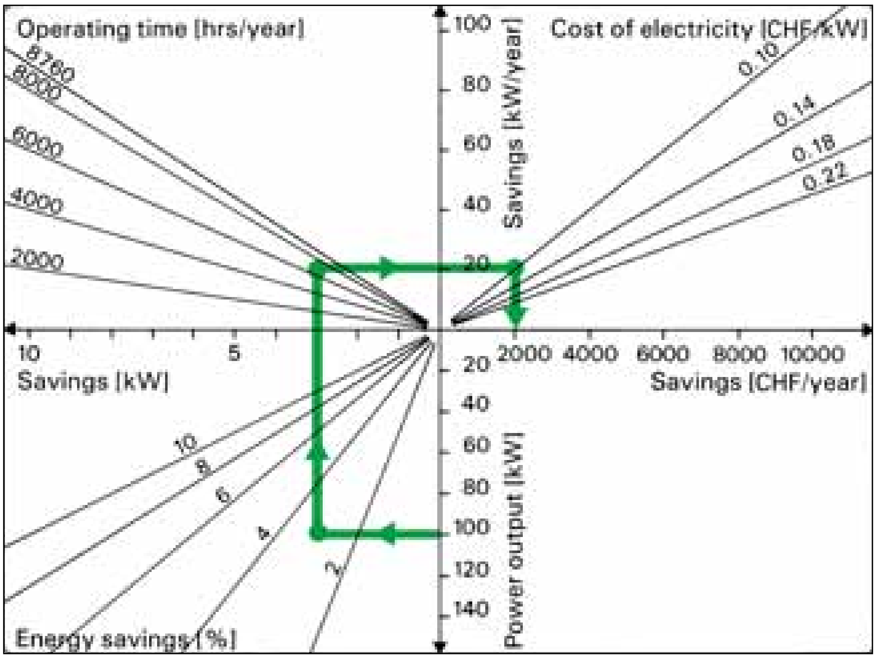
It also has to be borne in mind that V-belts were correctly tensioned according to instructions. Improperly tensioned, or wobbling V-belts produce substantially higher losses, as shown by the example outside the grey zone (see graph on the right).



● Various fan drives in the ventilation industry

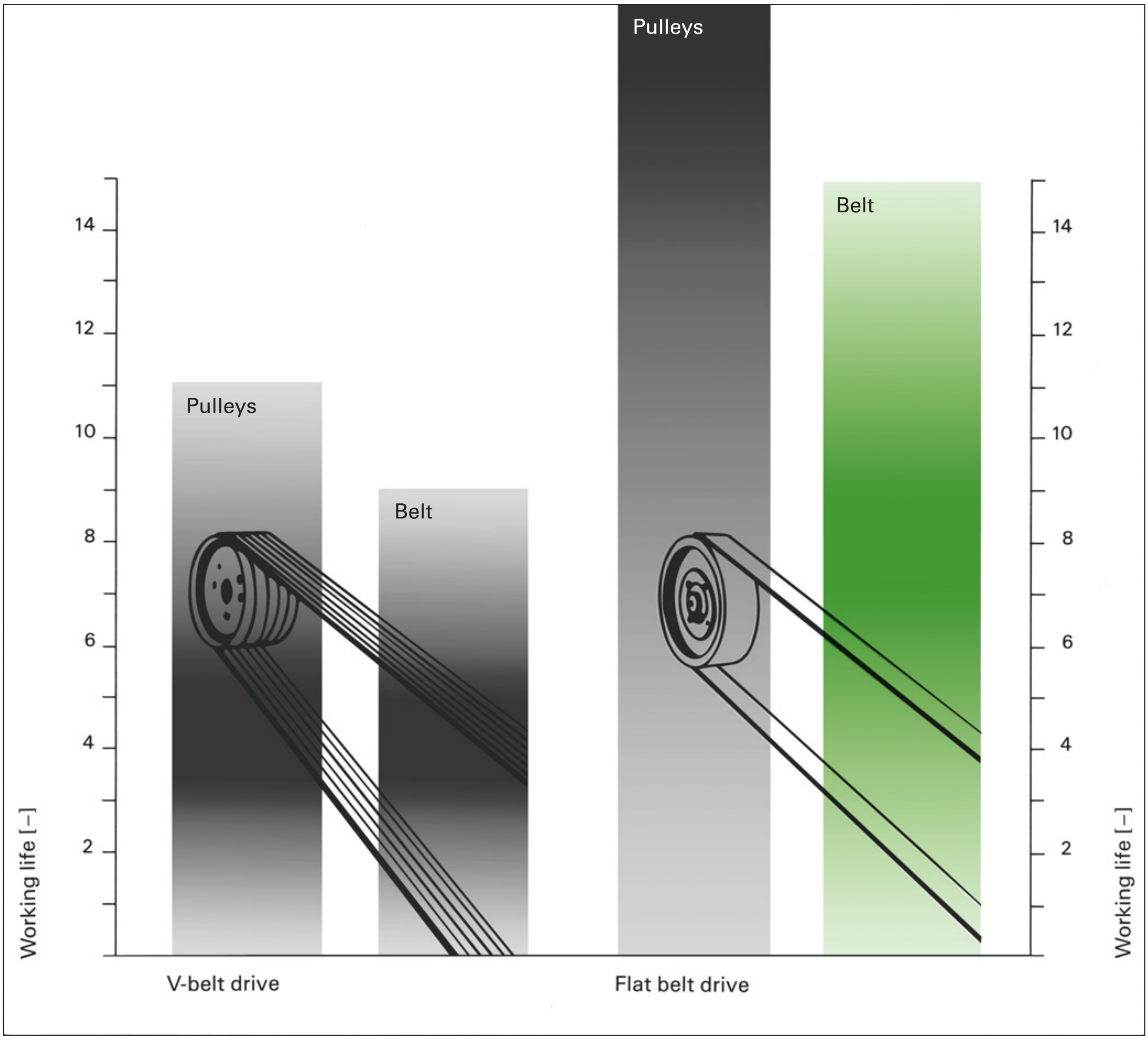
The graph on the right provides a simple overview of these interrelationships.

It shows, for instance, that a power output of 100 kW and an energy reduction of 3% over a yearly operating time of 7200 hours (300 days), at an electricity unit price of 0.1 CHF / kWh, will result in a cost reduction of 2160 CHF



3.2 Service life
As with the flat belt drive, the belt is frictionally engaged on the outer pulley diameter, not on the lateral wedge surfaces as in the case of the V-belt drive, owing to the system design, the wear on the belt and pulleys is consequently less. Also, if several V-belts run on one drive, they wear unevenly due to production allowances. The illustration below provides a qualitative comparison of the Service life of pulleys and belts with flat belt and V-belt drives working under comparable operating conditions.

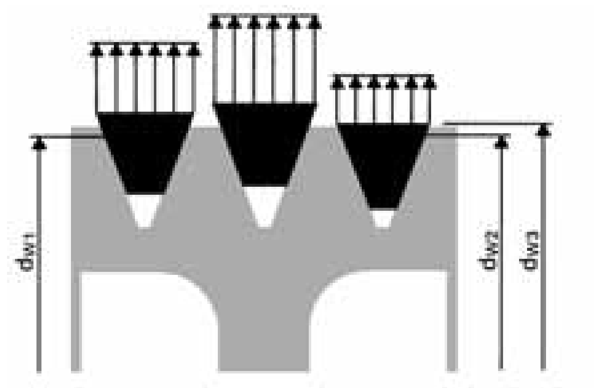
Qualitative comparison of service life
This graph clearly shows that – under similar working conditions – the service life of a flat belt drive will be two to five times longer than that of a comparable V-belt drive.



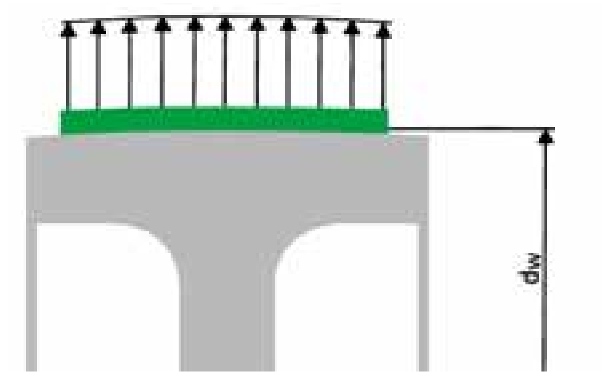
3.3 Minimal maintenance
Flat belts keep their uniformly high tension force throughout their service life and thus need no maintenance, whereas V-belts have to be checked and retensioned from time to time. In other words, once a flat belt drive has been correctly installed, it is maintenance-free (apart from usual control checks) and guarantees constant power transmission during its entire service life.

3.4 Smooth running

In contrast to flat belts which are characterized by a uniform distribution of tension over the entire belt width, V-belts have the disadvantage that the tensions in the individual belts are unevenly distributed due to different effective diameters which are brought about by unequal wear on the belt and pulleys as well as manufacturing tolerances. Such belt tensions lead to vibrations and fluttering, uneven and noisy running. The consequences are premature bearing damage – a damage that will never occur with a flat belt drive. For a comparison, refer to the following illustrations.



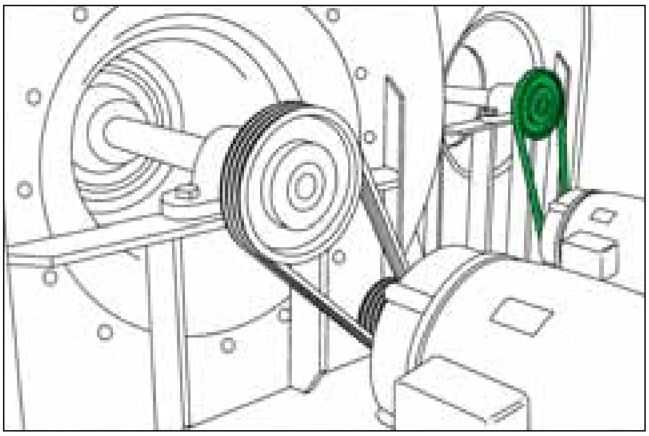
- ☐ Differences in the effective diameter ➔ $d_{W1} \neq d_{W2} \neq d_{W3}$.
- ☐ Uneven distribution of tension across individual belts.
- ☐ Unequal speed conditions in individual belts cause tensions, vibrations and fluttering.
- ☐ Vibrations cause premature bearing damage.



- ☐ Precisely defined diameter d_W across the entire belt width.
- ☐ Even distribution of tension across the entire belt width.
- ☐ Smooth running as a result of exactly defined speed conditions across the entire belt width, even at high speed.
- ☐ Smooth running assures longer bearing life.

3.5 Abrasive properties

Habasit high efficiency flat belts are particularly well suited for applications where the rubber wear of belt drives is to be reduced – a particularly important aspect for clean-room conditions – and to prolong the service life of individual components. To determine the abrasion of comparable V-belt and flat belt drives (fan drives), tests were made at the HTL Brugg-Windisch over a period of 230 days. The operating time of the fans during this time was 2200 hours, with 220 start-ups. Weight measurements of the belts at the beginning and at the end of the test showed a weight loss of 12.13 g for the V-belt set (4 pieces), i.e. 1.82% of its initial weight, whereas the flat belt showed a weight loss of 1.12 g, i.e. 0.69% of its initial weight. For the soiling rate of the installation, and especially of the filter, the absolute weight of the abraded material is decisive; in the case of the V-belt, it was higher than that of the flat belt by a 10:1 ratio.



Operating hours:	2200 h
Number of start-ups: (star-delta type starts)	220
Pulley diameters:	160/250 mm
Wear of V-belts: (4 belts)	**12,13 g**
Wear of Habasit high efficiency flat belts:	**1,12 g**

3.6 Installing/tensioning

Whereas V-belts are often tensioned somewhat haphazardly, i.e. until the individual belts no longer wobble, flat belts can be installed very simply and securely. Belts are tensioned to the calculated initial tension by means of simple measuring marks to be applied to the belt, or with an initial tension measuring device. Calculated values must be adhered to exactly.
Shaft loads caused by tensioning a flat belt amount to approx. 1.5-2.5 times the peripheral force and are thus comparable to the shaft forces of a correctly tensioned V-belt in accordance with specifications.

A comparison of the two manners of tensioning in the V-belt drive and the flat belt drive is shown below:

As a rule, a V-belt is tensioned like this

This is how a flat belt is tensioned

4. Cost effectiveness

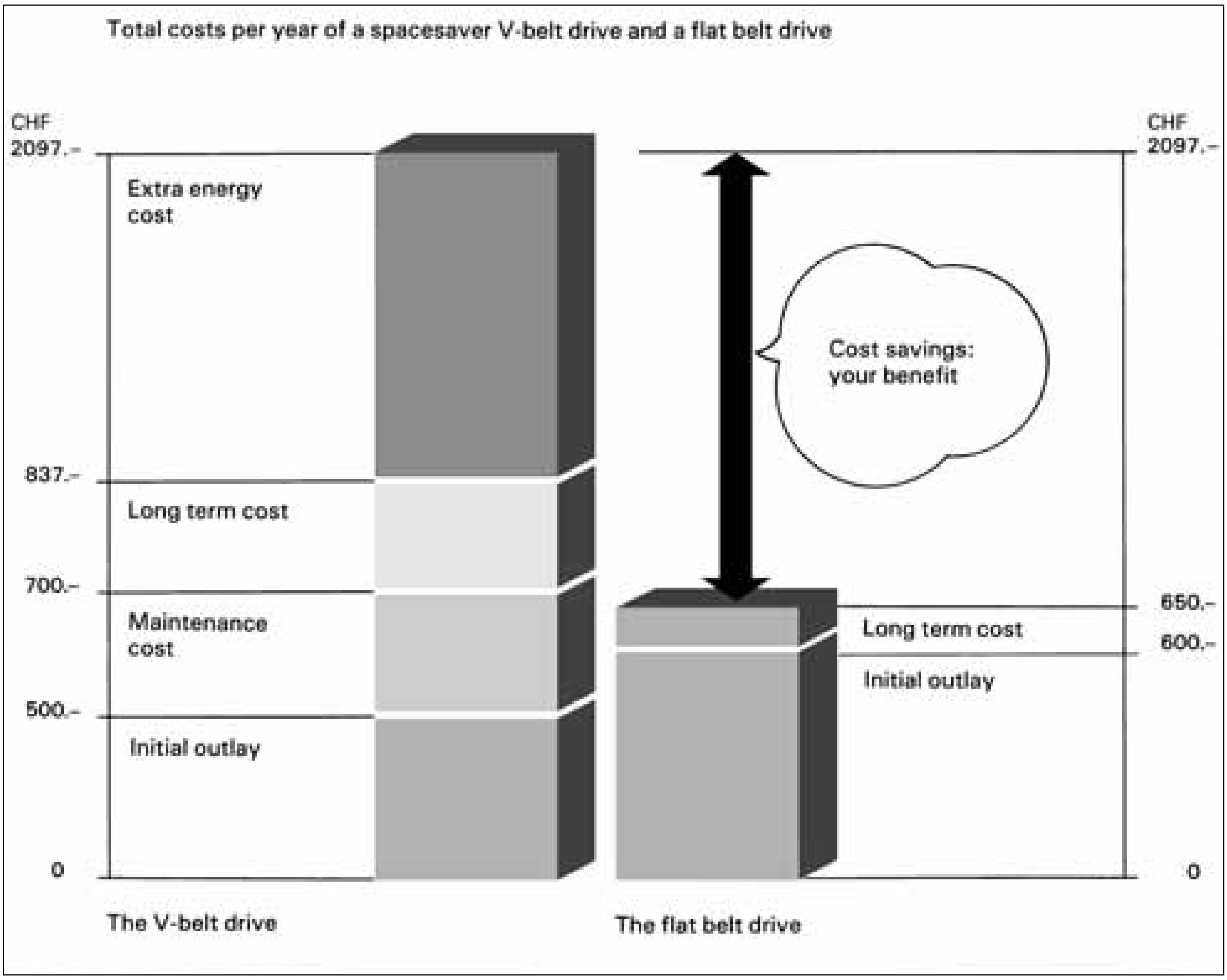
In assessing which drive system is the more economic in the long term, the following aspects have to be taken into account:

– initial outlay
– maintenance costs
– service life
– energy savings

Based on the advantages discussed in section 3, the example below clearly shows the greater cost effectiveness of the flat belt drive compared to the V-belt drive.

Example: Belt drive; motor rated output: 75 kW; operating hours: 6000/year; life expectancy: 10 years

☐ Initial outlay:	market prices; pulleys 80%, belts 20% of system price
☐ Maintenance costs:	V-belt drive: 2 h/year at CHF 100.–; flat belt drive: negligible
☐ Long term costs:	Cost of spare parts distributed over 10 years
☐ Energy costs:	3.5% energy savings with partial load operation at 50 kW; electricity unit cost: 0.12 CHF/kWh



It makes sense to refit existing V-belt drives with flat belts since they are paid off within one to two years, depending on the drive size.

5. Examples of application

Due to their excellent properties and reliability, Habasit flat belts are successfully applied in all lines of mechanical engineering.

The following examples have been randomly selected to provide a general overview of the versatility of the Habasit flat belts.

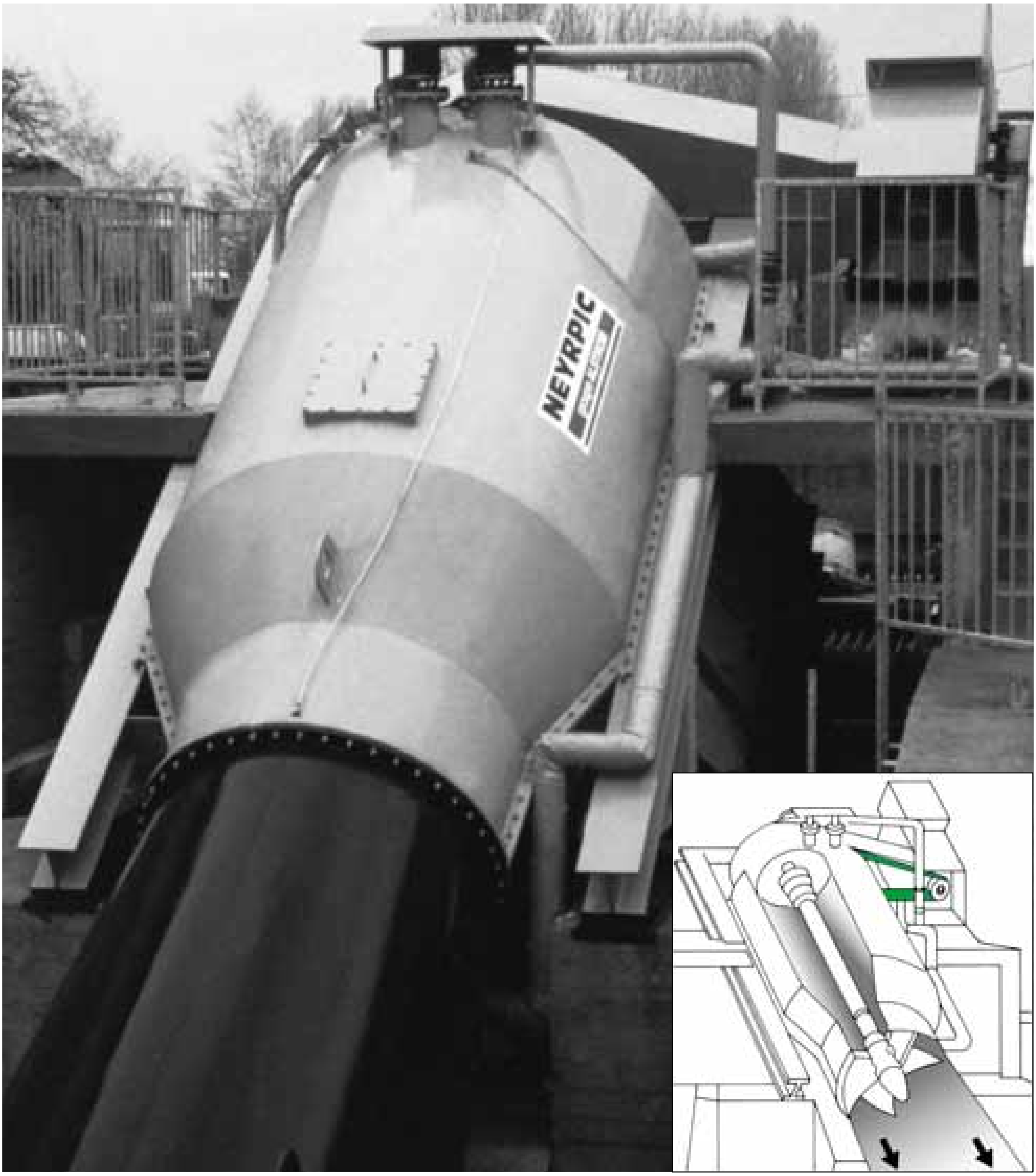
5.1 Fans in the ventilation industry

Since fans are generally operated for long periods of time, flat belts can prove especially economical because of their high efficiency and maintenance-free operation.

In the case of axial ventilators, where the flat belt runs directly in the air stream, its resistance to wear is an added advantage because there is practically no abrasion (particles) and consequently no additional strain on the air filter system. Whenever a high standard of clean air is required the flat belt has special advantages.

Low-noise fans with Habasit flat belts operate more quietly than those fitted with conventional multi-V-belt drives. In other words, they only achieve maximum noise reduction in conjunction with the flat belt drive system.

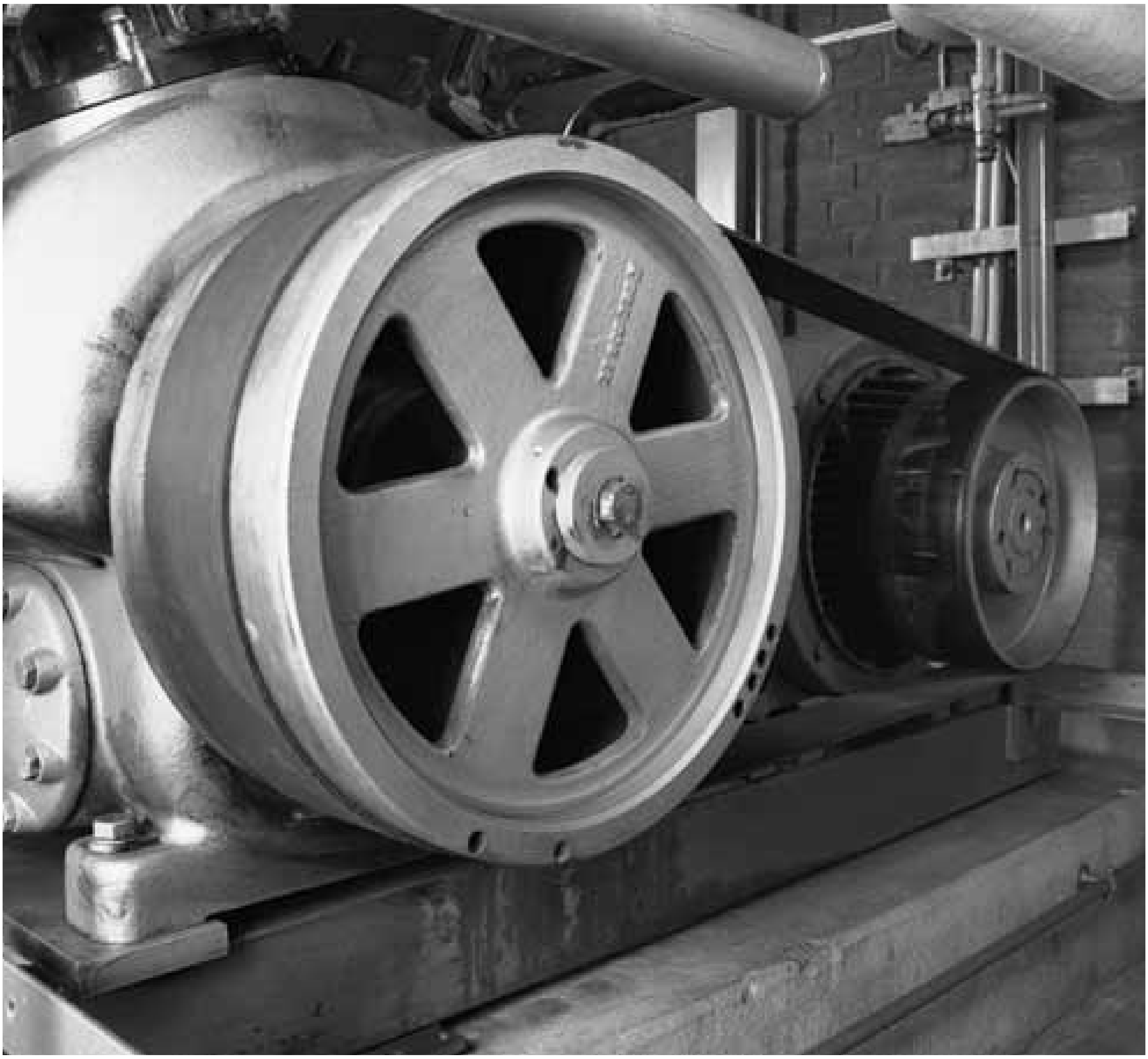
5.2 Generators for hydroelectric power plants



In modern hydroelectric power plants, flat belts are also increasingly used with turbine generator power transmissions.

Thanks to the absolute reliability of the Habasit flat belt as a power transmission element, outputs of 1500 kW can be achieved in hydroelectric power plants without problems – in spite of the customary fluctuations in temperature and air humidity. It is a special advantage that in such plants Habasit flat belts can be joined on the spot. In many cases high installation cost will, therefore, be avoided.

5.3 Compressors



The impacts typical for piston compressors are allayed by the elastic power transmission of polyamide flat belts, thus sparing the shaft bearings. The impressively smooth, low-oscillation running behavior, even at high speed, is the result of uniform load distribution across the entire width of the belt which has the direct consequence of a longer belt life. For larger compressors with long operating times, the high efficiency of flat belts can lead to significant savings in energy costs.

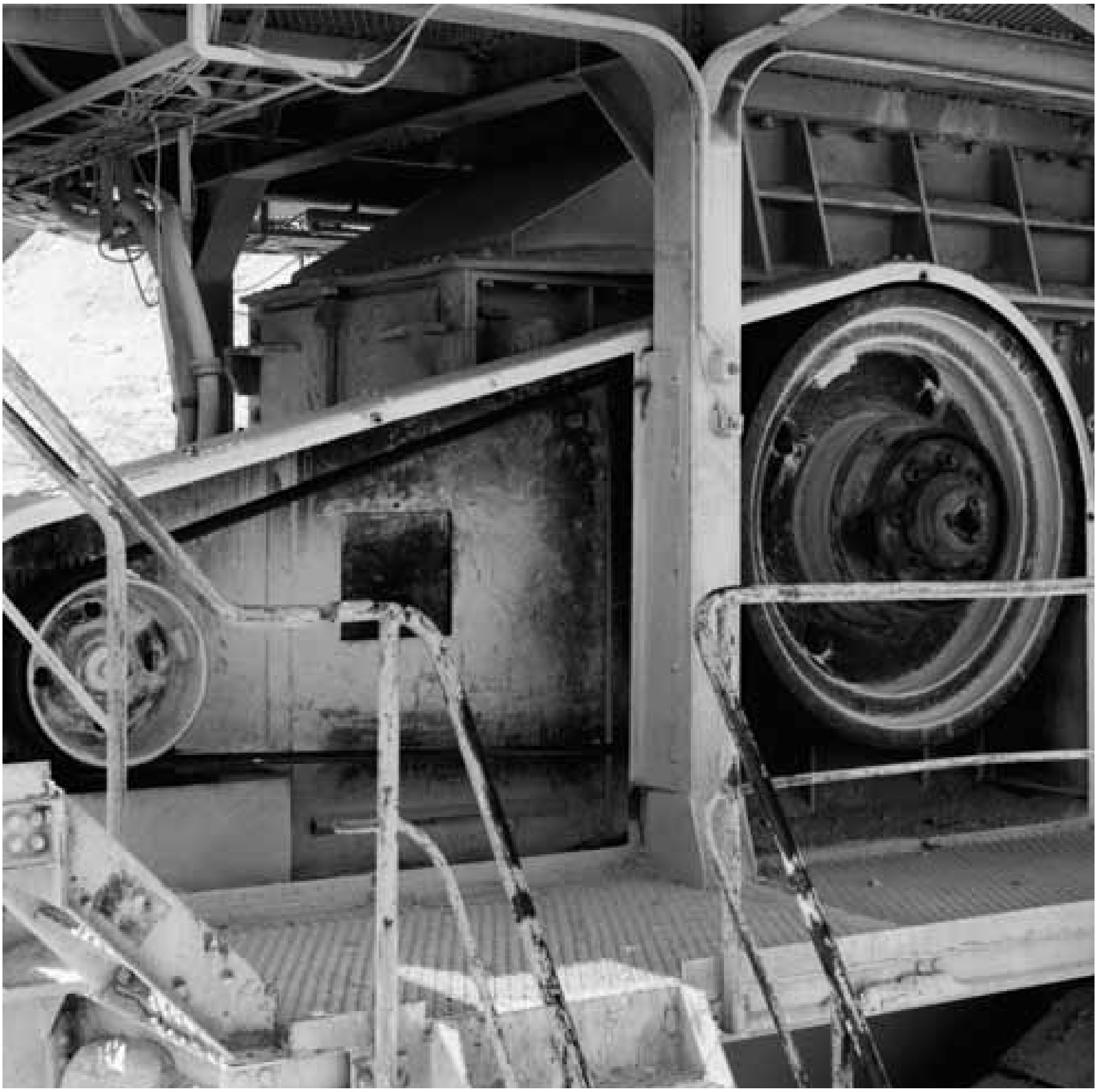
5.4 Milling machines for the tooling industry
The high spindle speeds of certain milling machines produce belt speeds of up to 100 m/s. Under these conditions, only flat belts can transmit the full motor power. At the same time, the smooth running of the belt ensures a very uniform spindle rotation and thus a very clean cut.

5.5 Sliding lathes for the tooling industry
In the case of sliding lathes, the workpiece bar guided by the headstock is accelerated to the number of revolutions suitable for processing.
To achieve both surface finish quality and workpiece precision, a vibration-free power transmission is of decisive importance. This is why flat belts are predominantly used in this field.

5.6 Rotary printing presses in the graphic trade

The high quality standards of today's printed products – which are taken for granted – are based on the sophisticated technology of modern printing presses. In particular, the constancy of rotation and accuracy of register are absolutely essential, which means that press-cylinder drives also have to meet the most stringent requirements. Since the effective diameter of flat belt drives is precisely defined and remains unchanged during operation, a preset transmission ratio will be accurately maintained, independent of speed and load.
To reduce to a minimum the natural belt vibration, which might cause even slight angular velocity oscillations, Habasit Armid flat belts with a high modulus of elasticity are used for this application.

5.7 Stone crushers for mining and ore extraction



In the punishing world of stone crushers, only robust components can take the strain – the ideal environment for Habasit high efficiency flat belts. The 200 kW flat belt drive shown above is running in a quarry under the toughest operating conditions, to the full satisfaction of the client.

Antriebs-, Transportelemente
Eléments de transmission, de transport
Power transmission, conveyor belts
Elementos de transmisión, de transport
Elementi di trasmissione, di trasporto
Elementos de transmissão, de transporte
Aandrijf-, transportelementen
Transmissions-, transportelement
Voimansiirto-, kuljetuselementit
Kraftoverførings-, transportelementer
動力の伝達及びコンベヤーの原理

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