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INDUSTRIAL PLANTS

Chapter nineteen:

Belt conveyors – First part

DOUBLE DEGREE MASTER IN

“PRODUCTION ENGINEERING AND MANAGEMENT”

SEAT OF PORDENONE

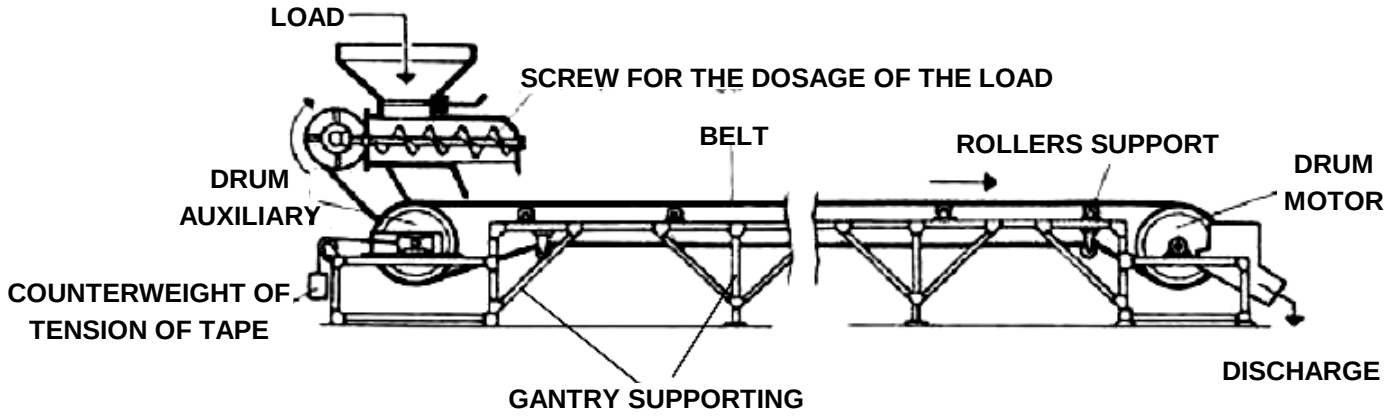
UNIVERSITY OF TRIESTE

Generality

The **belt conveyors** produce a transporting continuous, in horizontal or in sloping of bulk materials and light concentrated loads.

The main elements that constitute the belt conveyor are:

- belt of conveyor;
- series of rollers of support the upper and lower;
- drum motor with coupled the motor group through a reducer;
- drum of postponement or auxiliary with counterweight to the belt tension;
- metal gantry supporting.



Generality

There are different types of tapes in relation to the possible uses of the conveyor.

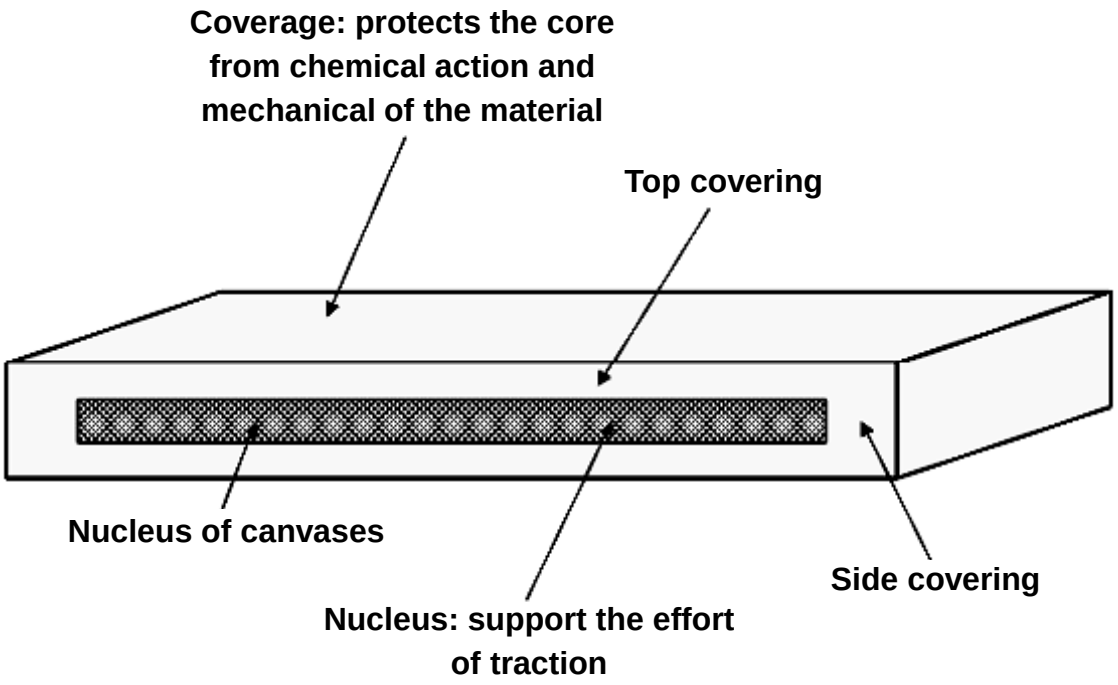
They differ in particular:

- tapes of canvas and rubber;
- tapes in natural and synthetic fiber;
- tapes in steel;
- tapes in metal mesh.

Generality

The **tapes of canvas and rubber** are constituted by "a structure of rubber and fabric in the shape of ring-closed belt, with junction vulcanized or metal, used for the transport of various materials".

The structure of a tapes of canvas and rubber used for this type of carrier is:



Generality

The core of the tape is constituted by the superposition of two or more canvases, the number and the physical characteristics, such as the quality and thickness of the rubber covers, are chosen on the basis of the stresses to which the tape will be subjected and to the characteristics of the material transported.

The rubber covers have four degrees of coverage (M, N, P, Q) with specific tensile strengths and elongations decreasing percentages for both the light conveyor and not. The minimum mechanical properties of the cover rubber are as follows:

Degree of quality or coverage	Resistance to tensile		Resistance to abrasion
	Load of breaking (N/mm^2)	Elongation (%)	Chainge of volume (mm^3)
M	25	450	≤ 125
N	20	400	≤ 150
P	15	350	≤ 200
Q	10	300	≤ 250

Generality

The resistance at break for traction of the core and the elongation in the longitudinal direction are the following:

Load of breaking minimum (N/mm)	
In the longitudinal direction	In the transverse direction
157	62
196	78
245	98
309	122
392	157
490	Elongations ≤4% to the reference load = 1/10 of the breaking load ≥ 10% to the breakling load
617	
784	
980	
1225	
1570	
1960	
2450	

Generality

The widths of the tapes of rubber and canvas are unified and are equal to 300, 400, 500, (600), 650, 800, 1000, 1200, 1400, 1600, 1800, 20000, 2200, 2400, 2600, 2800, 3000 and 3150 mm.

These types of tape are used for the transport of bulk materials, especially if they must be overcome of the different levels (not to exceed the coefficient of friction of the material on the tape) and for temperatures of the material not exceeding the 100-120°C.

Generality

The **belt conveyors in steel** are used for:

- temperatures above 100-120°C;
- handling of abrasive materials;
- feeding of pieces and details of small and medium size to more workstations.

The materials used, which must possess a high tensile strength and elongation negligible, are essentially:

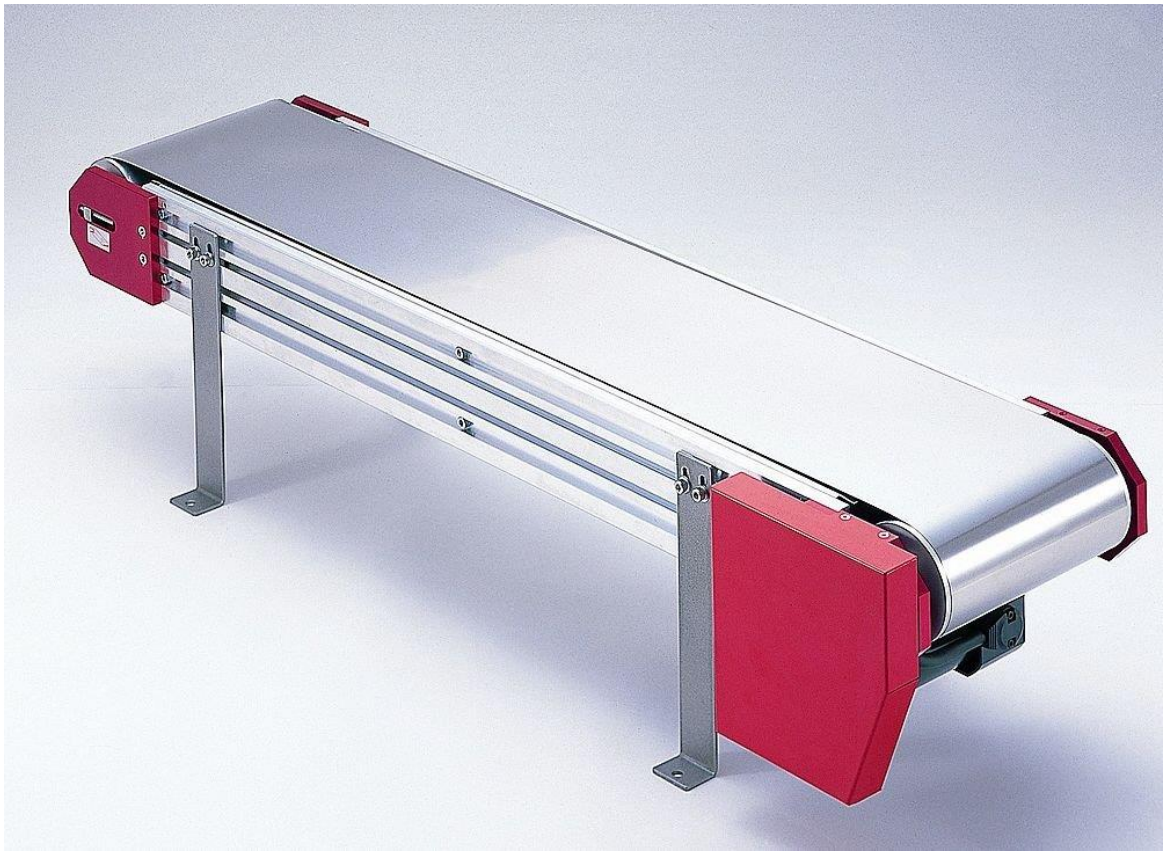
- stainless steels;
- carbon steels.

The characteristic parameters of the belt conveyors of stainless steel are:

- thickness of the sheet: 0,8 - 1,2 mm;
- width of the tape: 0,2 - 1,2 m;
- maximum speed: 0,6 - 1 m/s;
- diameter of the pulleys: 100 times the thickness of the tape;
- coefficient of adhesion: μ = 0,1 (0,2 if the drum is coated of rubber).

Generality

Belt conveyor steel

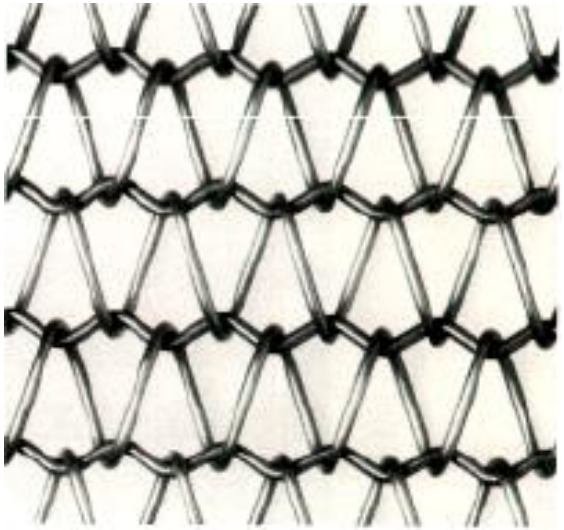


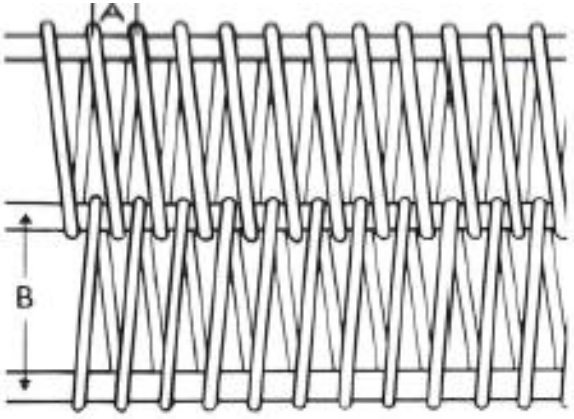
Generality

The belts of wire mesh are used for:

- temperatures up to 1000°C;
- movement of materials inside of dryers, coolers etc. as they allow the landscape of the air also from below and have an effective heat exchange.

The conveyor belts are made of metal mesh wire or metal flat; concatenated with particular forms which constitute a flat fabric, load-bearing and very flexible.





A: step of the spiral; B: step of the traverse

Generality

The belts of conveyors are produced in:

- stainless steels;
- special steels resistent at the temperatures;
- carbon steels;
- carbon steel zincates.

The elements to be collected for assessing a satisfactory performance are:

- quality of material (at example utilized of: inox steel 304);
- width of the tape;
- length.

The networks of stainless steel (NiCr) withstand temperatures up to 1000°C.

The manufacturers provide data concerning the resistance at traction of the wire mesh as a function of temperature.

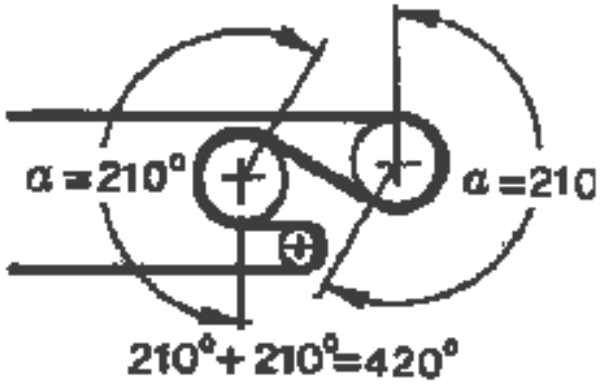
The diameter of the pulleys is assumed to be equal to 20-25 diameter of the wire.

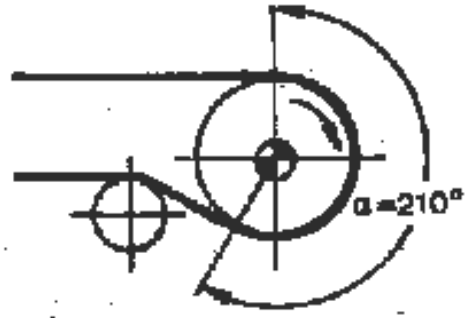
The main problem that you can have is related to adhesion between the belt and the rollers-pulleys.

Generality

The adhesion between belt and drum can be improved:

- choosing suitable materials for belts and drums;
- increasing the angle of adhesion;





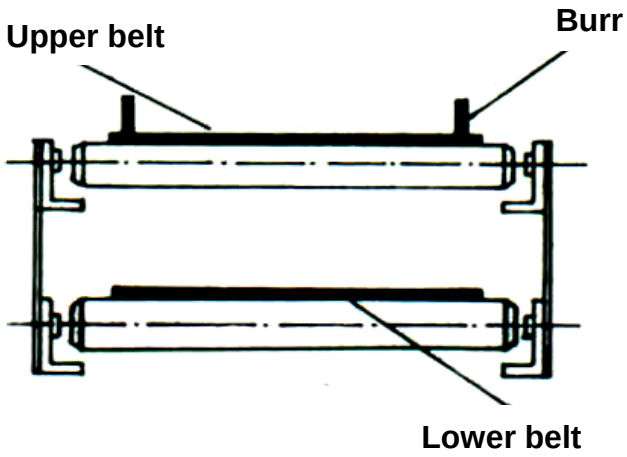
- adopting a tensional counterweight that maintains high and constant tension of the tape.

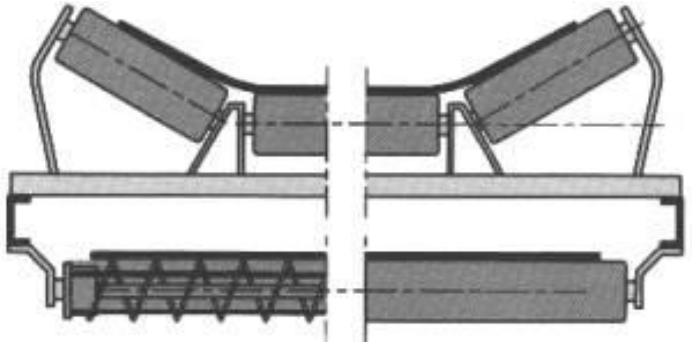
Generality

In the case of **tapes made of wire mesh**, is used a rubber coatings, counter-rollers or double motors drum.

A further distinction can be made considering the **plans belt conveyor** and the to **concave belt conveyor**.

The belts conveyor plans are intended to carry individual necks or bulk materials in small quantities, while the concave conveyors are intended to handle high flow rates of materials in bulk.



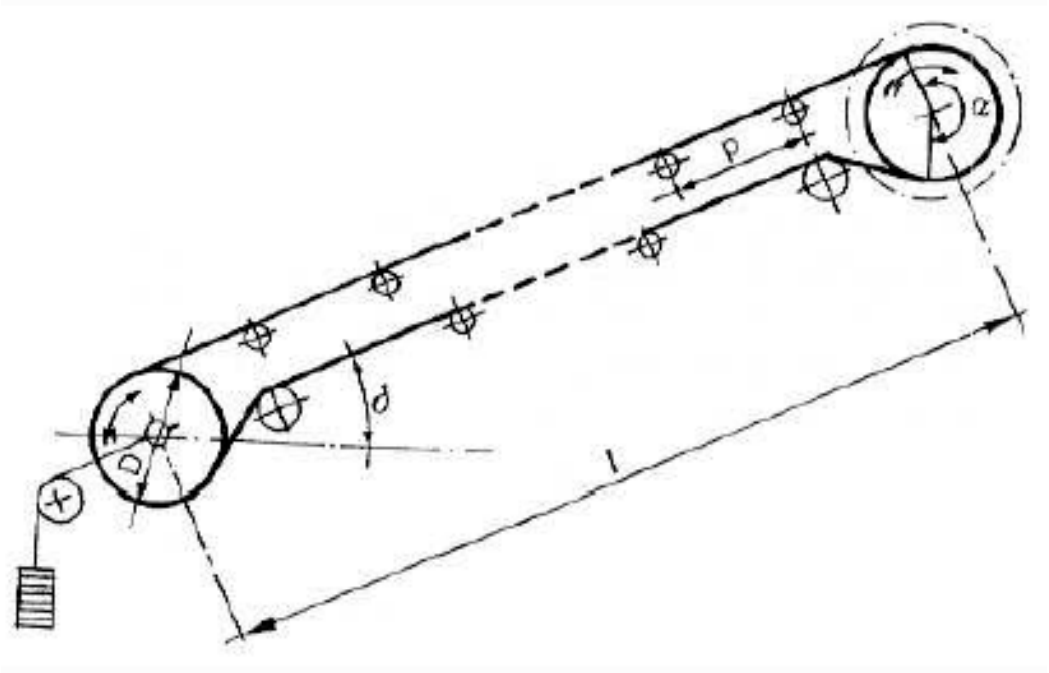


Generality

Concave belt conveyor

Characteristics and components of the belt conveyor

The parameters which characterize a belt conveyor are:



- ***length of the conveyor***, which is measured between the axes of the motor drums and moved drums (l);
- ***width of the tape*** (B);
- ***number of canvases or thickness or material of the tape***;

Characteristics and components of the belt conveyor

The parameters which characterize a belt conveyor are:

- ***inclination of the tape***, if there is a difference of level (δ);
- ***the belt speed*** (up to 2 m/s for the flat belts and up to 5-7 m/s for those concave), which depends on the chemical-physical characteristics of the material transported, by the width of the tape and of the working conditions;
- ***diameter of the drums***, which depend on the stiffness of the tape and which must prevent its bending stress;
- ***diameter and wheelbase of the rollers***. The roller diameter is equal to 60, 76, 89, 102, 108, 133, 159 e 194 mm.
  The wheelbase of the rollers is a function of the width of the tape.

Characteristics and components of the belt conveyor

The parameters which characterize a belt conveyor are:

The wheelbase of the rollers is a function of the width of the tape:

Width of the tape (m)	Wheelbase between the upper rollers (m) function of the apparent specific weight of the material (kN/m^3)			
	8	12	16	24
0,40	1,50	1,40	1,40	1,30
0,50	1,40	1,30	1,30	1,20
0,60	1,30	1,30	1,20	1,20
0,80	1,30	1,20	1,20	1,10
1,00	1,10	1,10	1,00	1,00
1,20	1,10	1,10	1,00	1,00
The wheelbase of the lower rollers of return is by 2.60 to 6.00 m for any width of the tape and for any load. To prevent lateral movements of the tape are installed stations of self-centering on the upper portion of the tape and, where necessary, on the lower one, and the distance between them are compared to the drums of 30 m and 15 m.				

- ***type of roller bearings, of the ball type with permanent lubrication*** to avoid the consequences of infiltration of dust and moisture;
- ***winding angle* of tape *on the drive pulley***;

Characteristics and components of the belt conveyor

The parameters which characterize a belt conveyor are:

- ***potential of transport***, different depending on the type of material transportable

  a) ***boxes, necks and cassettes***

  The potential of the transport is equal to:

$$Q = k \cdot q \cdot B \cdot v$$

  where:

  k = constant that depends on the units of measurement;

  q = distributed load on the tape that you get from:

Width of the tape (m)	Maximun concentrated load (N)	Maximun distributed loead (N/m^2)
0,40	400	1700
0,50	380	1200
0,65	320	1000
0,80	280	700

  B = width of the tape

  v = speed belt (variable up to 1 m/s)

Characteristics and components of the belt conveyor

The parameters which characterize a belt conveyor are:

- ***potential of transport***, different depending on the type of material transportable

  b) <u>for bulk materials</u>

  The potential of the transport is equal to:

  $$Q = k' \cdot \gamma \cdot A \cdot v$$ (transported weight/unit time)

  $$Q = k''' \cdot A \cdot v$$ (transported volume/unit time)

  where:

  k', k" = constants dependent on the unit of measurement (= 3600 if γ in t/m^3, A in m^2 and v in m/s);

  γ = specific weight of the transported material;

  A = media section of the layer of material on the tape;

  v = belt speed, which depends on the width of the same and the characteristics of the material and the working conditions.

Characteristics and components of the belt conveyor

The parameters which characterize a belt conveyor are:

- ***potential of transport***, different depending on the type of material transportable

  b) ***for bulk materials***

  If B is the width of the tape (m), has empirically:

  - for plan tapes, the middle section of the layer of material on the tape is equal to:

$$A_p = \frac{(B+4)\cdot B^2}{110}$$

  - for concave tapes with three rollers, where the two sloping side of 20° to the horizontal planes, the middle section of the layer of material on the tape is equal to:

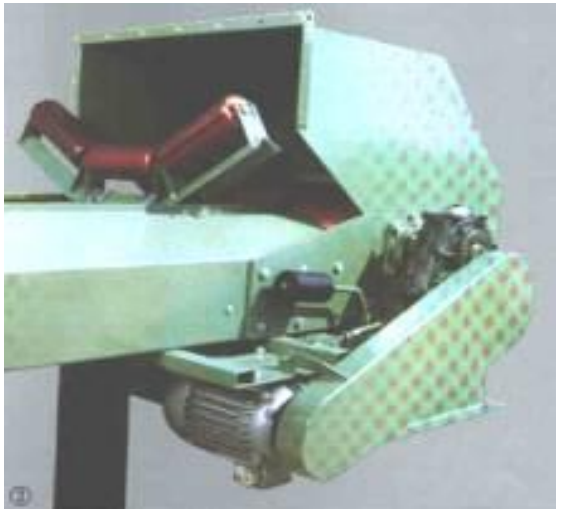
$$Ac = 2\cdot\frac{(B+4)\cdot B^2}{110}$$

Characteristics and components of the belt conveyor

The **frame of the conveyor belt** serves to withstand the static and dynamic loads of exercise. There are frames "self-supporting", in that their structure is such as to limit the number of supports, or may be in coated sheet metal to obtain the typical of faired conveyor. The use of **faired conveyor** is of fundamental importance when it is necessary to protect the material from atmospheric elements to ensure the functioning of the plant and to protect personnel from possible contamination.

Characteristics and components of the belt conveyor

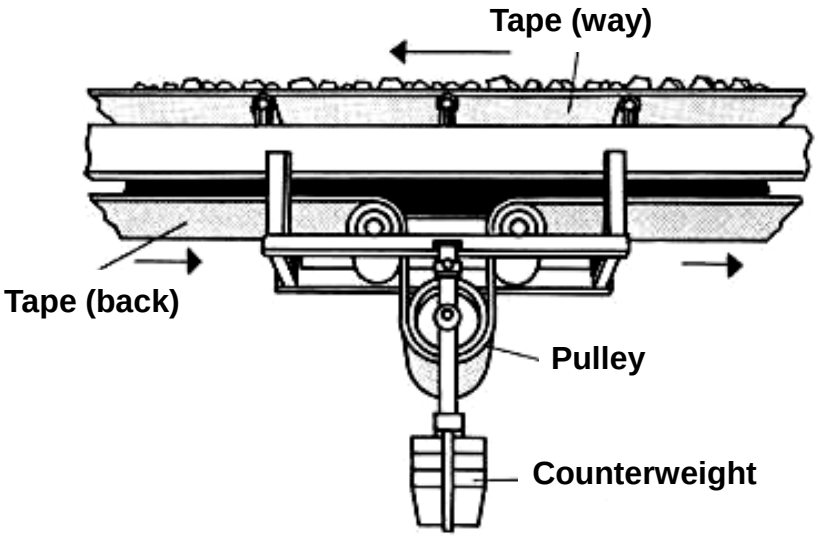
The drive head is constituted by the motor drum, dimensioned for maximum adhesion (possibly covered with rubber) and a minimum wear of the carpet, and by the electric motor. The drum can be cylindrical or, to facilitate the self-centering of the belt, curved. The diameter of the drum motor (there is a minimum value), like that of the reference, is a function of the stiffness of the belt so as to limit the effect of the flexion continues on the tape. The drum has to be wider than the tape in order to avoid damage of the latter and to ensure a certain space between the edge of the belt and the fixed parts. Drive pulley is connected to the electric motor via a kinematic chain equipped with gearbox. The drive head can be streamlined.



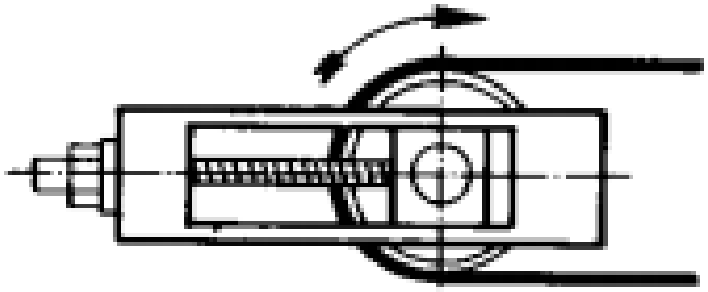
Characteristics and components of the belt conveyor

The **head for reference** is made with a drum on which is wound the tape. On the head for reference is a tensioner, comprising a roller mounted on sliding supports with stroke adjusted by means of screws or a counterweight. This **tensioner** allows to realize the load required to maintain the adhesion between the tape and the motor drum.

It can be at counterweight for lengths of transport more than 50 m or at screw in the case that the length of the conveyor is less than 50 m. The **tensioning device to counterweight** ensures a constant tension of the tape regardless of the operating conditions in which it is located.



The **turnbuckle at screw** needs frequent controls in order to adjust the tension periodically as a function of the expansion of the tape.

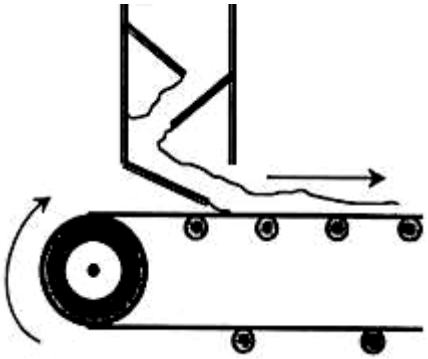


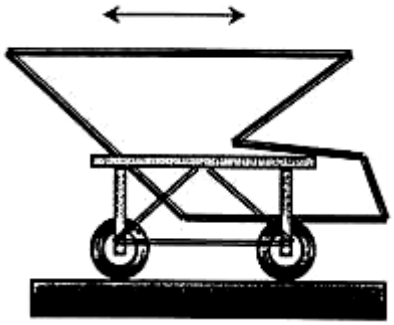
The function of the rollers is to support the tape in the path of return, and to ensure the smooth sliding under load. They are supported by appropriate roll holders. The body of the roller is constituted by a steel tube of thickness and diameter suitable for their intended uses; it is worked at the two ends to obtain the maximum precision of assembly and is then coupled where to the heads are mounted where the sealed bearings in such a way to ensure lubrication and protect them from dust and other impurities.

Characteristics and components of the belt conveyor

The number of rollers on the section is a function of the width of the belt and the transport zone in which they are.

The **collection hopper** and **chute of load** are dimensioned so as to absorb instantaneous changes in capacity rate and possible accumulations, so as to avoid clogging within them and consequent damage of the tape.

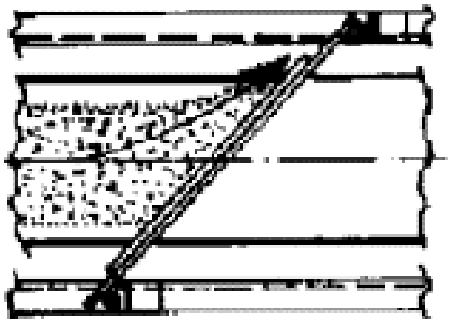


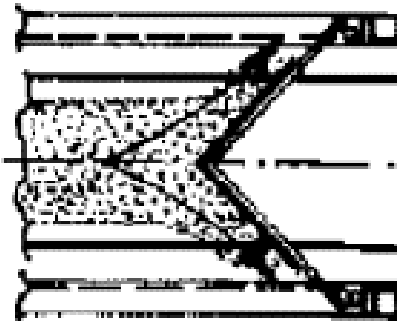


Characteristics and components of the belt conveyor

The **burrs** consist of two side members which have the purpose to prevent the material from falling sideways from the tape. They are used only in the belt conveyors given plane than in that at concave the material is retained toward the center by the geometry of the belt itself. The scrapers can be made of rubber or metal.

The **discharge devices** are used when the discharge does not take place in correspondence with the driving head, but in an intermediate portion to the length of the tape. They may be fixed or movable, and can be used only when the tape is flat. The discharge devices are inserted along the fixed conveyor belt, are adjustable in height and often have the lower edge rubber (diverters, plowshares etc.).

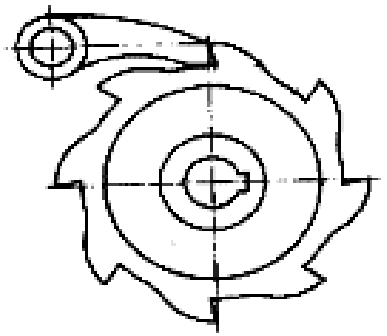




Characteristics and components of the belt conveyor

The **mobile discharge** is composed of two superimposed pulleys where the upper one acts as a discharger, while the lower one by reference. The two pulleys are fixed to a carriage that slides along two rails on the sides of the tape.

If the conveyor is tilted, the weight force that acts on the material breaks down into a component normal to the tape and a parallel. The parallel component opposed to the motion and can be dangerous when the carrier must stops (eg lack of electric current), in which case the force must overcome the resistance to motion. To overcome this, it fortifies the drive shaft of a brake, consisting of an electromagnetic device or by a simple **ratchet**.

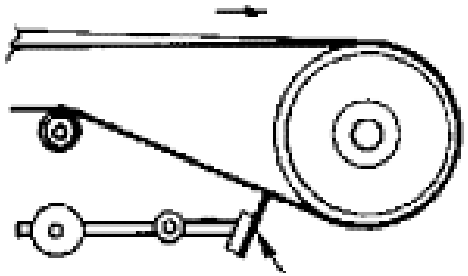


Characteristics and components of the belt conveyor

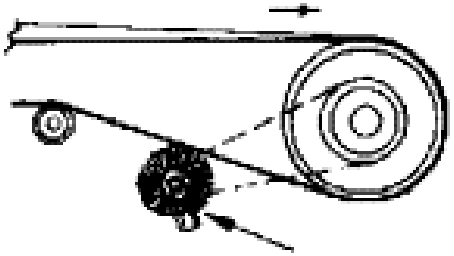
The use of **effective cleaning systems** of the tape allow savings attributable to the reduction of maintenance time of the tape and the increased productivity, depending on the amount of recovered material and the longer duration of the moving parts. The devices of the tape cleaning systems are capable of keeping clean the outer surface of the tape.

There are several types of cleaning system and are classified into two categories:

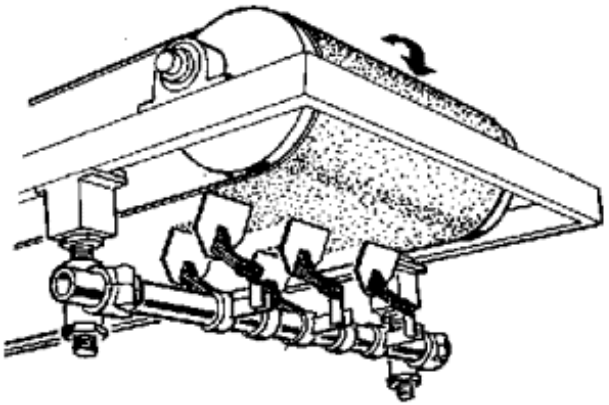
a) static



Scraper



Rotating brush



Characteristics and components of the belt conveyor

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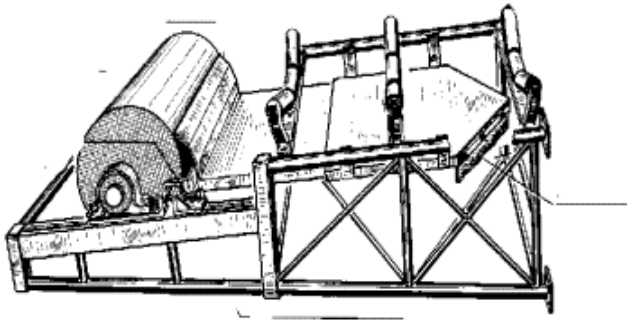
There are several types of cleaning system and are classified into two categories:

b) dynamic



Cleaning the inside of the tape