

The invention relates to a separator for the separation of tobacco particles from a tobacco/gas mixture of the generic type mentioned in the preamble to claim 1 and the preamble to claim 13.

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In the course of tobacco preparation, but especially in the treatment of expanded tobacco, the manufacture of which is known for example from the earlier patent application P 37 10 677.5-23 the tobacco particles have to be separated from the tobacco/gas mixture being worked on. In particular with the expansion of tobacco sometimes steam is also used, so that hereinunder the concept "gas" will also include media in steam form.

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The basic principles of particle separation by forces of gravity may be found, e.g. in "Ullmanns Enzyklopädie der Technischen Chemie", 4th ed., Vol. 2, Process Engineering I. Such "separators" are also already in use in the tobacco industry. Thus, DE-OS 36 19 816 mentions a device for expanding tobacco which contains, together with a cyclone dust separator, a separator with a wire sieve. The sieve allows the steam/air mixture to flow to an outflow pipe, returning it to the circuit, while the tobacco particles are guided downwards to an air sluice.

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Known from EP-A-0 029 is a process for heating tobacco which is impregnated with an expanding agent, in which the gas containing the expanded tobacco is separated

from the tobacco particles by means of a tangential separator.

5 A separator of the generic type mentioned for the separation of dust particles from a gas is presented in DE-PS 639 871. In this arrangement, connected onto the inlet is an annular duct from the underside of which several ducts mounted crown-type lead downwards in helical turns in the same sense of rotation as the
10 crude gas supply duct and open out into a chamber situated under the annular duct in constant crossing over to the chamber walls; the radius of curvature of these ducts is smaller than the radius of the hood.

15 In this there is therefore a form of embodiment of a centrifugal separator in which the streams of mixture have to be carried at a relatively high speed in order, through movement changes on passing through the curved ducts, to effect the desired separation.

20 A drawback in this arrangement is the relatively high expenditure in apparatus for the necessary high transport speed, both in the inlet and in the deflection chamber, and finally in the hood; in addition, for the
25 satisfactory functioning of this separator, it is absolutely necessary that all the spaces coming in contact with the dust/gas mixture, particularly the helically curved ducts, should be carefully kept clean, as deposits on their walls, particularly caked particles,

lead immediately to an impairment of the degree of effectiveness of the separation. And finally, the bottom end of the hood must be kept closed, for example by means of a bucket wheel gate, to ensure the necessary high delivery speeds. However, there are many cases of utilization in which it is possible, or necessary, to work with an open outlet.

Accordingly, the invention has for its object to provide a separator of the generic type mentioned in which the above-mentioned drawbacks do not occur.

In particular, a separator is proposed which makes possible a very satisfactory separation of gas/tobacco particles in constructionally simple manner with relatively low transport speeds.

This is achieved according to the invention by the features mentioned in the characterizing parts of claims 1 and 13.

Appropriate forms of embodiment are given in the characteristics of the dependent claims.

The advantages gained with the invention are based upon the special design of a centrifugal separator the deflection chamber of which is formed by a simple upwardly closed and downwardly open cylinder which is situated in a further cylinder hereinafter termed "hood", so that the gas phase issuing downwardly from the deflection

chamber is sucked upwards over the entire operative flow cross-section of the hood, while the tobacco particles from the deflection chamber fall freely downwards out of the hood.

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The horizontal flow cross-section of the hood must be designed in size in such a way that the vertical flow rate of the gas phase must always be smaller than the falling speed of the tobacco particles to be separated, i.e. the entire system must be arranged taking into consideration, on the one hand, the highest gas flow to be expected, and on the other hand, the lowest dropping speed of the tobacco particles to be expected.

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To ensure these conditions, the size ratio of the area of the deflection chamber to the area of the inlet must be in the region of 5 to 30; at the same time, the size ratio of the hood area to the inlet area must be greater than 50, particularly greater than 100.

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At the inlet of this separator there occur the usual speeds of about 20 m/s necessary for the pneumatic transport of the tobacco/gas mixture, while the gas outflow rates at the upper end of the hood are about 0.1 to 0.2 m/s.

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The necessary pneumatic transport of the mixture ends in practice at the wall of the deflection chamber, as there the tobacco particles fall freely downwards by gravity, while the gas is sucked upwards out of the hood by an exhaust device situated above the deflection chamber.

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5 If the separator is operated in such a manner that at the bottom outlet of the hood an approximately ambient pressure prevails, the hood may be downwardly open, i.e., the separator may be operated without an exhaust member prone to breakdowns, particularly soiling.

10 Varying performances of passage of the gas phase and/or the tobacco phase, as opposed to standard separators, i.e. cyclones or tangential separators, have no appreciable influence on the degree of separation as, with the open separator described here, on a modification of the throughput rate, a varying amount of infiltrated air is exhausted, i.e. the vertical flow rate of the gas phase remains approximately constant.

15 Therefore, a separation of the tobacco particles from the tobacco/gas mixture is possible also without the use of a bucket wheel gate, this being based on the stated insensitivity of the separator to infiltrated air. As - contrary to cyclones or other standard tangential separators -
20 the gas phase can be exhausted in the greatest cross-section of the hood, the flow is evened out, and therefore a relatively high insensitivity of the degree of separation to the operational parameters is obtained.

25 However, if in the entire system there prevails an internal excess pressure or depression, the hood must be shut off downwards by an extraction member, generally a bucket wheel gate or a screw extractor.

When the separator is closed the degree of separation improves as the gas phase reduces, as in this case the difference between the vertical flow rate of the gas phase and the dropping speed of the tobacco particles increases.

Even when tobacco/gas mixtures which cause considerable soiling have to be treated, the degree of separation worsens only insignificantly so that no great claims have to be laid on the corresponding tobacco preparation.

Likewise, the unavoidable incrustations on the inner surfaces of inlet, deflection chamber and hood affect the degree of efficiency of separation only insignificantly, so that the very careful cleaning which had been hitherto usual has to be carried out only at great intervals.

Furthermore, several tobacco/gas mixtures can now be simply separated in one separator as the various two-phase flows to be separated are switched on together.

Because of the low flow rates occurring in the separator there occurs only a small loss of pressure so that also to this extent it is simple to conduct the process with reduced power consumption.

In order to achieve an even rate of flow over the hood cross-section, as is necessary for the homogeneous separation of the tobacco particles, a flow resistor is mounted in the upper region of the hood, and this

consists as a rule in a perforated metal plate with holes evenly distributed over the surface of the plate.

5 In order to prevent tobacco particles being carried along into the outflow duct for the gas, a sieve or filter may be provided under the flow resistor; as an alternative to this it is also possible to design the flow resistor itself as a sieve or filter.

10 To simplify the cleaning of the separator there may be provided in the hood and/or the deflection chamber an opening closable by a gate which permits access to the inside of the hood and/or the deflection chamber.

15 If the gas phase contains steam or other condensing parts, according to a preferred embodiment, the wall of the hood may be provided with heating to prevent condensation and the soiling of the walls resulting therefrom.

20 Finally, it is further possible to provide several deflection chambers alongside one another in a hood and thereby to interconnect several tobacco/gas mixtures to be separated, one gas flow and one tobacco particle flow being respectively produced thereby.

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The invention will be explained in greater detail on the basis of examples of embodiment related to the accompanying diagrammatic drawings wherein;

30 Fig. 1 is a vertical section through a first form of embodiment of a separator;

Fig. 2 is a horizontal section through the separator of Fig. 1;

Fig. 3 is a vertical section through another form of embodiment of a separator;

5 Fig. 4 is a vertical section through a further form of embodiment of a separator;

Fig. 5a is a vertical section or top view of a modification of the deflection chamber;

10 Fig. 5b is a vertical section or top view of a further modification of the deflection chamber;

Fig. 5c is a vertical section or a top view of a further modification of the deflection chamber;

Fig. 6 is a vertical section through a separator with parallel deflection chambers;

15 Fig. 7 is a horizontal section through the separator of Fig. 6, and

Fig. 8 is a vertical section through an embodiment of the separator with indications of dimensions.

20 The separator seen in Figs. 1 and 2, denoted generally by reference 10, has a vertically arranged, downwardly open hood 12 which has a regular cross-section; as will be seen in Fig. 2, this cross-section has a generally rectangular, particularly square shape or also circular shape, as
25 shown by the dot-dashed lines. The door 24 is used for an easy inspection and cleaning of the separator 10.

At its upper end the hood of the separator 10 is provided with an outlet funnel 14 with an outlet opening 16, which
30 has a smaller cross-section than the hood 12. Connected to the outlet opening 16 is a fan (not shown).

In the hood 12 there is a vertically mounted, downwardly open, round deflection chamber 20 to which, along a transport duct 22, generally a transport tube, the two-phase mixture, thus the tobacco/gas mixture, is supplied. The direction of transport is shown by the big arrow, while the flows of the two phases of the tobacco/gas mixture in the duct 22 are indicated by means of the two different arrows.

The transport duct 22 opens out tangentially into the deflection chamber 20 which has a circular cross-section and is designed as a rule as a vertically mounted cylinder closed at the top and open at the bottom.

The tobacco/gas mixture arriving from the duct 22 comes to apply tangentially on the inner wall of the deflection chamber 20 and in a spiral-shaped path along the inner wall of the deflection chamber 20 while undergoing a breaking action to the lower opening of the deflection chamber 20.

On coming out downwards out of the deflection chamber 20 the tobacco particles fall, as shown by the arrows, while the lighter phase, namely gas, is exhausted upwards by means of the fan and leaves the hood 12 through the outlet opening 16.

In order to achieve an even rate of flow over the cross-section of the hood 12, there is provided in the upper region of the hood, thus substantially under the funnel 14 but above the deflection chamber 20 a flow resistor 18

which consists in a perforated metal plate with holes evenly distributed over its surface.

5 If the tobacco/gas mixture is supplied to the separator 10 with sufficient pressure, the hood 12 can be open at the bottom, as may be seen in Fig. 1, i.e. in this case, the separator 10 can be operated without a breakdown-prone, particularly soiling-prone extraction member for the separated tobacco particles.

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However, if in the separator or in the entire system, there prevails an inner excess pressure or under-pressure, the hood 12 must be downwardly closed by an extraction member. In this example of embodiment according to Fig. 15 3 this extraction member is formed by a bucket wheel gate 28 or also by a worm conveyor, situated in the outlet opening in the funnel-shaped lower region 26 of the hood 12.

20 Furthermore, the example of embodiment according to Fig. 3 is differentiated by an additionally provided sieve 30 from the embodiment of Figs. 1 and 2; this sieve 30 is mounted in the hood 12 between the deflection chamber 20 and the flow resistor 18 and prevents tobacco particles 25 from being entrained into the suction duct connected at the outlet 16.

The horizontal flow cross-section of the hood 12 must be designed to such a size that the vertical rate of 30 flow of the gas phase is always smaller than the fall speed of the tobacco particles to be separated, i.e.,

the separator has to be constructed to take into consideration the highest gas flow to be expected, on the one hand, and the lowest fall rate of the tobacco particles to be expected, on the other hand.

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Fig. 4 shows a form of embodiment of a separator 10 which may be used when the gas phase is steam or contains condensing parts. In this case the walls of the hood 12 should be provided with heating means to prevent condensation and the soiling of the walls resulting therefrom. The heating means in the wall of the hood 12 are shown by the zig-zag line.

At the upper end of the hood 12 the gas phase consisting of steam or condensing constituents is exhausted to the left according to the representation in Fig. 4 and supplied to an outflow nozzle 32 which, relative to the horizontal, slants to some extent downwards in the outflow direction, so that the condensate arising there collects at the bottom of the outflow nozzle 32 and can be led away along a duct 34.

At the end of the duct 34 there takes place a separation of this phase into the downwardly outflowing condensate on the one hand, and the gas on the other hand.

Otherwise, this form of embodiment is constructed as already described, so that no description need again be given of it.

Figs. 5a to 5c show various forms of embodiment of the deflection chamber. In the form of embodiment of Fig. 5a the cylindrical deflection chamber 20 is provided with a closed pointed roof 38 so that no tobacco particles or impurities can become deposited on the deflection chamber.

Figs. 5b and 5c finally show forms of embodiment of deflection chambers 20 which are upwardly open. By a suitable adaptation of dimensions, pressures and flow rates it will be ensured that in this case also the gas phase and the tobacco particles are exhausted downwards out of the deflection chamber 20. Sediments on the deflection chamber can by means of this modification be largely avoided.

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Fig. 5b shows an example of embodiment in which there connects upwardly onto the cylindrical deflection chamber 20 a funnel-shaped area 40 which is provided at its upper end with a cleaning opening, so that the inner space of the deflection chamber 20 is freely accessible, particularly for cleaning purposes.

Fig. 5c shows an example of embodiment of the deflection chamber which has over its entire height side walls 42 extending slantingly inwards, and is also provided at its upper end with a cleaning opening 44. There is obtained a smooth inner wall of the deflection chamber 42, so that the deposition of tobacco particles or of impurities is largely ruled out.

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Figs. 6 and 7 show a form of embodiment of a separator which differs from the forms of embodiment discussed hitherto in that the hood 12 has two deflection chambers 20 mounted vertically side by side into it. Each deflection chamber 20 is provided with an associated transport duct 22 for supplying the tobacco/gas mixture.

In this manner two separate flows of mixture can be processed at the same time, a gas flow and a tobacco flow being produced.

By the sizing of the removing transport systems it may be appropriate to taper the hood 12 downwards, as shown in Fig. 6.

Finally, Fig. 8 shows a form of embodiment of the separator 10 according to Fig. 1 and 2, but with a deflection chamber 20 corresponding to Fig. 5b.

In this figure the dimensions and operational conditions have been entered, as achieved in a production plant.

In this particular instance, 1500 kg of tobacco per hour were processed with a flow of gas or vapour mass of 500 kg per hour. The inflow rate of the tobacco/gas mixture was of the order of magnitude of about 20 m/s required for pneumatic transport.

The speed of the upwardly exhausted gas was comprised between 0.1 and 0.2 m/s, for which purpose a depression of 5 mbar was maintained in the upper funnel-shaped end

region of the hood 12.

The tobacco particles fell out of the open lower end of the hood 12 maintained at ambient pressure p_u .

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The inlet 22 for the tobacco/gas mixture had an area of size $A_1 = 0.008$ sq.m., the deflection chamber 20 formed by a cylinder had an area of size $A_2 = 0.1$ m², finally, the hood 12 had an area of size $A_3 = 1.4$ sq.m.

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In order to achieve the desired gravity separation it is possible to depart from these values; in this regard, however, specific limit values for the area ratios have to be kept to, namely:

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$$5 \leq A_2 / A_1 \leq 30 \text{ and}$$

$$A_3 / A_1 \geq 50.$$

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Particularly good results are achieved when the ratio A_2/A_1 is between 10 and 20, and the ratio A_3 / A_1 is greater than 100, but smaller than 200.



Claims

1. Separator for the separation of tobacco particles from a tobacco/gas mixture,
 - 5 a) with a hood (12),
 - b) with a circular deflection chamber (20) mounted in the hood (12),
 - c) with an inlet (22) opening out tangentially into the circular deflection chamber (20) for the tobacco/gas mixture to be separated,
 - 10 d) with a downwardly directed outlet in the deflection chamber (20) for the tobacco particles,
 - e) with an outlet for the tobacco particles at the lower end of the hood (12), and
 - 15 f) with an outlet (16) for the gas above the deflection chamber;
 - g) the gas from the hood (12) being removed by suction above the deflection chamber (20),characterized by the following characteristics:
 - 20 h) the deflection chamber (20) is formed by a cylinder (20) closed at the top and open at the bottom;
 - i) the ratio of size of surface (A2) of the deflection chamber (20) to the size of surface (A1) of the inlet (22) is comprised between 5 and 30, and
 - 25 j) the ratio of size of surface (A3) of the hood (12) to the size of surface (A1) of the inlet (22) is above 50.
2. Separator according to claim 1, characterized in
30 that the size ratio of surface (A3) of the hood (12) to surface (A1) of the inlet (22) is greater than 100, but smaller than 200.



3. Separator according to either claim 1 or 2, characterized in that the size ratio of surface (A2) of the deflection chamber (20) to the surface (A1) of the inlet (22) is comprised between 10 and 20.
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4. Separator according to one of claims 1 to 3, characterized that in a hood (12) several deflection chambers (20) with associated inlets (22) are provided.
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5. Separator according to one of claims 1 to 4, characterized in that the bottom end of the hood (12) is open.
6. Separator according to one of claims 1 to 4, characterized in that an extraction member (28) is integrated
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- into the bottom end of the hood (12).
7. Separator according to claim 6, characterized in that a worm conveyor or a bucket wheel gate (28) is provided as extraction member.
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8. Separator according to one of claims 1 to 7, characterized in that a flow resistor (18) is provided in the upper region of the hood (12).
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9. Separator according to claim 8, characterized in that the flow resistor (18) is formed by a perforated plate with holes evenly distributed over its surface.
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10. Separator according to one of claims 1 to 9, characterized in that a sieve (30) is arranged in the upper region of the hood (12).



11. Separator according to one of claims 1 to 10,
characterized in that heating means are provided in the
wall of the hood (12).

5 12. Separator according to one of claims 1 to 11,
characterized in that the deflection chamber (20) is
provided with a pointed roof (38).

10 13. Separator for the separation of tobacco particles
from a tobacco/gas mixture,
a) with a hood (12),
b) with a circular deflection chamber (20) mounted in
the hood (12),
c) with an inlet (22) opening out tangentially into
15 the circular deflection chamber (20) for the tobacco/
gas mixture to be separated,
d) with a downwardly directed outlet in the deflection
chamber (20) for the tobacco particles,
e) with an outlet for the tobacco particles at the
20 lower end of the hood (12), and
f) with an outlet (16) for the gas above the deflec-
tion chamber (20),
g) the gas from the hood (12) being removed by suction
above the deflection chamber (20),
25 characterized by the following characteristics:
h) the deflection chamber (20) has a cylinder (20)
open at the bottom,
i) the deflection chamber (20) is provided at its
upper end with an upwardly open cone (40);



- j) the ratio of size of surface (A2) of the deflection chamber (20) to the size of surface (A1) of the inlet (22) is comprised between 5 and 30, and
- 5 k) the ratio of size of surface (A3) of the hood (12) to the size of surface (A1) of the inlet (22) is above 50.

14. Separator according to claim 13, characterized in that the deflection chamber has the shape of a cone (42) with an opening (44) at its upper end.

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15. Separator according to one of claims 1 to 14, characterized in that connected to the upper end of the hood (12) is an outflow nozzle (32) which extends slantingly downwards relative to the horizontal.

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16. Separator according to one of claims 1 to 15, characterized in that the hood (12) has a regular cross-section.

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17. Separator according to claim 16, characterized in that the hood (12) has a circular cross-section.

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18. Separator according to claim 16, characterized in that the hood (12) has a rectangular, particularly square, cross-section.