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G. W. HAMMACK

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APPARATUS AND METHOD FOR CLEANING AND SEPARATING LEAF TOBACCO

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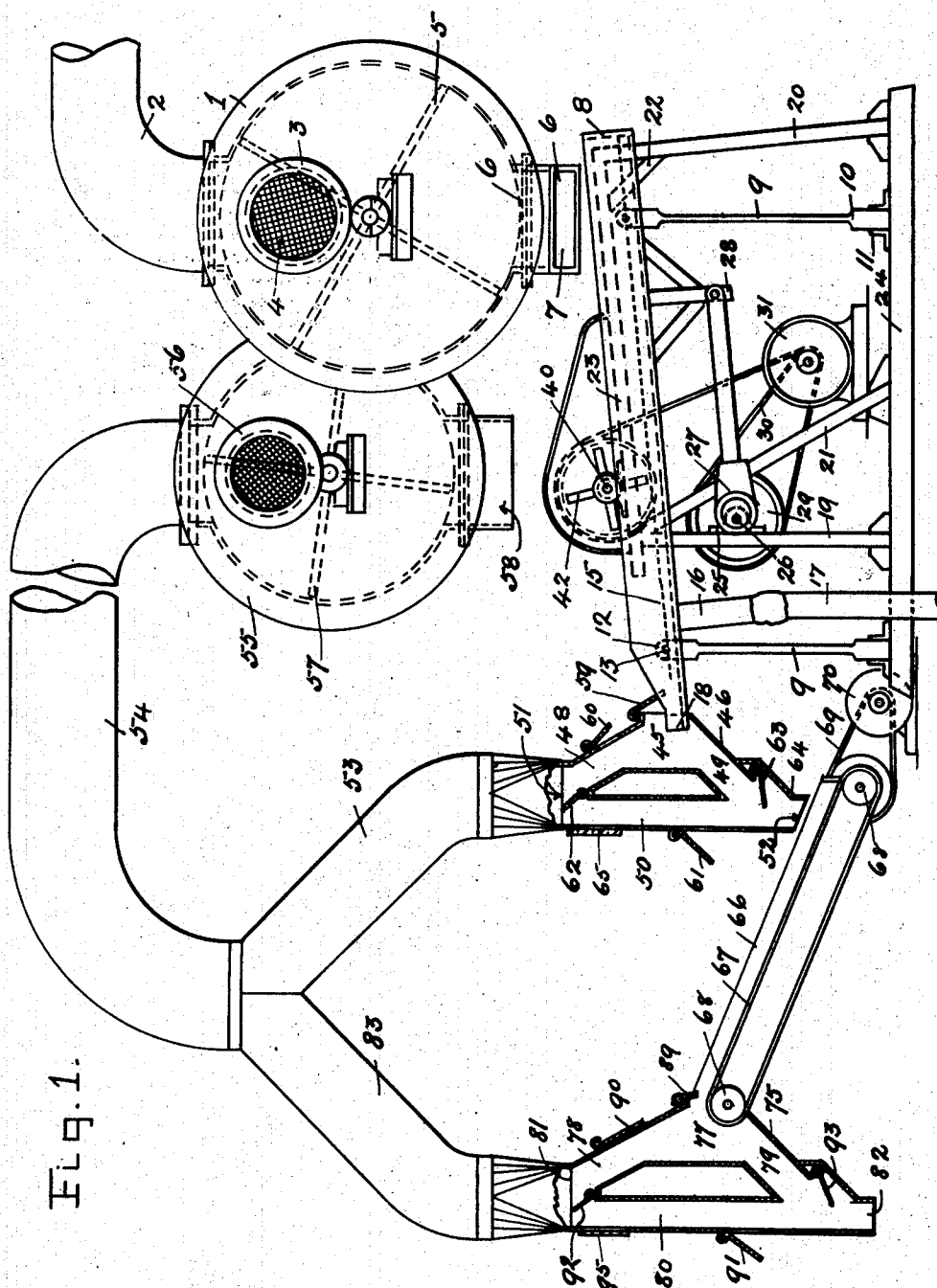


Fig. 1.

INVENTOR
GEORGE W. HAMMACK.
BY *Arthur S. Sorenson*
ATTORNEY

UNITED STATES PATENT OFFICE

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APPARATUS AND METHOD FOR CLEANING
AND SEPARATING LEAF TOBACCO

George W. Hammack, Richmond, Va.

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My invention relates to methods and machines for cleaning, grading, and separating leaf tobacco; and particularly Bright tobaccos and Burley tobaccos after it leaves the stemmery. All machines will not handle light and heavy tobacco equally well; and in pneumatic machines, adjustment is necessary for handling the heavier Bright tobaccos and the lighter Burleys. In many factories the cleaning, grading, and separating is done by a series of different operations; involving several handlings, much floor space, and much time. My object is to do what is necessary for the best results in one continuous operation; to use as little space as possible; to take less time per unit of product; to obtain better results; and to provide a machine in which different tobaccos can be handled with the least amount of adjustment.

From the stemmery comes the tobacco,—leaf and stems, scraps, stems with small pieces of leaf adhering, and No. 4 scrap—that is scrap small enough to pass through a No. 4 screen, which has a quarter-inch mesh. This agglomeration is to be cleaned and separated; the leaf from the stems and the small scrap from the larger leaf. The first operation is to remove from the tobacco as much dust and dirt as possible. This I do in a rotary pneumatic separator, such as that which is fully described in the Patent No. 2,117,845, granted to me on May 17th, 1938. From this rotary pneumatic separator the tobacco is dropped upon a shaker or shaking screen, on which the No. 4 scrap is separated. The larger scrap and stem pass from the shaking screen into a stationary pneumatic separator in which a considerable part of the leaf is separated and carried upward by the exhaust from a fan. Heavy bunches of leaf and stem fall from the bottom of this separator on to a belt conveyor. It is not always practicable to separate all leaf from the stem material in one stationary separator. Some of the leaf, when it passes from the shaking screen, may be so bulked, that is, stuck or twisted together, that if the draught in the first separator is strong enough to lift it, the stem material would also be lifted. After separating as much leaf as possible in the first separator I drop the heavier material from this first stationary separator onto a belt conveyor. In passing through the separator the tobacco is subjected to more than the lifting force of the current of air. First, the heavier parts are thrown, as they leave the shaker, against the opposite wall of the separator; they drop towards the lower part of the

separator, where they are tossed up again by a stronger current of air; and by this tossing and buffeting the outer leaves are loosened, and they are lifted by the upward current of air, and are carried out at the top of the separator. The heavier parts drop into the lower part of the separator. In this part the tossing and buffeting is continued; and more leaf is separated and lifted. The remainder is dropped onto the conveyor. It is now necessary to open up or thin out the tobacco on the belt conveyor so that when it is delivered into a second stationary separator as much surface as possible may be presented to the air current. This thinning out of the tobacco I effect by running the belt conveyor at such a speed that the tobacco falling upon it is carried onward more rapidly than it falls from the separator. In practice I usually run the belt conveyor at a speed of three hundred feet a minute; but the speed may be varied to suit the condition of the tobacco.

My belt conveyor now delivers the heavier leaf and the heavier stem material into a second stationary separator, also connected with the exhaust system; and in this separator more leaf is separated from the stem material; the latter being dropped from the bottom of the separator. In this separator too the tobacco is subjected to a tossing in the air current and a buffeting against the walls.

The art of stemming tobacco differs in the factories. Different equipment is used, with different results. In one type of factory, and where stemming machines are used, the tobacco leaves are fed by hand into the beater-box end of the stemming machine (sometimes called the butter-box) in which the end or butt of the leaf stem is stripped or combed of leaf for a length of about two inches, to present a free stem to the gripping fingers of the stemming machine proper. In this beater-box sometimes the end of a stem is broken off; and sometimes a whole leaf is pulled through. In the stemming machine the stem is gripped by fingers while the leaf is stripped off. The stem is delivered in one direction, the leaf in another. But here too stems break, and stem material is passed on with the leaf. Consequently the proportion of stem material passed on with the leaf will vary, both in quantity and size; from small pieces to whole stems. I am speaking of separate leaf and stem; not of fins of leaf still attached to stem material. Whatever the proportion of stem, it is to be removed, as far as may be possible and economical.

In order that different tobaccos may be handled by my method, it is important that the air currents through the separators and through the main air line between the separators and the exhaust fan shall be under control. Even if only one class of tobacco is to be handled the control of the air currents is a factor in the success of the system. Tobaccos vary in weight; the heavier tobaccos need heavier air currents; and the lighter tobaccos, such as Burley, need lighter air currents. These currents must not be stronger than is necessary to lift and to carry the tobacco, lest a whipping action be set up, and much of the leaf be broken. It is partly for this reason that the process of separating the leaf from the stem may not be carried out by using currents of air strong enough to lift both light and heavy leaf. The process must be carried out in steps, lest the lighter leaf be broken. I adjust the air velocity in the main air line and through the separators for the reasons and in the manner described hereinafter.

In the drawing: the figure shows in part elevation and in part section the devices I use in my method of cleaning and grading leaf tobacco, having particular reference to my double separator, used in connection with my rotary pneumatic separator, and with other devices.

The stemmed tobacco is delivered to the rotary separator 1 through the pipe or conveyor 2. This rotary separator is fully described in my Patent No. 2,117,845, hereinbefore mentioned. Air is drawn through and out of the separator by exhaust means attached to the opening 3; through which can be seen a part of the rotary screen 4. Dust and dirt are drawn through the screen, while the vanes 5 carry the tobacco around to the discharge outlet 6. From the outlet 6 the cleaned tobacco drops through pipe 7, onto the vibrating and shaking tray 8,—hereinafter referred to as the shaker. This shaker is mounted on the limber-jacks 9. These limber-jacks have substantial feet 10, which are fixed to the floor or to a frame by brackets 11. Their heads 12 embrace pins 13 or other fastenings by which they are attached to the shaker 8. The stem 9 of the limber-jack is slight and has considerable spring in it; so that when the shaker is pulled lengthwise in either direction, and is released, it will return to the position shown. The limber-jacks are simply vertically arranged springs by which the shaker is supported.

Spaced from the bottom of the shaker tray 8 is a wire screen 15, which has a mesh of one quarter inch, large enough to pass small particles of tobacco leaf. Under the bottom of the shaker tray, and under the end of the screen 15, is a hopper 16, into which the small pieces which have passed through the screen may fall. From the hopper 16 the small particles of tobacco pass to the pipe 17, from which they are usually collected in other receptacles. All tobacco which is too large to pass through the screen 15 travels along to the shaker mouth 18.

A frame-work consisting of uprights 19 and 20, braces 21 and 22, top rails 23, and foot rails 24, is arranged on each side of the shaker tray 8. On the uprights 19 are mounted bearings 25, supporting a shaft 26. Mounted on the shaft 26 is an eccentric 27, the rod of which is pinned to a bracket 28 which is well braced to the bottom of the shaker tray 8. Also on shaft 26 is a pulley 29, driven by belt 30 from the motor 31. As shaft 26 turns, the eccentric 27 will impart to the shaker a rapid lengthwise reciprocating

movement. A shaft 40 is mounted in bearings carried by the top rails 23 of the frame. On shaft 40, which extends across the shaker, are mounted a number of spiders 42, which, revolving anti-clockwise, stir the leaf up as it shakes along on the wire screen 15.

From the mouth 18 of the shaker tray 8 all leaf which is larger than that which has passed through the screen 15 is delivered into the inlet chamber 45 through the inlet 44 of the double separator 46. This separator comprises the inlet chamber 45, the front rising duct 48, the front falling duct 49, the back rising duct 50, the top outlet 51, and the bottom outlet 52. The cross-sectional area of the inlet chamber 45 is made appreciably greater than the cross-sectional area of each of the ducts 48 and 49, so that the air current passing upward through the inlet chamber shall have an appreciably less velocity than the velocity of the air currents in the ducts 48 and 49 above and below it, for the reasons stated hereinafter. This separator is connected by exhaust piping 53 and 54 to the rotary pneumatic separator 55, the air outlet 56 of which is connected with the exhaust system. In this separator 55 the tobacco leaf is separated from the exhaust air currents, and from which it is usually dropped upon a conveyor. The tobacco is carried through the separator by the vanes 57 to the material outlet 58. This separator 55 is similar in design to the separator 46.

Returning to the separator 46; a swinging and adjustable plate 59 is placed over the material inlet 44 and over the mouth 18 of the shaker to control the volume of air passing into the separator at this inlet and over the tobacco being fed in by the shaker.

The strength of the air-pull on the leaf up the first duct 48 is controlled by the air door 60; and the strength of the air-pull up the second duct 50 is controlled by the air door 61; and the strength of the air-pull up the second duct 50 is controlled by the air door 61. The purpose of the adjustable air vane 62 is to balance or adjust to one another the draughts passing up first duct 48 and second duct 50, by partially closing the outlet from either duct. The purpose of the lip 63 is to project down-sliding tobacco into the air stream, and to prevent it from just sliding over the corner 64 into the outlet 52. In the upper wall of the upper part of the separator I set an inspection glass 65. It is shown at the back of the separator, but it may be placed on the side in such a manner that the upward flow in both first duct 48 and second duct 50 may be seen at the same time.

When the tobacco is introduced at the inlet 44 it is caught by the air entering at 52 and rising in duct 49. The lighter free leaf will be carried up duct 48. The heavier leaf and stem material will drop into duct 49 where it will be tossed on the rising current of air, and leaf material will be separated from stem material. The heavier portions will then fall through duct 49, and slide off lip 63, there to be thrown against the opposite wall of the separator, and to be tossed on the air current entering at the foot 52, which current is stronger than the currents up either of the ducts 49 and 50. The air current entering at 52 again catches up leaf material and carries it up the second duct 50. Heavier material drops through the outlet 52, and onto the conveyor 66; in this case shown as a traveling belt 67, mounted on rollers 68, and

driven through belting 60, by motor 70. The current up the duct 50 is stronger than the current up the duct 49, due to the admission of free air at the material inlet 44; and if too strong at the junction of ducts 49 and 50 the draft up duct 50 may be adjusted by admitting some free air at the door 61, so that the draft below the door 61 is sufficient to lift the separated leaf, and yet be not so strong as to injure the leaf or to cause it to hang on the lower edge of the baffle 43. To avoid such hanging, the air inlet 52 is preferably in line with duct 50.

Now we want to spread out or thin out our material, before subjecting it to the action of the air streams in a second separator, so that the air may have a lighter burden. This I do on the belt 67, by adjusting the speed of the belt so that it moves the tobacco away from the outlet 52 faster than the belt receives it from the said outlet. This has the effect of thinning-out the leaf on the belt 67. It is my usual practice to run this belt at a speed of 300 feet per minute, or somewhat less. The belt 67 carries leaf and stem material to a second separator 75, which may be constructed on the same lines as the separator 46. The traveling belt 67 throws the tobacco leaf and stem into the entrance chamber 77. The movement of the belt 67 together with the air-flow into the chamber 77 will throw the heavy bulked material against the opposite wall of the baffle 84, loosening the outside leaves of leaf material. Part of the loosened material is drawn up the duct 78, and through the top outlet 81, into the exhaust pipe 83, and into the exhaust main 54. The remaining separated leaf will be carried up the back duct 80 to the top outlet 81; while the heavier stem will drop through the bottom outlet 82. On this stem material there may be still a small proportion of the leaf. This is removed by "threshing" in another machine.

The control and the adjustment of the air currents through my separators 46, 75, and 55, and through the air line 54, are very important, and are a factor in the success of my system. Tobaccos vary in weight. The heavier tobaccos need heavier air currents; and the lighter tobaccos, such as Burley, need lighter air currents. The air currents must not be stronger than is necessary to lift and to carry the tobacco, lest a whipping action be set up, which will break the leaf.

I adjust the air velocity in the main line 54 to 3500 feet per minute. This air line 54 and its branches 83 and 82 must be free of any obstruction, to eliminate the possibility of tobacco collecting at the obstruction and blocking the pipe. I therefore place the air regulating valve between the exhaust fan and the outlet 86 of the separator 55, through which separator the leaf is passed in order to separate it from the draught.

The separators 46 and 75 are approximately forty-two inches wide, cross wise. They differ in width, fore and aft, according to the size of the separator. In this case assume that this width is ten inches across the top outlet, and that the width of each of the ducts 48, 50, 78, and 80, is five inches, fore and aft. Then the combined areas of these four ducts will be eight hundred and forty square inches, which will give an air velocity through them of about one thousand feet per minute when the diameter of the pipe 54 is eighteen inches. Note that the speed of 3500 feet per minute of the air in the

pipe 54 is found to be a suitable speed for keeping the tobacco moving in the pipe on its way to the separator 55.

The drawing shows that the width (fore and aft) of the outlet 52 is substantially the same as that of the ducts 48 and 50; and it also shows that the outlet 52 is practically the air inlet for the duct 50; or that 52 is the bottom inlet to duct 50. Again we may regard the separator as a structure comprising an outer casing with openings at top and bottom, the lower one having an area less than the area of the upper one, and an inner baffle dividing the casing into two ducts of substantially equal cross-sectional area, both ducts communicating, without obstruction, with the upper opening, and the ducts uniting near their lower ends and communicating, without obstruction, with the casing's lower opening. Obviously, the air current flowing in at 52 is stronger than is the air current above at the junction of the two ducts 49 and 50; for the air which supplies them must enter at 52; and if the air inlet 52 were so large that the velocity at 52 were no greater than the velocity up the duct 50 or at the junction of 49 and 50, material falling down duct 49 would simply fall out at 52. That is, it would not be held at the junction of the ducts until more leaf was separated, and leaf separated there would not be carried up duct 50. This applies also to the separator 75 and its ducts and openings.

The drawing also shows that the fore and aft dimension of the material inlet chamber 45, and also of the inlet chamber 77, is appreciably greater than the fore and aft dimensions of the ducts 48 and 49, and of ducts 78 and 79. The greater fore and aft dimension of these inlet chambers 45 and 77 multiplied by the uniform width of the separator, mentioned above as substantially 42 inches, will give a greater volume per unit of height, than the volume of the ducts 48, 49, and 78, 79, for the same unit height or length. Consequently the air velocity in the enlarged chambers will be less than the air velocity in the said ducts. The purpose of enlarging these inlet chambers is to give very light leaf mixed with light pieces of stem a better opportunity to drop onto the current rising in duct 49, lest it be whipped up by the current entering the inlet at inlet 44 with the leaf and passed into the duct 48 before separation can be effected. In the upper part of these two chambers the air velocity will be slightly greater than in their lower part because of the inflow of free air under the damper 59 in the inlet 44 and under the damper 89 in the inlet to the separator 75.

The air speed of one thousand feet per minute through the ducts 48 and 78 of the separators 46 and 75 respectively is suitable for separating leaf of average weight. For heavier leaf I use a little higher speed; and for lighter leaf I may use a lower speed. Taking one thousand feet per minute as the air speed through these two ducts 48 and 78: I adjust the opening of the air doors 60 and 90 so that the air speed below these doors is less than the air speed above them an amount sufficient so that the movement of tobacco leaf is slower below the doors than it is above them. The object is to hold the tobacco in the lower part of the ducts and in the inlet chamber 45 and 77 while the leaf is being separated from the stems, and then to move the leaf away quickly by way of the upper parts of the ducts 48 and 78. For the same reason the air

speed through the ducts 50 and 80 is adjusted by the adjusting of the opening of the air doors 81 and 91. The adjustable vanes 82 and 92, at the point where the first and second ducts join the top outlets, are used to balance the up-draft between the two rising ducts. In the drawing they are shown adjusted for a greater volume of draft up the ducts 48 and 78 than up the ducts 50 and 80. The air dampers 59 and 89 are used to close the openings of the material inlets to the separators from the shaker and the conveyor respectively as much as possible without interfering with the passing of the leaf tobacco, and to limit the amount of air entering at these points. They also serve to increase the velocity of the air which does enter, for the air speed at these points aids in throwing the tobacco from the shaker and the conveyor into the separators. The effective height of the material inlet being only enough to allow the leaf tobacco to pass freely, it follows that the effective area of the inlet is less than the cross-sectional area of the duct 48 above it. Hence the air inflow at inlet 44 does not satisfy the exhaust pull up duct 48; and the air necessary to supply the deficiency must come up duct 49. Therefore the direction of the air current in duct 49 is upward.

I do not confine myself to the exact shape of the separator shown in the drawing. For instance: ducts 48 and 50 are not necessarily contiguous at their upper ends; and duct 48 is not necessarily inclined to the vertical. My object is to so build the separator that the material to be acted upon is thrown into a first air current of suitable F. P. M., above which is a current of greater F. P. M. to lift only the separated leaf; below which first current is a current through which the rest of the material will fall, and be tossed, while more leaf is separated, until it meets the strong current rising from the air inlet at the bottom of the separator, upon the crest of which it will be tossed, and the remaining free leaf will be separated, and will be caught up in a current which is stronger than the said first current.

I claim:

1. A pneumatic separator comprising a casing defining a substantially vertical duct open at both ends, the said duct having an inlet for material and air formed in its front wall; a baffle set within and across from side to side of the casing and extending from near the upper end of the casing to near the lower end of the casing, and forming within the casing a first duct and a second duct, the said first and second ducts communicating openly at their lower ends to form the lower opening in the casing, the said lower opening in the casing communicating directly and openly with the first duct and the second duct, and having a cross-sectional area materially less than the cross-sectional area of the portion of the casing above it at the junction of the first and second ducts so that the velocity of the air current induced upwardly in the lower opening will be greater than the velocity of the air currents above it at the junction of the first and second ducts; and exhaust means without and beyond the separator for inducing upward currents of air through the separator.

2. A pneumatic separator comprising a first duct vertically disposed and bent intermediate its ends and having in the outer face of the bend an inlet for material and air, the said

duct being of substantially uniform cross-sectional area throughout its length, except that the area in the region of the said inlet is larger than the area above and below it; a second duct vertically disposed and at its upper end contiguous to the upper end of the first duct, and near its lower end communicating with the first duct at its foot; exhaust means without and beyond the separator adapted to induce upward currents of air through the ducts; and an adjustable plate valve hinged on the common edge of the first and second ducts at their upper ends and adapted to adjust the relative air-flows between the two ducts.

3. A pneumatic separator comprising a first duct vertically disposed and bent intermediate its ends, and having in its wall at the bend an inlet for material and air less in area than the cross-sectional area of the duct above it; a vertically disposed second duct open at its lower end for the free passage of air and material, and at its upper end joining with the upper end of the first duct to form an exhaust passage, and near its lower end communicating openly with the first duct at the foot of the latter; the said ducts affording free passage for material and air throughout their lengths; exhaust means connected with the exhaust passage for inducing upward currents of air through the separator; and means for feeding the material to be separated into the separator at the material inlet.

4. A pneumatic separator comprising a first duct vertically disposed, and having in its wall intermediate its ends an inlet for material and air, the said duct being enlarged in the region of the inlet to reduce the velocity of the air current flowing up the duct and past the inlet; a vertically disposed second duct open throughout for the passage of material and air, at its upper end joining with the upper end of the first duct to form an exhaust passage, and near its lower end communicating openly with the first duct at the foot of the latter; exhaust means connected with the said exhaust passage for inducing upward currents of air through the separator; and means for feeding the material to be separated into the separator at the material inlet.

5. A pneumatic separator comprising a vertically disposed bifurcated duct branching upwardly, the said duct being open throughout for the free passage of material and air, the combined area of the two branches being greater than the area of the said duct; an inlet for material and air in the wall of one of the branches, the area of the said inlet being less than the cross-sectional area of the duct above it so that the current of air in the said branch below the said inlet shall flow upwardly; exhaust means connected with the free ends of the branches for inducing upward currents of air through the duct and through its branches; and means for feeding the material to be separated into the separator at the material inlet.

6. A pneumatic separator comprising a vertically disposed bifurcated duct branching upwardly, the said duct and branches being open for the free passage of material and air, and the combined cross-sectional areas of the two branches being greater than the cross-sectional area of the said duct; a inlet for material and air in the wall of one of the branches, the cross-sectional area of the said branch being enlarged in the region of the inlet and above and below the said inlet to reduce the velocity of the air currents rising through the said region; and the area of the inlet being

smaller than the cross-sectional area of the branch above it so that the current of air in the said branch below the inlet shall flow upwardly; exhaust means connected with the free ends of the branches for inducing upward currents of air through the duct and through its branches; and means for feeding the material to be separated into the separator at the material inlet.

7. A pneumatic separator comprising a first duct and a second duct vertically disposed, the lower end of the first duct being inclined and connected to the second duct, the said ducts being open throughout their lengths; exhaust means connected with the upper ends of the ducts and adapted to draw currents of air upward through the said ducts; an open inlet for material and air formed in the wall of the first duct intermediate its ends, the said inlet having an area less than the cross-sectional area of the said first duct above it, so that the air current in the first duct below the inlet shall be upward and of less velocity than the air current in the first duct above the inlet; and means for feeding the material to be separated into the inlet.

8. A pneumatic separator comprising a first and a second duct vertically disposed, the lower end of the first duct being inclined and connected into the side of the second duct, the said second duct being open throughout its length; exhaust means connected with the upper ends of the ducts and adapted to draw currents of air upward through the ducts; an open inlet for material and air formed in the wall of the first duct intermediate its ends, the said inlet having an area less than the cross-sectional area of the said first duct above it, so that the air current in the first duct below the inlet shall be upward and of less velocity than the air current in the first duct above the inlet; and means for feeding the material to be separated into the inlet.

9. A pneumatic separator comprising a first duct and a second duct vertically disposed, the

lower end of the first duct being inclined and connected into the second duct, the said ducts being open throughout their lengths for the free passage of material and air; exhaust means connected with the upper ends of the ducts for inducing upward currents of air through the ducts; means located in the walls of the ducts for adjusting the relative velocities of the air currents up the two ducts; an open inlet for material and air formed in the wall of the first duct intermediate its ends; and means for feeding the material to be separated into the separator at the material inlet.

10. The method of separating leaf tobacco from stem which consists of producing at less than atmospheric pressure a confined main upward current of air strong enough to support leaf tobacco but not strong enough to support stem, then taking off from the said main current branch currents also at less than atmospheric pressure, allowing a relatively small volume of free air to enter and mingle with one of the branch currents so that the branch current below the point at which the free air enters shall have an upward flow and a lower velocity than the velocity of the branch current above the said point, and projecting the loose tobacco material into the said branch current at the said point, whereupon light leaf will be lifted on the branch current above the said point while heavier leaf and stem is dropped into the slower current rising below the said point where it is tossed on the said rising slower current until more leaf is separated, the lighter of which leaf is carried upward, and the heavier of which leaf is dropped with the stem material to the stronger upwardly flowing main current of air on which the material is again tossed and leaf is separated and carried up on a second branch current while the heavier stem material is dropped through the main current.

GEORGE W. HAMMACK.