April 24, 1962 F. A. M. LABBÉ 3,030,965

TOBACCO MANIPULATING MACHINES

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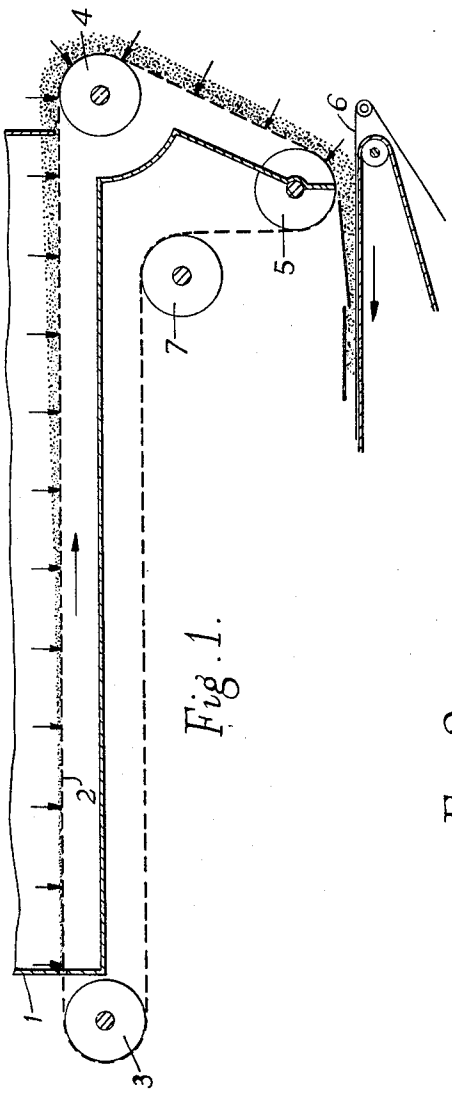

Fig. 1.

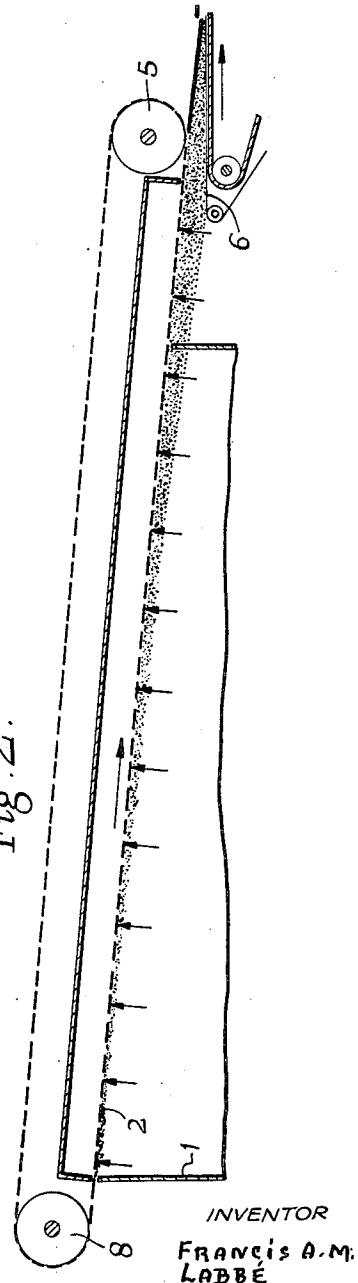

Fig. 2.

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Fig. 3.

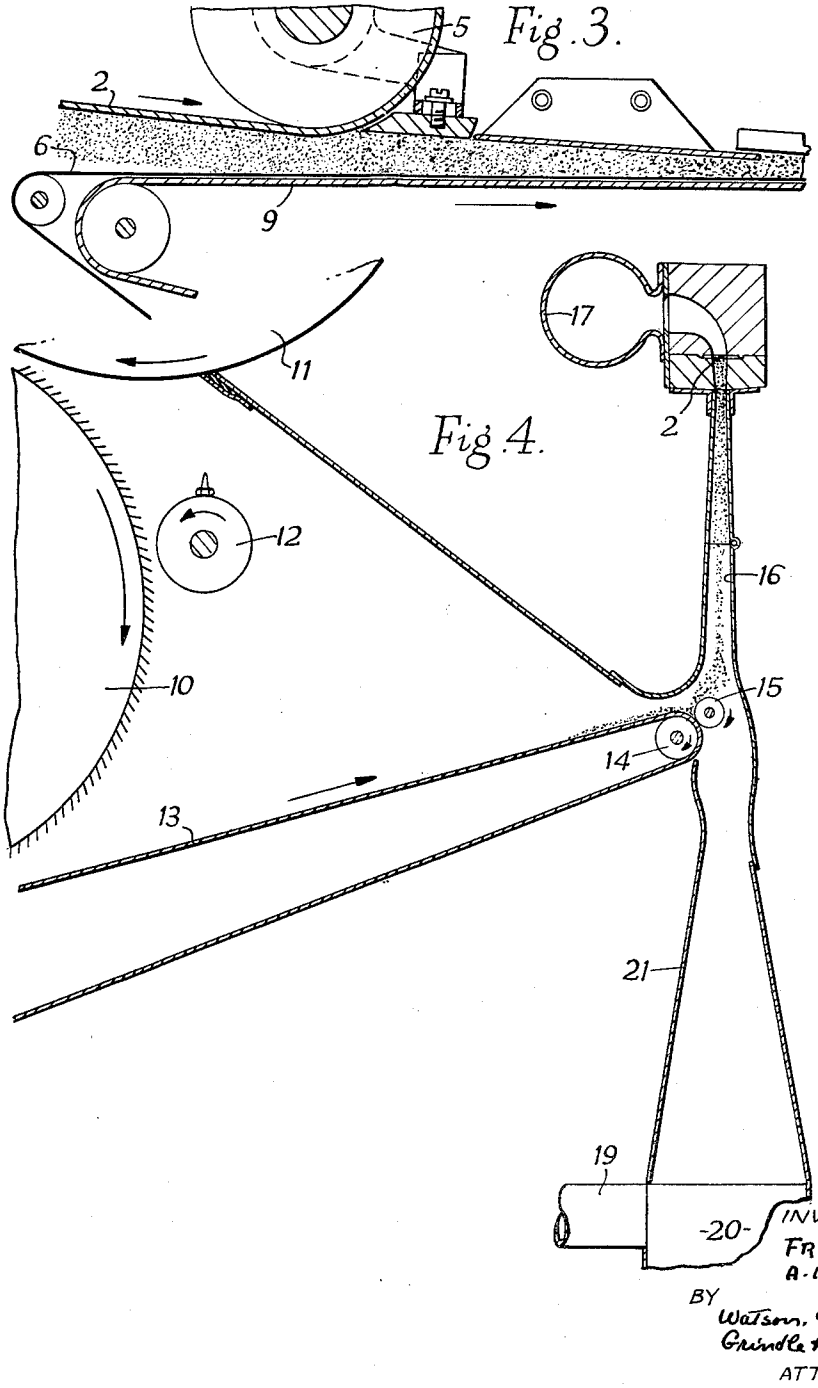

Fig. 4.

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Fig. 5.

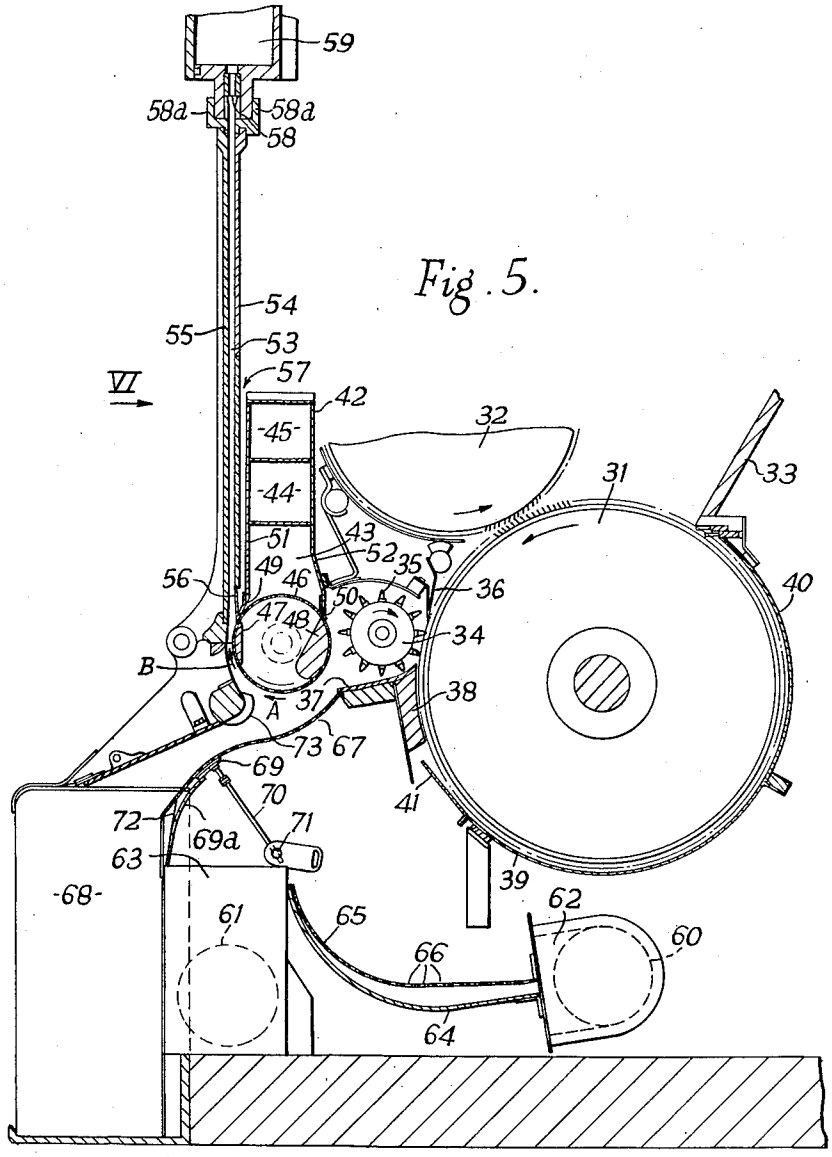

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Fig. 6.

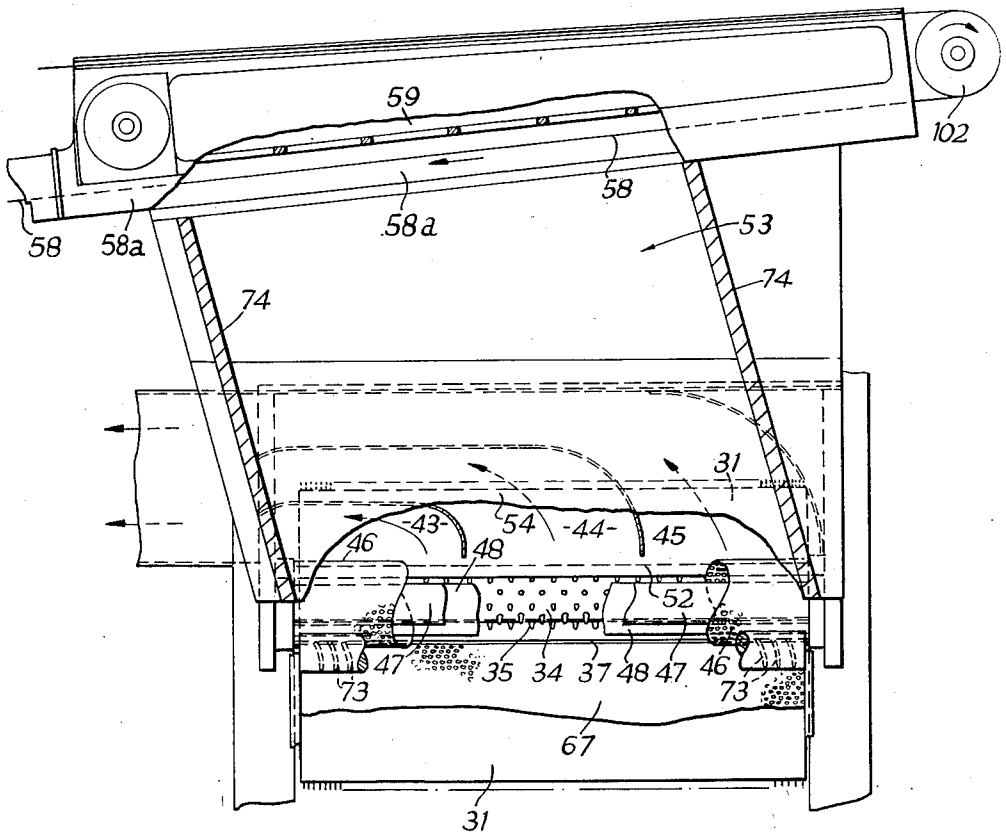

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Fig. 7.

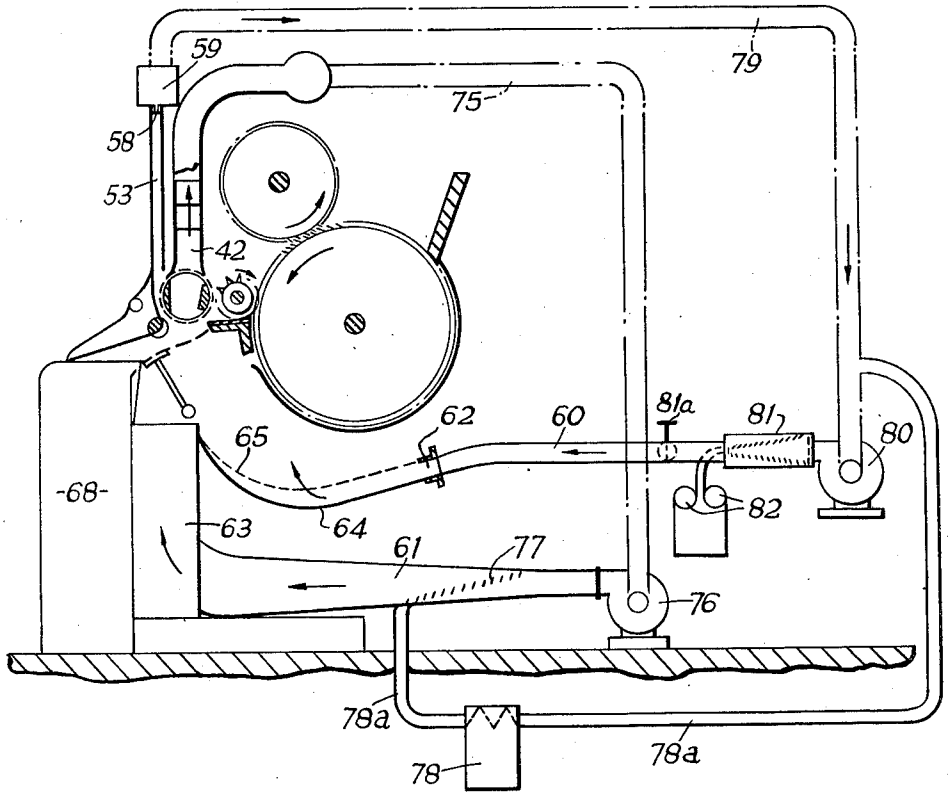

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Fig. 8.

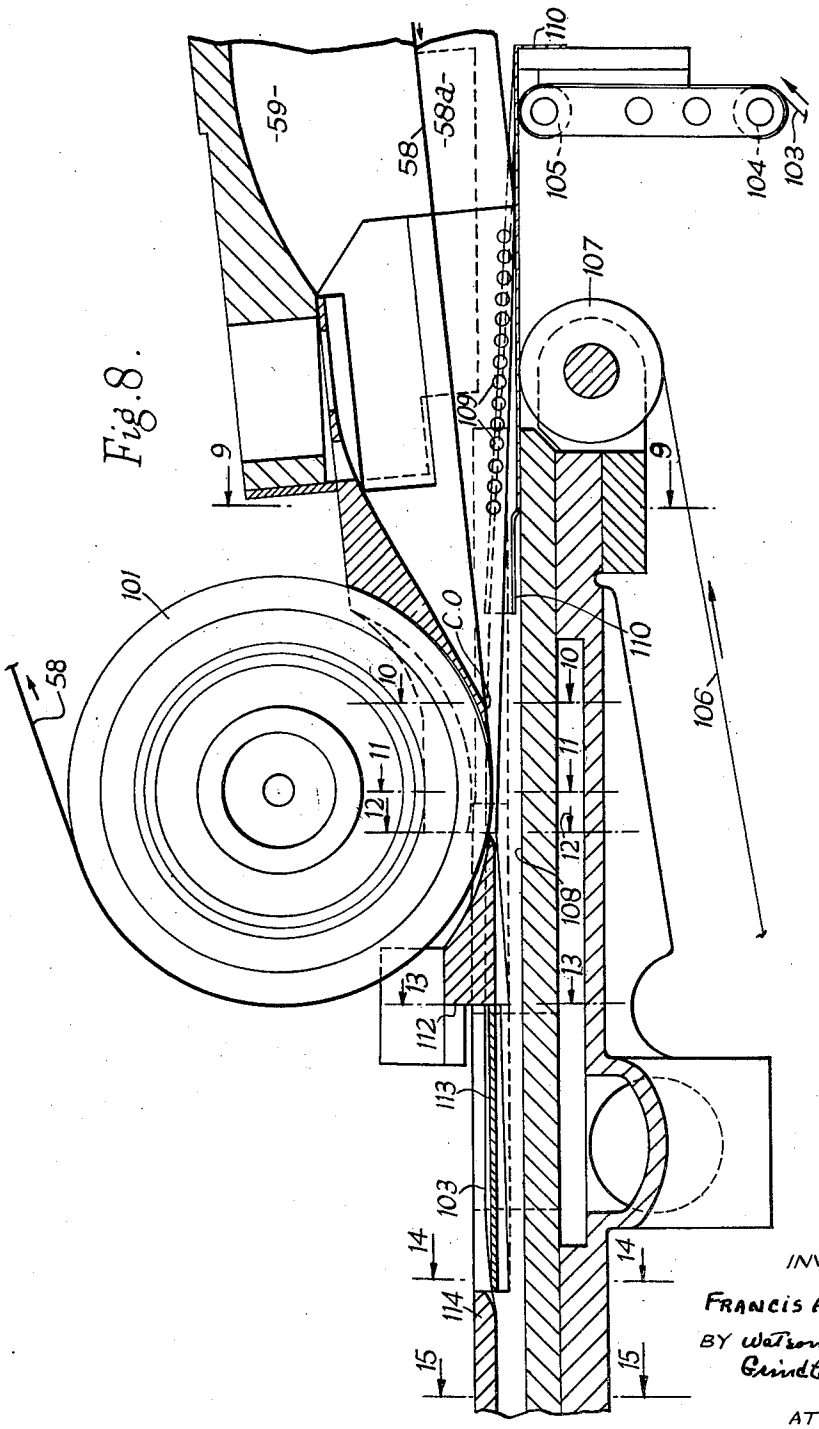

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Fig. 9.

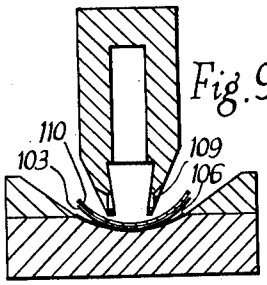

Fig. 10.

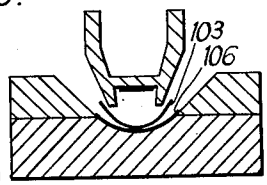

Fig. 11.

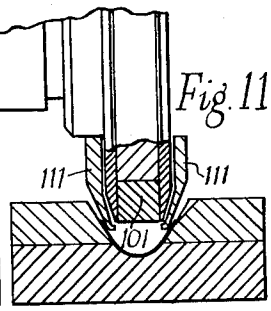

Fig. 12.

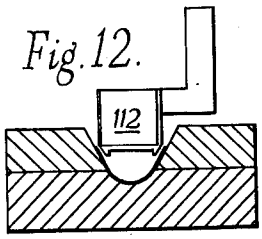

Fig. 13.

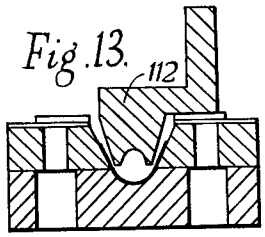

Fig. 14.

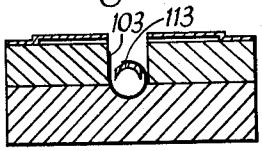

Fig. 15.

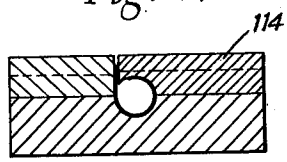

Fig. 16.

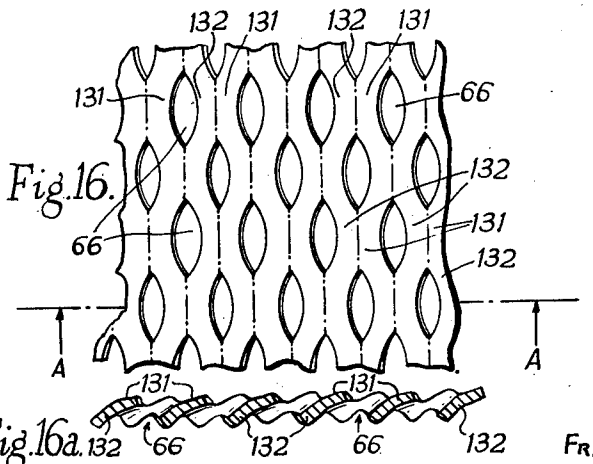

Fig. 16a.

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TOBACCO MANIPULATING MACHINES

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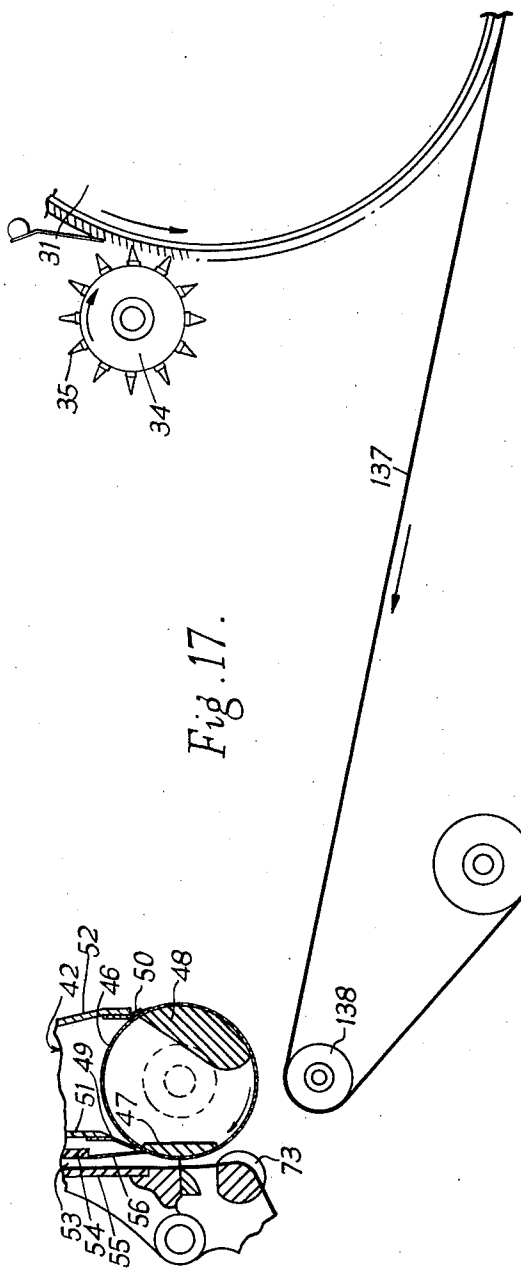

Fig. 17.

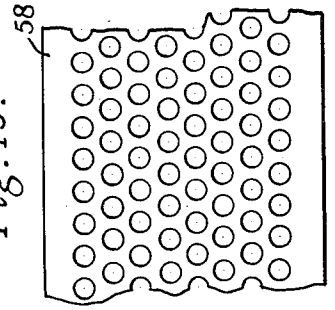

Fig. 19.

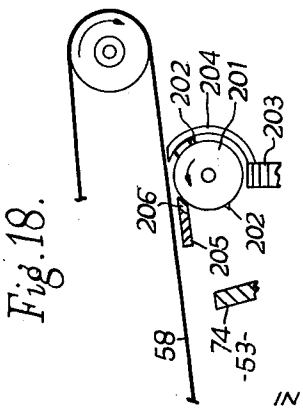

Fig. 18.

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United States Patent Office 3,030,965 Patented Apr. 24, 1962

3,030,965

TOBACCO MANIPULATING MACHINES

Francis Auguste Maurice Labbé, Orleans, France, assignor to Usines Decoufle, Paris, France, a French company

Filed May 29, 1958, Ser. No. 738,805
Claims priority, application France Jan. 7, 1954
37 Claims. (Cl. 131—61)

This application is a continuation-in-part of my co-pending application, Serial No. 479,573, filed January 3, 1955, and now abandoned.

In cigarette-making machines designed to produce a continuous tobacco filler, the tobacco particles are commonly distributed in shower-like fashion on to a belt of woven fabric having a flat or trough-like cross-section and to which a rapid motion is imparted, the tobacco particles forming thereon a continuous, loose charge; this charge is subsequently compressed and then deposited on to a paper web which wraps the tobacco to form, after the gluing operation, a continuous rod which is finally cut to cigarette-size sections.

As a rule, the quantity of tobacco contained by the cigarette manufactured according to this conventional method is not quite uniform in that some cigarettes are over-filled and other cigarettes under-filled with tobacco.

This is due to the fact that the continuous charge of tobacco fed to the belt is irregular; to avoid this lack of uniformity, various procedures have already been proposed.

It is an object of the present invention to provide a method and means adapted to reduce irregularities in the formation of the continuous charge of tobacco on the belt.

For this purpose, according to the invention there is provided the method that consists in:

(1) Distributing the tobacco particles into a smooth-walled duct or passage wherein they are subjected to a very rapid air-stream directed either up or downwardly, such that the tobacco particles cannot agglomerate and form tufts or bundles which, as they settle on the belt, produce local thickenings in the charge.

It has been observed that the greater the velocity of the air-stream, the greater the regularity of the charge; however, this improvement decreases if the velocity of the air-stream thus applied exceeds 50 ft./sec., and it appears economic to adopt this speed for tobacco containing fragments of midribs and speed of 33 ft./sec. when the tobacco used has been stemmed.

(2) Separating the tobacco from the air-stream to form a coherent charge or filler by means of an endless belt of flat or trough-like cross-section, having perforations of any desired shape, dimensioned to prevent the shortest tobacco blades from passing therethrough; for example, holes having a diameter of $\frac{3}{64}$" and spaced at $\frac{5}{64}$" intervals may be employed; the endless belt may consist of a strip of metal, plastic material, woven cotton or any other suitable material.

(3) Conveying the tobacco filler thus strongly pressed by the air pressure against the endless belt between two stationary and smooth walls to the cigarette-paper web while avoiding any reduction in the rate of feed of the filler, which, due to the high degree of cohesion of the tobacco charge, necessarily remains at all times and at all points equal to that of the tobacco-supporting belt. It has been observed that this result is obtained with certainty if the density of the tobacco constituting the filler is at no time or place lower than half the density of the finished cigarette, and if the distance separating the lateral stationary walls between which the belt and the filler carried thereby are moved, undergoes but a very slight reduction along these walls.

(4) Distributing or transferring the filler on to the cigarette-paper web without allowing the former to increase its volume to a substantial extent as this would be detrimental to its cohesion.

Thus according to one feature the invention provides that the velocity of the air stream, and the manner in which the tobacco particles are introduced into it, are such that tobacco particles are violently accelerated by the air stream, in such a way as to ensure that they reach the conveyor band or belt substantially in the form of separated particles. That is to say, those particles which are already separate when introduced into the fast air stream are spaced further apart by being accelerated, and groups of particles which are interlinked before reaching the fast air stream tend to be pulled apart by the sudden acceleration and thus to be carried towards the conveyor band substantially in a separated condition.

The invention also provides means whereby tobacco particles which, in order to be introduced into the fast air stream, are fed towards the latter in a path transverse to the path in which they are to be carried by the fast air stream, are caused to move in a general arcuate path from the first said path to the second, by applying to the particles a generally centripetal force, which latter may be provided by air directed against the tobacco particles. The air so directed may be drawn by suction across the path of the particles and through a perforated guard member which acts as a barrier against excessive inward movement of tobacco particles of normay size, but allows dust to pass therethrough so that the dust is separated from the tobacco. The force used to deflect the tobacco particles is insufficient to cause the heavy particles, such as pieces of stem, to change their direction of movement (due to their greater momentum) to the same extent as the other tobacco particles and the heavy particles can thus be segregated from the tobacco whose direction of movement is changed as aforesaid.

The invention further provides means whereby tobacco being fed to a conveyor band so as to form a filler thereon is given a component of movement in the direction of movement of the band, the said component having a velocity substantially equal to that of the band. This may be accomplished by conveying the tobacco to the band by an air stream which is guided, for example, by vanes, at a suitable angle to the length of the band, and which has sufficient velocity to enable the tobacco to move towards the band with a component in the direction of movement of, and having substantially the same velocity as, the band.

The invention also provides means whereby a tobacco filler may be formed on a porous conveyor band through which suction means act to compress the filler laterally, for example to a density at least half that required in the final cigarette rod, and whereby this compressed filler may be carried by the conveyor band into engagement with a paper web at a position where the latter is curved in cross-section so that the filler is laterally controlled during transfer. Control means may be located immediately beyond the conveyor band to engage the filler when the latter has been transferred to the paper, and a compression tongue and paper-folding means may be located so as to continue the lateral control of the filler and prevent it from expanding laterally or substantially increasing its volume at any time.

Apparatus in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:

FIGURES 1 and 2 are schematic views showing in longitudinal section two alternative forms of embodiment;

FIGURE 3 is a fragmentary view showing on a larger

scale a constructional detail of the arrangement of FIGURE 2, i.e. a device for distributing the filler on to the paper web;

FIGURE 4 is a cross-sectional view showing a tobacco-distributor with ascending air draught;

FIGURE 5 is a sectional end view of a modified apparatus for feeding tobacco and forming a filler;

FIGURE 6 is a side view taken in the direction of the arrow VI, FIGURE 5, and partly broken away;

FIGURE 7 is an end view showing diagrammatically a system of air supply;

FIGURE 8 is a sectional side view showing mechanism for transferring a tobacco filler to a paper web;

FIGURES 9 to 15 are sections taken on the lines 9—9 to 15—15, respectively, of FIGURE 8;

FIGURE 16 is a plan view, greatly enlarged, of a fragment of a perforated plate;

FIGURE 16*a* is a section on the line A—A, FIGURE 16;

FIGURE 17 shows an alternative construction to that shown in FIGURE 5; and

FIGURE 18 shows an arrangement for feeding mouthpiece portions.

FIGURE 19 shows, to a greatly enlarged scale, a fragment of a perforated conveyor band.

In the form of embodiment illustrated in FIGURE 1, the tobacco particles are carried along downwardly through a passage or duct **1** by the air-stream produced through a perforated endless belt **2** passing over rollers **3**, **4** adjacent to the inlet and outlet of the passage, respectively, and also over a roller **5** disposed above an endless paper web **6**, and finally over a return roller **7**.

The tobacco particles, subjected to a strong suction, are pressed against the endless belt **2** without having the possibility of agglomerating in the passage **1** and forming tufts or bundles; the density of the filler formed at the outlet of this passage is greater than half the density of the tobacco in the finished cigarettes.

This filler is then held on the endless belt by the air-suction produced through this belt both around the rollers **4**, **5** and in the sloped zone between these rollers; a positive drive is constantly applied to the filler, firstly between the rollers **3**, **4** and **4**, **5** by the endless belt **2**, then over one portion of the periphery of roller **5**, both by the endless belt **2** and by the paper web **6**; the thickness of the tobacco filler is calculated to cause it to engage simultaneously the endless belt **2** and the paper web **6**; finally, the tobacco filler is carried along by the paper web **6** alone.

In the alternative form of embodiment illustrated in FIGURE 2, the tobacco particles are subjected to a vertical upward suction in the passage **1** due to the high-speed air-stream passing through the endless perforated belt **2** supported at the inlet side of the passage by the roller **8** and beyond the outlet side thereof by the roller **5**.

Then the tobacco is deposited as already described on to the endless paper web **6** so that its drive is constantly positive.

FIGURE 3 illustrates on a greater scale the roller **5** on which the endless perforated belt **2** travels above the endless cigarette-paper web **6** driven by an endless belt **9**.

Adjustment means makes it possible to position the roller **5** so that its level above the paper web **6** enables the tobacco filler to be driven under constantly positive conditions.

The arrangement illustrated in FIGURE 2 may be arranged in the manner shown by way of example in FIGURE 4, i.e. to comprise a cylindrical carded drum **10**, a refuser roller **11** and a picker roller **12** adapted to spread the tobacco particles over a relatively fast-moving conveyor belt **13**. At the entrance to the passage the belt **13** is carried by a roller **14** and another picker roller **15** rotating at high speed in the same direction as the roller **14** is provided for projecting the tobacco particles across the upper part **16** of the passage, at a level thereof where the air-stream produced by a suction nozzle **17** has already reached a sufficiently high speed; the air exhausted through the nozzle **17** is admitted through a duct **19**. The "stems" and foreign substances in the tobacco are not drawn up by the air-stream and they fall into a collector **20** provided for this purpose at the lower end of the lower part **21** of the passage.

The perforated belt **2** travels past the upper end of the part **16** of the passage in close vicinity to its region of minimum width.

Of course, the forms of embodiment described hereinabove are given for illustrative purposes only and should not be construed as limiting the scope of the invention, as many modifications and alterations may be brought thereto without departing from the spirit and scope of the invention as set forth in the appended claims.

Thus notably the distributor illustrated and described is particularly suitable for manufacturing filter-tip cigarettes; in fact, as will be described later with reference to FIGURE 18, it will be sufficient to place the filter tips at suitably spaced intervals on to the endless belt so that they will retain this initial and proper spacing due to the air-stream produced, the tobacco-filler sections forming themselves automatically only between the adjacent ends of the filter-tips; then the cigarettes may be manufactured and completed in the usual fashion, the tobacco-feeding arrangements being adjusted to supply the required quantity of tobacco, due allowance being made for the filter-tips.

Referring now to FIGURES 5, 6 and 7, the apparatus shown comprises means for feeding cut tobacco from a hopper and introducing the tobacco into a passage through which it is conveyed by a stream of air to a perforated conveyor band, on which the tobacco forms a filler which is held on the moving band by suction.

A carded conveyor drum **31**, arranged for rotation in the direction shown by the arrow, FIGURE 5, receives cut tobacco in bulk on the upper part of its carded surface and carries it past a carded refuser roller **32**, all as in Molins' United States patent application Serial No. 769,482, filed October 24, 1958. The drum **31**, the roller **32**, and a wall **33** form the lower part of the tobacco hopper disclosed in the above-mentioned application.

A fast-rotating picker-roller **34**, having picker pins **35**, is arranged to pick tobacco from the carding of the drum **31**, a comb **36** being provided to control the tobacco at the region where it is picked. A guide plate **37** is located beneath the picker roller to guide tobacco particles in a desired direction as they are impelled over the guide plate by the pins **35**. The plate **37** is partly supported by a member **38** having a concave surface close to the carding of the drum **31**.

The picker roller **34** is arranged to rotate at a speed of 1000 revolutions per minute, and its diameter—that is, the distance between the ends of diametrically opposite pins **35**—is about 3.7 inches.

A concave guide **39**, having a concave extension **40** and a straight extension **41**, extends beneath and partly round the drum **1**. The extension **41** projects beneath and is spaced from the member **38** in such a way that air can pass upwardly between the concave surface of the member **38** and the carded surface of the drum, as will be explained later.

Beyond the picker roller **34** is an air duct **42** which communicates with suction means as will shortly be described. As shown in FIGURES 5 and 6 the air duct is divided into three sections **43**, **44** and **45** which extend upwardly from the entrance to the air duct, and then sideways. (In FIGURE 7 the air duct **42** is shown diagrammatically as extending upwardly.)

At the entrance to the air duct **42** is a perforated cylinder **46**, 4 inches in diameter which is arranged to be rotated, in the direction indicated by the arrow, FIGURE 5, and at a speed of 500 revolutions per minute, about two fixed members **47** and **48**. Sealing strips **49**

and 50 extend to the surface of the cylinder from walls 51 and 52, respectively, of the air duct, so as to bear against the cylinder surface at positions where the cylinder passes over the fixed members 47 and 48. Thus air can enter the air duct only through the perforated cylinder and between the members 47 and 48.

Alongside the duct 42 is a long, narrow passage 53 defined by opposed side walls 54 and 55 and between end walls 74 (FIGURE 6). A thin scraper blade 56 made of doctor blade steel is fixed to the lower part of the wall 54 and bears against the surface of the perforated cylinder 46. Between the walls 51 and 54 is a narrow channel 57 open to atmosphere at its upper end.

As can be seen in FIGURE 6, the passage 53 between the end walls 74 is of substantial length and at its lower end coincides substantially in length with the length of the drum 31 and the perforated cylinder 46 and the opening to the duct 42. The purpose of the passage 53 is to guide upwardly a stream of air by which tobacco particles are conveyed towards a perforated conveyor band 58 on which they form a filler. The band 58 runs through a trough formed by opposed walls 58*a* which converge in a direction away from the band. A suction chamber 59 is located above the band 58 to draw air through the band.

The conveyor band 58 is an endless metal band which in the particular construction being described is 9 millimetres wide and is made of nickel, and provided with holes to the number of 700 per square inch of band, each hole having a diameter of 0.026 to 0.028 inch. This arrangement of holes gives a perforated or open area amounting to approximately 30% of the area of the band.

As shown in FIGURE 5, air reaches the duct 42 and the passage 53 by way of two separate supply ducts 60 and 61, from which air is delivered into and through discharge orifices 62 and 63. Extending from the orifice 62 to one wall of the orifice 63 is a curved plate 64, which guides upwardly the air discharged from the orifice 62. Above the plate 64 is a further curved plate 65, which has apertures 66; these are shown in FIGURE 5 as plain apertures but in practice the plate 65 which is made of expanded aluminium, is formed with apertures as shown in the greatly enlarged views in FIGURES 16 and 16*a*. As shown, each of the perforations 66 is bounded at one side by an upwardly sloping part 131 and at the other side by a downwardly sloping part 132, so that the sloping parts in effect from louvres by which air flowing upwardly through the apertures 66 is directed somewhat towards the right as viewed in FIGURES 5, 16 and 16*a*.

A curved, perforated plate 67 extends from the plate 37 to a receptacle 68, which latter is positioned to receive heavy tobacco particles, such as fragments of tobacco stem, which as will be explained later tend to travel past the entrance to the passage 53 and so fall into the receptacle.

A shutter 69 is mounted on pivoted arms 70 which can be swung about a pivot 71 to cause the shutter to cover a greater or less area of the perforated plate 67, in order to regulate the flow of air through the latter. The shutter has an extension 69*a*, movable with it, which bears resiliently against a plate 72 so as to seal off all that part of the perforated plate 67 which extends to the left of the shutter, as viewed in FIGURE 5.

Adjacent the entrance to the passage 53 is a series of side-by-side vanes 73, which are curved as shown in FIGURE 6 in order to direct the air entering the passage towards the left in FIGURE 6—that is, to give the air a component of movement in the direction of movement of the conveyor band 58. The end walls 74 of the passage 53 are set at an appropriate angle of inclination to the length of the conveyor band 58 to allow for this forward component of movement of the ascending air stream.

FIGURE 7 shows on a small scale the general layout shown in FIGURE 5 and illustrates diagrammatically the arrangements by which air is supplied to and drawn through the air duct 42 and passage 53.

Air is drawn from the duct 42 through a pipe 75 by a low pressure fan 76, which blows the air at a pressure of 4 inches water gauge. The greater part of the air from the fan 76 passes through a screen 77 of expanded metal similar to that shown in FIGURES 16 and 16*a*, and thence through the pipe 61 to the discharge orifice 63. A small proportion of the air, with most of the dust, is deflected by the screen and passes through a dust-removing cyclone 78 by way of a pipe 78*a*.

The air which passes upwardly through the passage 53 is drawn through the band 58 into the suction chamber 59 and from there through a pipe 79 by a high-pressure fan 80 which exerts a pressure of 34 inches water gauge. The air blown by the fan 80 passes through a dust-separating device 81 comprising a conical tube of louvred metal. The greater part of the air, having been substantially freed from dust by the separating device 81, is discharged through the pipe 60 and orifice 62, past a manually controlled regulating valve 81*a*. That part of the air which does not escape through the perforations of the louvred tube in the device 81 is led from the latter through a pair of dust-removing cyclones 82, which have a high efficiency, and thence escapes into the atmosphere. The reason for allowing some air to escape to atmosphere is that some air is drawn through the conveyor band into the suction chamber 59 at a position to the left of the passage 53 as viewed in FIGURE 6, at which position the conveyor band is open to atmosphere.

The air which passes through the cyclone 78 is led by the pipe 78*a* into the pipe 79 as shown.

It will be understood that the arrangement and disposition of the pipes 60, 61, 75 and 79, as well as of the fans 76 and 80 and the various dust-separating devices, is for clarity illustrated merely schematically in FIGURE 7 in order to show the way in which the air is circulated.

It will now be convenient to describe the operation of the apparatus so far described with reference to FIGURES 5–7, since it concerns the feeding of tobacco to form a tobacco filler, while the apparatus shown in FIGURE 8 concerns the transfer of the filler so formed to a paper web, and will be described later.

Referring to FIGURE 5, cut tobacco is carried forward by the carding of the drum, surplus tobacco being brushed back by the refuser roller 32. The tobacco carried past the roller 32, in the form of a "carpet," is picked from the teeth of the carding by the pins 35 of the picker roller 34, which rotates at high speed, for example 1000 revolutions per minute as stated above. The pins 35 impel the tobacco across the guide plate 37 at considerable speed, and in a substantially separated condition—that is to say, to a considerable extent in the form of discrete particles.

It will be seen that the tobacco thus impelled is travelling in a path which is transverse to the path in which it is to be conveyed towards the conveyor band 58, and it is necessary to change its direction of movement.

It is an important feature of the apparatus that the tobacco should be delivered to the conveyor band 58 as far as is practicable in the form of separated particles, for reasons which will be mentioned when the formation of the filler is described. It is accordingly necessary to effect the change of direction of the tobacco in such a way as to avoid, as far as is practicable, any reduction in the speed of the tobacco particles during or immediately after such change.

For this purpose the change of direction is effected by directing air against the particles (as they approach the entrance to the passage 53), in such a direction or directions, and at such velocity of velocities, in relation to the velocity of the tobacco impelled towards the said entrance, as to cause the particles to move through a generally arcuate path. The air discharged upwardly through

the perforated plate 67 is drawn partly through the passage 53 and partly through the perforated cylinder 46 into the duct 42. That part of the air which passes through the perforated cylinder 46 moves at a speed of about 10 feet per second in a direction or directions such that at any rate a substantial proportion of the air can be said to move approximately radially in respect of the axis of the perforated cylinder 46. For example, some of the air may move in a substantially vertical direction through the said axis. Further, the fixed member 48 is shaped to guide air which flows past it in an approximately radial direction.

Thus although it probably cannot be said that the whole of the air flowing through the cylinder is directed radially, a good proportion of it moves approximately radially, and at any rate in converging directions, and other parts of the air have a substantial component of movement in the radial direction. Accordingly the air which is drawn across the path of the tobacco particles into the duct 42 can be said to move in converging directions so as to apply an external and generally centripetal force to the tobacco particles, the average value of this force, in relation to the velocity of the particles, being such as to cause the latter to move through a generally arcuate path which leads them into the passage 53.

The term "external force" as used above is to be understood as meaning a force other than that which would be exerted by the reaction of a solid surface, such as an arcuate guide surface. It may be pointed out here that an arcuate guide surface would for the present purpose be an unsatisfactory means of changing the direction of the tobacco particles, since their speed would necessarily be reduced by friction between the particles and the curved surface, and as pointed out above, reduction of the tobacco speed is to be avoided as far as practicable. The reason for this is that any such reduction in speed must have the effect of reducing the separation of the particles one from another, with a consequent risk that some of the particles may become intertwined or interlinked, thus forming clumps or bunches, which it is desired to avoid.

The perforated cylinder acts as a guard member to prevent undue inward movement of the particles, and is rotated at a high speed, for example 500 revolutions per minute, such that its surface speed, for example about 8.5 feet per second, is in excess of the speed of the tobacco particles, which move past the cylinder at a speed of about 8 feet per second. Thus if any particle touches the cylindrical surface of the cylinder, it is likely to be thrown off, to be again constrained by the air to move through a substantially arcuate path.

The force exerted by the air is sufficient to change the direction, in the manner described above, of most of the tobacco particles, but relatively heavy particles, such as pieces of tobacco stem, are not deflected by the air, but tend to continue more or less in their original path by reason of their greater momentum. These heavy particles move past the entrance to the passage 53 and fall into the receptacle 68 which is suitably placed to receive them.

The perforated plate 67 acts as a guard to prevent any tobacco particles from falling downwardly.

Whereas exceptionally heavy particles, as just described, are in general not deflected by the air, tobacco dust, such as is usually present in cut tobacco, is deflected more than the tobacco particles and is drawn through the perforated cylinder 46 and passes with the air through the pipe 75, to be separated from the air in the cyclone 77. In the particular construction being described, the holes in the cylinder 46 are 0.026 inch in diameter and number 625 holes per square inch of the cylinder circumference.

As mentioned above in the description of FIGURE 5, there is an opening for air to enter the space between the concave member 38 and the carded surface of the drum 31. The purpose of this is to enable air to exert a pressure in that space such as to tend to prevent short tobacco fragments (generally referred to as "shorts") from being carried downwardly by the carding, and thus to cause them to be impelled, together with the longer tobacco, across the plate 37 by the picker pins 35. Any heavy pieces of stem, however, which may be left in the carding, are unlikely to be blown back like the "shorts," and therefore tend to be carried around by the carding of the drum back into the hopper.

Mention has also been made of the channel 57 between the duct 42 and passage 53. This channel is open to atmosphere in order to allow air to be drawn through it downwardly, and between the cylinder 46 and the scraper 56, by the suction exerted by the fast moving stream of air passing up into the passage 53. The purpose of this is to provide a flow of air past the cylinder surface in order to assist the scraper 56 in removing from the cylinder any particles of tobacco which may be clinging to it, and to urge any such particles into the air stream passing into the passage 53.

In the particular construction being described, the perforated cylinder 46 has a radius of 2 inches, and this may be considered as the minimum radius of the generally arcuate path through which the tobacco particles are caused to move. In operating the apparatus, the velocity of the tobacco approaching the entrance to the passage 53 is about 8 feet per second, while the velocity of the air directed substantially radially against it and drawn into the suction duct 42 is about 15 feet per second.

In practice in the examples described herein the following formula may be applied in order to obtain the required change of direction of the tobacco particles:

$$\frac{Vt^2}{R}=g\frac{Va^2}{Vl^2}-g\cos\theta$$

where

R=mean radius of curvature of path of tobacco particles,
Va=mean velocity of air directed substantially radially against the tobacco,
Vt=mean velocity of tobacco particles whose direction is to be changed,
Vl=limiting or terminal velocity of tobacco falling freely in air, which on the average is found to be in the neighborhood of 4 to 5 feet per second,
g=acceleration due to gravity, and
θ=the angle made by the tangent of the trajectory of the tobacco particles with the horizontal.

In the examples described herein with reference to FIGURES 5 and 17, the angle θ has, as a practical matter, been ignored since, at the stage where θ is large, the force (to be described later herein) which accelerates the tobacco particles up the vertical passage 53, combines with and assists the centripetal force now under discussion.

The passage 53, as can be seen in FIGURE 5, is very narrow, and the air drawn into it is therefore greatly accelerated and caused to move towards the conveyor band 58 at high velocity. In the particular example being described, this may be within the range of 40 to 45 feet per second.

Since by the arrangement described above, the tobacco fed and impelled by the picker pins 35 in a substantially separated condition has been guided and led into the passage 53 without any substantial reduction in its velocity, it tends to reach the entrance to the passage in substantially the same condition of separation as it had when leaving the picker pins. As the tobacco enters the stream of air which is moving upwards into and through the passage at high velocity, it is immediately and violently accelerated by the faster-moving air, and thus the spacing between tobacco particles is in most cases increased. Moreover, particles which are linked to one another tend, on enter-

ing the high speed air stream, to be pulled apart by the sudden acceleration imparted by the air.

Where particles which are linked together are as a whole given an acceleration there is no force acting on any part of the interlinked group to cause the separation. In practice, however, as these interlinked particles will be moving towards the fast stream in random form, it is unlikely that the whole of the group will be presented simultaneously to the sudden acceleration. A part of a group is likely to enter the stream before the remainder and the group progressively enters the fast air stream so that the parts as they enter the stream are subjected to the accelerating force while parts not yet in the stream are not subjected to that force. Accordingly there is a pull applied to those parts of the group which are in the stream tending to pull those parts away from parts not in the stream. It is this fact which provides the possibility of getting good separation in by far the greater part of the tobacco being fed to form the filler. Furthermore, it is more than likely that any particular shred of tobacco will be presented to the air stream in such a way that one end or one part only of the shred is subjected to the accelerating force of the stream, which therefore pulls that part of the shred in the direction of movement of the air stream, leaving the other part to trail behind, and as each part is brought into the air stream so it follows the leading part of the shred. Thus, in addition to the separating action there is a tendency generally to orientate individual shreds in the direction of movement of the air stream in addition to separating such shreds from one another. The result then is that these shreds so orientated reach the filler endwise on and fold up on themselves on impact with the filler. This is a factor which is beneficial to the filling qualities of the tobacco, thus making the filler and final cigarette rod firm to the touch.

It has been stated above that the picker pins **35** impel the tobacco across the guide plate **37** in a substantially separated condition. It will, however, be understood that the tobacco so picked and impelled is not necessarily in a completely separated condition, even at the instant when the tobacco particles are picked from the drum **31** and thrown forwardly, since a picker pin may engage and throw an interlinked group of particles. Moreover, friction between the tobacco and the plate **37** will retard those particles which engage the plate, and in general, the tobacco, by the time it is acted on by the generally centripetal force exerted by the air flowing through the perforated cylinder, has lost some of its initial velocity. This retardation of the tobacco may tend to cause interlinking of particles. It will therefore be understood that the tobacco when coming within the range of action of the high-speed air stream which carries it through the passage may well include a considerable proportion of particles which are interlinked in groups and which should, in order to obtain the best results, as far as is practicable be separated by the accelerating force exerted on them by the high-velocity air stream.

It is to be understood, therefore, that references herein to the tobacco being impelled substantially in the form of separated particles, or in a substantially separated condition, are intended to include the case where the particles are not completely separate and discrete, for reasons such as have just been explained. In the construction and arrangement being described, the presence of a fairly high proportion of interlinked particles of tobacco necessitates a high acceleration of the tobacco in the passage in order to pull the particles apart as well as to maintain separation of particles. Accordingly the change of direction of the tobacco from its first path into the second path can be effected without greatly accelerating the tobacco during this change of direction and before it enters the passage. On the other hand, in a construction in which it is practicable to ensure that the tobacco shreds are initially fed in a substantially complete state of separation, there may be less need for such a high acceleration in the passage to effect any necessary separation, and the tobacco can, in such a case, with advantage be considerably accelerated during its change of direction in order to effect a more gradual increase in the separation and spacing apart of the tobacco particles, and to ensure that no aggregation and interlinking of separate particles is allowed to occur during this stage.

In the construction described herein, the tobacco as it moves past the cylinder **46** has a speed of about 8 feet per second in the region marked A in FIGURE 5, and in the region marked B where it has changed its direction of movement, its velocity is about 17 feet per second. Thus although the tobacco has been somewhat accelerated while moving in its generally arcuate path, the velocity of 17 feet per second is low compared with the velocity of the air through the passage **53**, namely 40 to 45 feet per second.

From what has been stated above concerning the deflection of the tobacco particles from their horizontal path to their vertical path in the passage **53**, it will be seen that there are a number of variables, namely, speeds of particles and air, radius of curvature of the desired path of the tobacco particles, and the sizes of the particles which are to be segregated, on the one hand into the receptacle **68**, and on the other through the mesh of the cylinder **46**. If it were possible to have perfect conditions where no dust particles exist, it might be possible, in theory, to arrange the velocity of the centripetal air flow so as to cause the tobacco particles to travel in a desired arcuate path without the need at all for any cylindrical-shaped screen surface such as the cylinder **46**.

In practice, however, where the size of particles in the tobacco varies widely and includes at the one end stalks and birds' eyes, and at the other end fine dust and other very short particles, it will be appreciated that there are always some particles which are drawn away by the suction during the operation of changing their path. Such particles in the present case, which do not pass through the cylinder **46** will be carried round by the cylinder and be scraped off at the bottom of the vertical passage, if they are still adhering to the perforated surface of the roller at that point. Generally, some particles of tobacco will be held against the surface of the cylinder **46** and carried round thereby, although with carefully regulated air-speeds the amount of tobacco carried by the roller can be reduced very considerably. In the arrangement shown in FIGURE 5, it is desirable, in order to reduce the possibility of interlinking of tobacco particles, to prevent them, where possible, from closing on to the surface of the cylinder **46**, and accordingly the air speeds and directions should be chosen with this purpose in view.

FIGURE 17 shows an alternative construction to the apparatus shown in FIGURES 5 and 6. In this alternative construction, tobacco picked from the carding of the drum **31** by the picker roller **34** is impelled by the pins **35** so as to fall on to a wide endless band **137**, instead of being impelled over a plate such as the plate **37** in FIGURE 5.

The band **137**, whose width extends the whole length of the drum **31** and of the perforated cylinder **46**, is arranged to move at a speed of about 4 feet per second. The drum **31** rotates with a surface speed much less than this—for example depending on the rate of tobacco feed, is about one-tenth of the speed of the band **137**. Accordingly tobacco particles picked from the carding of the drum **31** tend to be generally sparsely distributed over the surface of the band **137**.

The perforated cylinder **46** rotates, as in the construction already described, with a surface speed of about 8.5 feet per second. The air speeds may be the same as described above with reference to FIGURE 5.

The band **137** passes about a roller **138**, and the tobacco particles on leaving the band are immediately subjected to the generally centripetal force exerted by the air flowing towards and through the cylinder **46**, and con-

sequently move in a generally arcuate path towards and through the entrance to the passage **53**.

In this construction, the particles carried by the band **137** are, as pointed out above, generally sparsely distributed. When they leave the band **137** their forward speed is very much less than the surface speed of the perforated cylinder, and accordingly the air flowing through the perforated cylinder can if desired be caused to move with such velocity as to draw the bulk of the tobacco on to the surface of the cylinder, to be carried by that surface in an arcuate path in order to change its direction.

A scraper **56** can strip off any tobacco still in contact with the cylinder at that point in substantially the same way as in the construction described with reference to FIGURE 5.

It will be appreciated that in the arrangement just described with reference to FIGURE 17, the surface speed of the cylinder **46** is, as pointed out above, greatly in excess of the speed of tobacco leaving the band **137**.

The tobacco particles, once deposited on the band **137**, soon come to rest on the band so that thereafter there is no relative movement between the particles on the band. In this way no opportunity is afforded to the tobacco particles to bunch together once they are at rest on the band. In the arrangement described, the tobacco is thrown from the picker roller downwardly to the band, and, as can be seen, the arrangement is such that there is little opportunity or time for the tobacco particles to interlink before coming to rest on the band. When the tobacco particles leave the band and come under the influence of the air passing through the cylinder **46**, they are accelerated before they are brough to rest on the surface of the cylinder **46**, and their spacing is thus generally increased. During the time while they are at rest on the cylinder **46**, there is no further relative movement between them, and thus no further opportunity of interlinking can occur other than that portions of tobacco which overlap will be pressed together against the cylinder **46**. However, the extent of interlinking cannot materially increase, in that the extent of entanglement cannot materially change when the particles are on the cylinder **46**. Thus, the treatment of the tobacco in the arrangement shown in FIGURE 17 makes it possible to take the tobacco through its arcuate path by being held against the surface of the cylinder **46**, instead of being caused to move through the desired arcuate path purely by aero-dynamic means as described with reference to FIGURE 5.

It is not considered advisable to carry the tobacco around on the surface of the cylinder **46** in the construction described with reference to FIGURE 5, because in that arrangement the tobacco particles moving from the picker roller towards the cylinder **46** are not resting on one another and therefore occupy a greater volume in space than the particles which are resting on the surface of the band **137**, FIGURE 17. Where tobacco particles are travelling unsupported in space, reducing the volume they occupy will increase the extent of and possibility of interlinking between particles. Thus as in the case such as in FIGURE 5 where the particles are freely moving in space, it is considered most desirable that they should be caused to continue to travel freely in space. On the other hand, in the arrangement in FIGURE 17, where they are already at rest on the band, there is no materially increased tendency for them to interlink when they are fed from the band and pressed against the surface of the cylinder **46**.

Where stems are not previously extracted from the tobacco, portions of stem can be caused to be separated from the tobacco coming from the band **137**, generally in a similar manner to that adopted for such separation in the arrangement shown in FIGURE 5.

Where tobacco particles are fed transversely into a narrow passage, through which a high-speed current of air, moving in the neighbourhood of 30–50 feet per second, is flowing, the tobacco particles being fed transversely into the stream are, by the nature of things, whether linked or otherwise, subjected to a sudden and violent acceleration. This is because the particles must necessarily enter the passage with a relatively low velocity in the direction of the fast air stream which flows through the passage. This is so whether the linear speed of the tobacco approaching the passage entrance is comparatively low, as may be the case (as in the arrangement shown in FIGURE 17) when the tobacco is received from a picker on to a wide endless band, moving at about 4 feet per second, or whether (as in the arrangement shown in FIGURE 5), the tobacco is thrown directly by a picker towards that high-speed current of air and increases its speed from 8 to 17 feet per second before entering the passage. The thickness of the stream is about 10 mm. in the arrangement shown in FIGURE 5, and is only about 2 to 4 mm. in the arrangement shown in FIGURE 17. Therefore each particle and, in fact, each part of a particle entering that stream is subjected in turn immediately to this accelerating force, thus producing all the beneficial effects mentioned above.

In other words the results can be and are, in fact, obtained by subjecting the tobacco shreds to a very rapid air-draught such that they cannot agglomerate or form tufts or bundles.

It will be plain from the specification that it is important that the particles reaching the perforated band should as far as practicable reach the band in a separated condition.

If in a machine the particles fed, by the picker roller in the present case, or in any other manner, were fed regularly as separated discrete particles, then all that would be necessary to do would be to take steps to avoid that such particles or any substantial proportion of them should become interlinked before reaching the band, and it would therefore be advisable to take such steps as soon as possible. To avoid interlinking in such a case, one of the easiest steps is to cause acceleration of the particles so that they get further apart from one another and the possibility of interlinking becomes reduced. In general therefore the greater the separation by acceleration the less will be the probability of the particles becoming interlinked in such a case.

On the other hand if the particles coming from the picker or band, as the case may be, are already to some material extent interlinked, then it is important to ensure that such particles are separated by the application of an external force. That is to say, a force must be exerted on each group of interlinked particles which should be greater than the resistance that can be offered, by two or more pieces of the group, to the force trying to separate them. The extent of that resistance tending to hold them together, depends on length, curvature, thickness, moment of inertia of section of tobacco, shape of edges and various other factors. Further, the degree of interlocking of particles of a particular blend or mixture of tobacco which is to be used on a machine will, of course, vary quite considerably, since the strands can take up so many varying positions relative to one another. Thus, in dealing with any particular blend or mixture which is to be used in a machine, one should ensure that the force which is to be applied to separate interlinked particles, will always be great enough to separate as far as practicable all different combinations of interlinking that are likely to be experienced with that type of tobacco under the conditions in which it is likely to arrive at the entrance to the passage carrying the fast air-stream. That force which is to be applied to separate the particles will, for convenience hereinafter be referred to as the "separating force."

Generally, in practice, the tobacco particles are not all discrete nor are they all interlinked, and as will be explained later in connection with the particular example being described, the particles coming from the picker are accelerated for the purpose of, first, reducing the natural tendency for the interlinkage to increase and second, to

give a sufficiently high acceleration to provide the necessary separating force to pull apart the bulk of interlinked particles.

One practical way in which the separating force can be provided is to ensure that the machine has fans, motors and air ducts so arranged that a sufficient acceleration will be given to the tobacco particles by a high-velocity air-stream to ensure and maintain separation in the case where the particles are already fed separately to the high-velocity air-stream. In the present case, where a substantial number of particles are already interlinked, then, of course, it is necessary to ensure that the air velocity by which the particles are given a sudden acceleration will suffice to provide the necessary separating force.

Generally speaking, velocities varying between 30 to 50 feet per second will usually suffice for this purpose, with most types of tobacco, especially in cases such as the present where the tobacco being fed towards the fast stream is fed transversely to the direction of movement of that stream. In such cases the stream may be approaching the passage **53** at a speed of about 8 feet per second, as is the case in the arrangement shown in FIGURE 5. In the construction shown in FIGURE 17, however, the tobacco particles are carried on the endless band **137** at a speed of about 4 feet per second. In both cases the tobacco is brought into the direction of movement of the air up the passage **53**, by causing the tobacco to travel in an arcuate path. In moving around that path a certain acceleration is given to the tobacco in each of the two examples described. Thus in the construction described with reference to FIGURE 5, the velocity of the tobacco increases from about 8 feet per second at position A to about 17 feet per second at the position B. This however is a relatively small acceleration, and the difference between the velocity of the tobacco in the direction of the fast air stream (namely about 17 feet per second at the position B) and the velocity of the fast airstream itself at that point, is great enough to provide effective acceleration of the tobacco such as to cause the necessary separation of particles, with most kinds of cigarette tobacco, when the air is travelling through the passage **53** at a speed of 40 feet per second or more.

Thus, it will be seen that no precise speed can be specified for the air or for the tobacco for all cases, but these are variables which will depend upon the nature of the tobacco and on its condition at the time that it is introduced into the fast air stream and the manner in which it is introduced into the fast air stream.

Due to the relatively narrow thickness of the tobacco stream, and its manner of introduction to the fast stream, the tobacco particles are rapidly brought completely under the influence of the fast-moving stream. Thus assuming that the velocity of the tobacco particles in the direction of the fast air stream is maintained at 4 to 8 feet per second up to their delivery into the fast air stream, the acceleration given to each particle of tobacco as it enters the fast air stream is sufficiently violent, even where the air velocity is as low as 30 feet per second, to effectively separate interlinked particles of most mixtures of cigarette tobacco encountered in practice, when picked, separated and delivered as shown in FIGURES 5 and 17.

The separating force required can, however, be determined by ascertaining experimentally the maximum force needed to pull apart typical samples of interlinked groups of particles of the tobacco to be used, and increasing this force by a sufficient factor to provide a "separating force" as discussed above. The various velocities required can then be calculated.

Where, as in the arrangement being described, the separating force is to be applied by means of a high-velocity stream of air, the required velocities can be calculated. It is found by the present inventor that the force exerted on any part of the tobacco by the air-stream varies as a function of the square of the difference between the velocity of the air and the velocity of the tobacco in the direction of movement of the air.

This can be expressed by the general formula:

$$F=mg\frac{(Va-Vt)^2}{(Vl)}\pm mg$$

Where

Va=velocity of air stream,

Vt=velocity of tobacco in the direction of movement of the air stream,

Vl=limiting or terminal velocity of tobacco falling freely in air, which on the average is found to be in the neighbourhood of 4 to 5 feet per second,

m =average mass of a tobacco particle, and

F =required separating force.

In the above formula, the expression "$\pm mg$" relates to the two alternative cases in which the air stream is directed upwardly and downwardly respectively. (In the construction being described, the air is of course directed upwardly, and the appropriate expression is "$-mg$".) Since, however, the expression "$\pm mg$" is very small relatively to the first expression, namely,

$$mg\frac{(Va-Vt)^2}{(Vl)}$$

it can be neglected.

It will thus be seen that when the "separating force" F referred to above has been selected for any particular condition or type of tobacco to be used, the above formula can be applied to find the required difference in velocity between the air-stream and the tobacco upon which it acts, and hence to find the required air velocity in any particular construction to satisfy F in the equation when using the particular tobacco for which the particular value of F has been chosen.

In practice the "separating force" thus found will impart a sudden and violent acceleration to the tobacco.

As a result of feeding the tobacco towards and into the passage **53** in the way described above, most of the tobacco reaching the conveyor band **58** does so in the form of separate particles. This has the valuable result that the tobacco filler built up on the conveyor band by the arrival of these substantially separated particles is subjected to the minimum disturbance during its formation, since an individual particle has insufficient mass to create any significant disturbance or displacement of tobacco already on the conveyor band. It will be appreciated that where groups or "lumps" of interlinked tobacco particles strike the filler simultaneously (as they do in conventional cigarette-making machines where the tobacco is showered and falls by gravity down a chute on to the conveyor band) this can result in considerable disturbance and displacement of the tobacco already in the stream or filler which is in the process of formation.

Disturbance of the filler during its formation is further reduced in the present apparatus by reason of the fact that considerable suction is applied to the filler through the perforations in the conveyor band **58**. This suction applies sufficient pressure to the tobacco not only to hold it firmly to the band, but in addition to compress it, during its formation, to such an extent that the completed filler as it moves out of the passage has a density which is at least half that required in the final cigarette rod—in the apparatus at present being described, the density of the filler as formed on the band **58** has a density two-thirds that of the final rod.

This compression of the filler during its formation gives it a strength, firmness and rigidity sufficient to enable it to withstand the bombardment to which it is subjected by the fast-moving tobacco particles, even though some of these particles may be heavier than normal (for example occasional pieces of stem may be carried into the passage **53**) or some groups or bunches of particles may reach the filler in an interlinked condition.

As has been stated above, the air entering the passage

53 is guided by the curved vanes 73 in a direction inclined to the length of the conveyor band 58, as viewed in FIGURE 6, and the end walls 74 of the passage are suitably inclined to assist the air to flow in the desired direction, namely a direction such that the air has a component of movement in the direction of movement of the conveyor band 58 which is substantially equal in velocity to the forward speed of the conveyor band.

This has a further beneficial result in the formation of the filler, since the tobacco particles (which on reaching the conveyor band are moving up with substantially the speed of the air which carries them minus their velocity downwards due to gravity) are in this way enabled to reach the conveyor band (or the partly formed filler carried thereby) with substantially no movement relatively to the conveyor band considered in the direction of movement of the band. That is to say, the effect is the same as if the conveyor band were stationary and the tobacco particles travelled to it in directions substantially normal to the band.

This has the important effect of overcoming or at least greatly reducing a difficulty which has long been known in the cigarette-making art, namely the irregularity in the formation of a filler which is caused by showering tobacco by gravity on to a travelling surface in such a way that tobacco already on the surface is actually moving past the falling tobacco. That condition results in irregularities because any upstanding or projecting parts of the filler or stream tend to intercept falling tobacco particles, thus causing undue accumulation of tobacco in front of and on top of such projecting parts, with corresponding sparsity of tobacco immediately behind such parts.

Various attempts have been made in the past to overcome this difficulty by attempting to give the falling tobacco a forward component of movement. Since, however, cut tobacco falling freely in air (such as when showered by the usual picker) has on the average a terminal velocity which is in the neighbourhood of 4 to 5 feet per second and which is attained in free air in about 3 to 4 inches, and since the average speed of the conveyor band which receives the tobacco is, in most conventional machines at the present time, also in the region of 4 to 5 feet per second, it will be seen that it is impossible in such conditions to give to the freely falling tobacco a component of movement in the direction of movement of the conveyor band which is equal or even nearly equal in velocity to the velocity of the conveyor band.

In the present apparatus, however, this is possible because of the very high velocity at which the tobacco is carried by the air stream towards the conveyor band 58. In the present case the velocity of the air stream through the passage is 40 to 45 feet per second (giving a resultant upward tobacco velocity of approximately 35 to 40 ft./sec.), while the angle between the direction of the air stream and tobacco approaching the conveyor, and the perpendicular to the conveyor, is 9°. For this arrangement an appropriate speed for the conveyor band is approximately 5.5 to 6.25 feet per second. If higher velocities of the conveyor band are required in order to increase the rate of cigarette production, the velocity of the air through the passage can be suitably increased so as to maintain the desired forward component of movement of the tobacco, without having to alter the angle of 9° mentioned above.

The apparatus by which the tobacco filler formed on the perforated band 58 is transferred to a continuous cigarette-paper web will now be described with reference to FIGURES 8–15.

The conveyor band 58 passes about a drive roller 101, FIGURE 8, and a further roller 102 which is shown in FIGURE 6. As seen in both FIGURE 6 and FIGURE 8, the band is slightly inclined to the horizontal so as to slope downwardly in the direction in which it carries the filler.

The suction chamber 59, as well as the walls 58*a* forming a trough for the filler, extend beyond the passage 53 (to the left as viewed in FIGURE 6), the trough beyond the enclosed passage being open to atmosphere as mentioned above. The suction chamber 59 extends to a position beneath the drive roller 101, beyond which point no positive suction is exerted on the band 58. A substantial length of the conveyor band extends over a paper web 103 which is led over guide rollers 104 and 105 to run horizontally towards the left, FIGURE 8, being supported and carried by an endless garniture tape 106 which passes over a roller 107 to run through a garniture trough 108. It will be seen from FIGURE 8 that the conveyor band 58 and the paper web 103 move in convergent paths in the region where they overlap. The paper web is arranged to move at the same speed as the perforated conveyor band.

The walls 58*a* of the trough, which confine the filler laterally, are suitably tapered off, as illustrated in FIGURE 8, to allow the conveyor band and paper web to converge. At a position where the conveyor band and paper web overlap, and where the trough is thus partly masked by the paper web, holes 109 are provided in the walls 58*a* to allow air to be drawn in through the conveyor band.

The garniture trough 108 changes gradually in cross-sectional shape from the roller 105 to the position just beyond the end of the suction chamber 59. This change in shape is illustrated in FIGURES 9 to 11, from which it can be seen that the trough gradually narrows so as to form the garniture tape 106 to a cross-section which approaches U shape. At the position C.O. where the suction is cut off—that is, where the suction chamber ends—the conveyor band and paper web have approached close enough to each other to be able to engage and grip the tobacco filler simultaneously. The cross-sectional shape of the trough 108 at this point is shown in FIGURE 10.

A curved metal spring element 110, FIGURES 8 and 9, is located in the trough 108 between the paper web 103 and the conveyor band 58, in order to restrain the paper web from being drawn up too far by the pressure of the air which is still, at that region, being drawn through the conveyor band 58. This is in order to prevent the paper from curling up around the walls 58 and covering the air-holes 109. This element 110 extends a distance a little behind the position at which the suction from the suction chamber 59 is cut off from the band 58, which position is indicated in FIGURE 8 by the reference C.O. Beyond the end of the element 110, the paper web is free to curl up about the trough walls 58*a*, as illustrated in FIGURE 10 at which position (as stated above) the tobacco filler is already engaged and pressed by both the conveyor band 58 and the paper web. At this position, therefore, the filler is controlled from above and below and is thus unable to expand downwardly, and is also controlled at both sides by the paper web which has been drawn by suction against the sides of the filler and prevent the filler from expanding sideways. After the positive suction by the suction chamber has ceased, there still exists a substantial static depression in the filler which therefore continues the suctional effect on the paper web and presses it against the filler.

Side members 111, see FIGURE 11, forming continuations or extensions of the walls 58*a* of the filler trough, but extending on either side of the roller 101, further assist in the sideways control of the filler at this position.

A compression shoe 112 (see FIGURE 12) has an edge which touches the band 58 as the latter passes around the roller 101 and acts to strip the tobacco filler from the band. The shoe 112 has a flat upper surface at that end which is adjacent the band 58, but as can be seen from FIGURE 8 this surface gradually changes to the cross-sectional shape shown in FIGURE 13.

Beyond the shoe 112 is a compression tongue 113, which continues the lateral compression of the filler.

Beyond the tongue is a folder **114** which is the first of two folders which, in the manner customary in continuous rod cigarette-making machines, fold first one edge of the paper web over the filler, and then the other edge after the latter has been pasted. FIGURE 15 shows one side of the paper folded down by the folder **114** while the other side is still upstanding.

From the above description it will be seen that the tobacco filler formed on the perforated conveyor band in the way which has already been described, and compressed by suction acting through the band to a density at least half that required in the final filler rod, is transferred to the paper web, and carried along by the latter, without being given any opportunity to expand laterally to any material extent.

Moreover, the rigidity and firmness given to the filler by the suctional compression during its formation enables the transfer to be effected with little if any disturbance or disarrangement of the tobacco, so that it is possible to preserve, to a great degree, the uniformity of filling and density of the filler.

As is well known in the continuous rod cigarette machine art, an unwrapped tobacco filler as formed on a conventional machine has a cross-section considerably in excess of that required in the wrapped cigarette rod, and must be reduced in size before the paper is wrapped and secured around it. Most of this reduction is commonly effected by mechanical compression exerted on the tobacco filler, as it moves lengthwise, by fixed members, such as the usual compression tongue, which physically engage the tobacco and compress it. Such mechanical compression is accompanied by varying degrees of displacement of tobacco lengthwise of the filler, with consequent disturbance of whatever degree of uniformity the filler possesses.

By the arrangement according to the present invention, however, the filler is precompressed and densified by suction to a material extent before it is engaged by any mechanical compressor devices, and this suctional compression, which does not displace tobacco except transversely of the length of the filler, thus relieves the mechanical compressor devices of a substantial proportion of the work they would otherwise have to do on the filler in compressing and shaping it to the desired cross-sectional size and shape.

FIGURE 18 illustrates diagrammatically an arrangement whereby mouthpiece portions, such as filter plugs, are incorporated in the filler formed on the conveyor band **58**.

To the right of the end wall **74** of the passage **53** is a stub-feeding device comprising a wheel **201** provided on its periphery with pushers **202**, and an intermittently rotatable fluted drum **203** each of whose flutes contains a double-length mouthpiece portion. As the wheel **201** rotates, in timed relationship with the drum **203**, each pusher **202** in turn passes through a flute and pushes a mouthpiece portion from it, and feeds it upwardly over a guide **204** towards the band **58**. A stripper member **205**, slotted at **206** to enable the pushers **202** to pass, ensures that the mouthpiece portions leave the wheel **201**. The top edge of the wall **74** is spaced a suitable distance from the band **58** to allow the mouthpiece portions to pass it.

In this way mouthpiece portions are placed at suitable intervals on the band **58** before the band enters the passage **53** to receive tobacco, and the tobacco then builds up on the conveyor band between the mouthpiece portions. Thus the filler which in this arrangement is formed on the band **58** is a composite one consisting of tobacco portions alternating with mouthpiece portions, and it is to be understood that where herein reference is made to a tobacco filler, or a continuous tobacco filler, such reference is intended, where the context permits, to include a composite filler of this character as well as a filler consisting wholly of tobacco.

What I claim as my invention and desire to secure by Letters Patent is:

1. In a cigarette-making machine of the continuous rod type, apparatus for forming a tobacco filler rod, comprising a narrow conveyor on which the filler rod is formed and which is arranged to move lengthwise, means defining a delivery zone extending a substantial distance lengthwise of and spaced from the conveyor, tobacco feeding means arranged to deliver tobacco particles to the said delivery zone along the whole length of the latter, opposed walls defining a narrow passage extending from the delivery zone to the conveyor and extending along the whole length of the delivery zone and along a substantial length of the conveyor, means to cause a stream of air to flow at high velocity through the said passage from the delivery zone toward the conveyor so as to carry the tobacco particles toward the conveyor to form a filler rod thereon, the velocity of the air stream being such as to impart acceleration to the tobacco particles on their entry into the air stream to ensure that the tobacco particles reaching the filler rod formed on the conveyor are in substantially separated form, said conveyor being air-pervious to permit flow of air therethrough, whereby a pressure differential is established at opposite sides of the filler to compress the latter to a density at least half that of the finished cigarette, and devices feeding a paper web toward and into engagement with that side of the filler away from the conveyor to grip the filler between the paper web and the conveyor and thereby to continue without interruption the compression of the filler.

2. Apparatus as claimed in claim 1 and including means located adjacent said conveyor and in advance of said passage for feeding mouthpiece portions to said conveyor at spaced intervals along the length of the latter.

3. A cigarette-making machine of the continuous rod type comprising a continuous narrow perforated conveyor, means to hold a tobacco filler on said conveyor, said means including, a suction device arranged to draw air through said conveyor so as to exert pressure on the filler such as to hold it against the conveyor and to compress it to a density at least half that required in the final cigarette rod, means to feed lengthwise a continuous web of cigarette paper at subtantially the speed of the conveyor, said conveyor being arranged to carry the compressed filler suctionally on the underside of the conveyor and to extend a substantial distance over the paper web and to move in the general direction of movement of the paper web for transfer to the latter of the compressed filler, the conveyor and paper web being spaced apart at the position of transfer by a distance such as to enable the compressed filler to be engaged simultaneously by the conveyor and the paper web, and means associated with the paper web immediately beyond the conveyor to engage the filler when the latter has been transferred to the paper web, the conveyor, the paper web and the said last-named means all being arranged to cooperate to maintain the filler in its compressed state, thereby ensuring that the filler does not substantially increase its volume at any time.

4. A machine as claimed in claim 3 wherein the conveyor and the paper web are arranged to move in convergent paths in the region where the conveyor extends over the paper web.

5. A machine as claimed in claim 3 comprising cigarette rod forming mechanism which has the usual compression tongue, and wherein the said means associated with the paper web includes said tongue, and comprising a guide element from which the paper web extends towards the rod forming mechanism, and wherein the said conveyor is arranged to transfer the compressed filler to the paper web at a position along the latter between said guide element and said rod forming mechanism immediately in front of the said compression tongue.

6. A machine as claimed in claim 5, wherein the conveyor and the paper web are arranged to move in con-

vergent paths in the region where the conveyor extends over the paper web.

7. A machine as claimed in claim 3, wherein the conveyor is arranged with its tobacco-receiving surface directed upwardly to receive tobacco projected downwardly to said surface to form a filler thereon, and comprising guide means to guide the conveyor downwardly in a direction such that the said surface on which the filler is formed is directed downwardly and extends over the said paper web.

8. In a cigarette-making machine of the continuous rod type, apparatus for forming a composite filler rod comprising tobacco portions and mouthpiece portions in alternation, comprising a perforated conveyor on which the filler rod is formed and which is arranged to move lengthwise, a suction device to apply suction to the said conveyor, means to feed mouthpiece portions to the conveyor to be suctionally held thereon at desired spaced intervals along its length, a delivery zone extending a substantial distance lengthwise of and spaced from the conveyor, tobacco-feeding means arranged to deliver tobacco particles to the said delivery zone along the whole length of the latter, opposed walls defining a narrow passage extending from the delivery zone to the conveyor and extending along the whole length of the delivery zone and along a substantial length of the conveyor, and means including said suction device to cause a stream of air to flow at high velocity through the said passage from the delivery zone towards the conveyor so as to carry the tobacco particles towards the conveyor to form thereon, between the said mouthpiece portions, the tobacco portions of the filler rod, the velocity of the air stream being such as to give acceleration to the tobacco particles on their entry into the air stream of a magnitude such as to ensure that the tobacco particles reaching the filler rod are in substantially separate form.

9. A cigarette-making machine of the continuous rod type, comprising a continuous narrow perforated conveyor, means to feed mouthpiece portions to the said conveyor at desired spaced intervals along its length, means to feed tobacco particles to the said conveyor between the mouthpiece portions, so as to form a composite filler rod on said conveyor, said last named means including a suction device arranged to draw air through said conveyor so as to exert pressure on the said composite filler rod such as to hold it against the band and to compress the tobacco portions to a density at least half that required in the final cigarette rod, means to feed lengthwise a continuous web of cigarette-paper at substantially the speed of the conveyor, said conveyor being arranged to carry the composite filler rod suctionally on the underside of the conveyor and to extend a substantial distance over the paper web and to move in the general direction of movement of the paper web for transfer to the latter of the filler rod, the conveyor and paper web being spaced apart at the position of transfer by a distance such as to enable the filler rod to be engaged simultaneously by the conveyor and the paper web, and means associated with the paper web immediately beyond the conveyor to engage the filler rod when the latter has been transferred to the paper web, the conveyor, the paper web and the said last-named means all being arranged to cooperate to maintain the tobacco portions of the filler rod in their compressed state, thereby ensuring that the said tobacco portions do not substantially increase their volume at any time.

10. Apparatus for forming a tobacco filler on a moving conveyor, comprising means defining a delivery zone spaced from and extending lengthwise of the conveyor, means to deliver tobacco particles to said delivery zone, means to direct a stream of air through said delivery zone toward said conveyor so as to impart to said tobacco particles a force which rapidly accelerates them and impels them at high velocity towards the conveyor, and guide means to direct the said air stream towards the conveyor at such an angle to the length of the band, relatively to the velocities of the particles and of the conveyor respectively, that the particles approach the conveyor with a component of movement in the direction of movement of the conveyor, the velocity of the said component being substantially equal to that of the conveyor.

11. Apparatus as claimed in claim 10 wherein the said guide means comprise vanes located in the region of the said delivery zone.

12. A continuous rod cigarette-making machine having means for forming a tobacco filler and transferring it to a continuous cigarette-paper web, said machine comprising a porous conveyor on which the filler is conveyed, suction means acting through said conveyor to compress the filler laterally, means to feed said cigarette paper web lengthwise, and means to form the said web to curved cross-section, the conveyor being arranged to carry the filler into engagement with the paper web at a position where the latter is curved in cross-section whereby the filler is laterally controlled and prevented from expanding laterally to any material extent during and after transfer to the paper web.

13. Apparatus as claimed in claim 12, comprising a control member located immediately beyond the said conveyor arranged to engage the filler when the latter has been transferred to the paper web, and to press the filler against the paper web, wherein the said control member has a concave surface which engages the filler and acts to impart a convex cross-sectional shape to that part of the filler which it engages, and further comprising a compression tongue located immediately beyond the said control member, and folding means for the paper web located immediately beyond the said tongue, whereby the filler is continuously pressed against the paper web by the conveyor, the control member, the compression tongue and the folding means in succession, and thereby prevented from substantially increasing its volume at any time.

14. Apparatus as claimed in claim 12, comprising a trough of which the said porous conveyor forms a part, said trough having side walls which latter confine the filler laterally and extend over the paper web, the said side walls being provided with lateral apertures to admit air to the trough at a position where the latter extends over the paper web, and wherein a guard member is provided to hold the marginal portions of the paper web away from the said walls so as to prevent the paper from being pressed against the walls by suction acting through the said apertures.

15. Apparatus as claimed in claim 12, wherein the said conveyor and the said paper web are arranged to move in convergent paths in the region where the filler is transferred to the paper web.

16. Apparatus as claimed in claim 12, wherein the conveyor is arranged to carry the filler on its underside and to extend above the paper web.

17. Process for forming the tobacco filler in a cigarette making machine, comprising a tobacco feeder, means defining a narrow substantially vertical passage having at one side an opening to which the tobacco is delivered from the feeder, means defining a channel at one end of the passage, and an endless conveyor moving in said channel and designed to carry the tobacco filler formed upon it to a paper web which is to enclose said filler to form a cigarette rod, the method comprising in sequence, feeding continuously separate shreds of tobacco into said passage through said opening, causing air to flow continuously in said passage toward said conveyor at sufficiently high velocity to subject such separated shreds to acceleration to increase their separation, transporting them at high speed in said passage, depositing them on said conveyor, pressing them against the conveyor with a force sufficient to create a coherent layer of tobacco of a density greater than half that of the tobacco in the

cigarette, carrying without slippage by said conveyor said layer of tobacco constituting the tobacco filler, and holding said filler with the same force against said conveyor while depositing said filler on the paper web.

18. In a continuous rod cigarette making machine, apparatus for forming a tobacco filler rod, comprising a narrow conveyor on which the filler rod is formed and which is arranged to move lengthwise, opposed walls defining a passage extending in depth to the conveyor and extending in length along a substantial length of said conveyor, means to move air continuously through said passage as a stream flowing toward said conveyor, means defining an inlet to said passage extending along substantially the whole length thereof, means to feed tobacco in the form of substantially separated particles toward the said inlet in a direction out of line with the direction in which the air stream flows through the said passage, and means to apply to tobacco particles moving toward the said inlet a generally centripetal force, acting in directions transverse to the said direction in which the said air stream flows through the said passage, and such as to constrain the said particles to change their direction by moving in a substantially arcuate path and to enter the passage generally in the direction of movement of the air stream in the said passage, and such that the speed of the particles while the latter are changing their direction is at least maintained.

19. Apparatus as claimed in claim 18, wherein the means to feed tobacco particles toward the said inlet imparts such a velocity to the tobacco that relatively heavy particles, such as pieces of tobacco stem, have sufficient momentum to resist substantial change in their direction of movement by the said generally centripetal force and thereby tend to move past the inlet to be segregated from tobacco which is constrained to enter the said passage.

20. Apparatus as claimed in claim 18 comprising suction means including a suction duct outside the said passage and adjacent the said inlet and arranged to draw air across the path of tobacco particles moving in the first said direction, in directions which are transverse both to the first said direction and to the direction in which the said air stream flows through the said passage, so as to apply to them the said generally centripetal force.

21. Apparatus as claimed in claim 20, comprising a perforated guard member having perforations through which the air is drawn and located between the said generally arcuate path of the tobacco particles and said suction means, said perforations being too small for the tobacco particles to pass through, whereby the said guard member acts as a barrier against excessive inward movement of tobacco particles in the direction of movement of the air.

22. Apparatus as claimed in claim 21, wherein the said guard member is movably mounted, and comprising a cleaning element past which the guard member moves, the said cleaning element being arranged to remove tobacco particles which may lodge on the surface of said guard member.

23. Apparatus as claimed in claim 22, wherein the said guard member is a rotatable perforated cylinder.

24. Apparatus as claimed in claim 23, wherein the said cylinder is arranged to rotate with a peripheral surface speed in excess of the velocity at which the tobacco particles move past it through said generally arcuate path, and in a direction such that that part of the surface which is closest to said path moves in the general direction of tobacco moving through said arcuate path.

25. In a continuous rod cigarette making machine, apparatus for forming a wrapped cigarette rod, comprising a conveyor by which tobacco is received to form a filler, means conveying a paper web at a position to receive the tobacco filler, opposed walls defining a passage extending in depth to, and in length along, a substantial length of the said conveyor, means to move air through said passage in the direction of its depth as a stream flowing toward the conveyor, means extending along substantially the whole length of the passage to feed tobacco particles into said air stream to be impelled thereby to the conveyor, and guide means arranged to direct substantially the whole of the air stream in a direction obliquely inclined to the length of the conveyor, the said means to move air through the passage, and the said guide means, being arranged respectively to impart to the air stream a speed greater than the speed of the conveyor and a direction such that tobacco particles impelled by the air stream toward the conveyor reach the latter while traveling toward it at a speed greater than the speed of the conveyor and with a component of movement in the direction of movement of the conveyor.

26. Apparatus as claimed in claim 25 wherein the said means to move air through the passage, and the said guide means, are arranged to impart to the air stream a speed and a direction such that the said tobacco particles reach the conveyor while traveling toward it with a component of movement substantially equal in speed to the forward speed of the conveyor.

27. In a continuous rod cigarette making machine, means for forming a continuous wrapped cigarette rod, comprising means to feed lengthwise a continuous cigarette paper web which is to form the wrapper of the wrapper cigarette rod, conveyor means having an air pervious conveyor surface and arranged to forward toward and onto the paper web, and in the same general direction of movement as that of the paper web, a tobacco filler containing all the tobacco which is to be wrapped in the paper web, and suction means associated with the conveyor means to create an airflow beneath the filler to support the filler above the paper web, while the filler and paper web are moving in the same general direction, and immediately before the filler engages the paper web.

28. A continuous rod cigarette making machine having means to form an endwise moving stream of tobacco, said machine comprising compressor means to compress and densify the stream transversely of its direction of movement to cigarette rod size and shape, said compressor means including compressor devices arranged to engage the endwise moving stream and compress and shape it to the cross-sectional size and shape and density of a continuous cigarette rod, and also including a perforated conveyor which forwards the stream toward said compressor devices, and suction means associated with and operative through the said perforated conveyor to cooperate with the said compressor devices to apply to the stream a suctional pressure sufficient to provide in the tobacco stream a density at least equal to half of that in the final cigarette rod, the remaining compression required being effected by the said compressor devices.

29. In a continuous rod cigarette-making machine, apparatus for feeding cut tobacco for the formation of a tobacco filler, comprising tobacco feeding means to impel tobacco forwardly, guide means to guide the impelled particles, said tobacco feeding means and guide means cooperating to cause the tobacco to be projected, substantially in the form of separated particles and in a given direction along a first path in which the particles move as a stream freely in space, means to change the direction of the tobacco particles from said first path by causing them to move through a generally arcuate path upwardly into a second path, said last named means consisting solely of means to direct air in converging directions substantially radially inwardly of said arcuate path and against the tobacco particles, so as to apply to the particles external force of such value in relation to the momentum of the particles as to cause the particles to move freely in space through said generally arcuate path into said second path, opposed walls defining a passage along which the said second path extends, means to direct air through the said passage to impel the tobacco particles along said second path, and means located ad-

jacent the far end of said passage whereby the tobacco particles impelled through the passage are received and formed into an endwise moving tobacco filler.

30. In a method of making a continuous cigarette rod, the steps which comprise forming a tobacco filler, feeding the filler in a predetermined path toward and through a rod forming zone, mechanically compressing and shaping the filler in said zone to the density and cross-sectional size and shape required in the continuous rod, establishing an air pressure differential at opposite sides of said filler while it is in said pre-determined path and during feeding thereof toward said rod forming zone to cause airflow through the filler, thereby to effect substantial lateral compression of the filler, and delivering the filler to said zone in a compressed condition as a result of said pressure differential and without permitting substantial expansion of the compressed filler.

31. A method of forming a filler on a conveyor and conveying it forwardly for delivery to a cigarette paper web, which method comprises the steps of projecting tobacco particles forwardly and causing air to flow toward the conveyor and across the path of the projected tobacco particles at a velocity sufficiently in excess of the forward speed at which the tobacco particles are moving to cause the air to increase the velocity of the tobacco particles and thereby tend to separate them, and to convey them thus toward and impinge them against the conveyor to form a filler, feeding the said filler lengthwise toward said paper web, and compressing the filler to the density required in the final cigarette rod, the compression of the filler being effected in two steps, first by subjecting it to suctional pressure, and second, while preventing any substantial expansion of the filler after it has been suctionally compressed, by subjecting it to mechanical pressure to complete its compression.

32. A continuous rod cigarette-making machine having tobacco dispensing means to dispense cut tobacco for the formation of a tobacco filler, and cigarette rod forming means including means to enclose the filler in a wrapper, the tobacco dispensing means including projecting means to project tobacco forwardly in substantially the form of separated particles, the said machine further including opposed walls defining a passage, the said passage having an inlet to admit into the passage tobacco projected by said projecting means, an air pervious conveyor located adjacent an end of the passage remote from said inlet to support a tobacco filler for endwise movement, air impelling means, including means to draw air through the conveyor, to direct air into and along the said passage and to cause the air to flow along the said passage as a continuous stream flowing directly toward the said conveyor and so directed as to entrain tobacco particles which have been projected by said projecting means and impel them along the passage toward the said conveyor to form the said endwise moving filler, said air impelling means including air guiding means to guide toward and into the passage the air which enters the passage, and to confine its flow, as it approaches the passage, the greater part of the air which enters the passage emanating from positions other than that occupied by the said projecting means, and means carrying a continuous wrapper at a position to receive the endwise moving filler and convey it through the said rod forming means.

33. Apparatus as claimed in claim 32 comprising means outside the said passage and adjacent the said inlet to apply to the particles a generally centripetal force such as to change their direction of movement by constraining them to move in a substantially arcuate path into said passage while at least maintaining their speed.

34. Apparatus as claimed in claim 33, wherein the said means to apply force to the tobacco particles comprises means to direct air against the particles in such directions and at such velocities in relation to the velocity and direction of the impelled tobacco as to cause the particles to move through said generally arcuate path.

35. Apparatus as claimed in claim 34, wherein the said tobacco feeding means is arranged to impart such a velocity to the tobacco that relatively heavy particles, such as pieces of tobacco stem, have sufficient momentum to resist substantial change in their direction of movement by the said generally centripetal force exerted by air flowing across their path and thereby tend to move in directions such that they are segregated from tobacco which is constrained to move into said passage.

36. In a continuous rod cigarette-making machine, means for forming a continuous wrapped cigarette rod, comprising means to feed lengthwise a continuous paper web which is to form the wrapper of the wrapped cigarette rod, an air pervious conveyor to carry on its underside an unwrapped tobacco filler toward and over the paper web for transfer to the latter, and suction means to apply suction to the filler through the conveyor, the said conveyor and suction means extending partially over the paper web and also extending rearwardly beyond the paper web considered in the direction of movement of the latter.

37. Apparatus as claimed in claim 36, comprising a compressor member extending over the paper web immediately beyond the said conveyor to engage the filler when the latter has left the conveyor and is on the paper web.

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