March 7, 1944. R. D. TOUTON 2,343,345

METHOD OF CURING GREEN TOBACCO

Filed Dec. 11, 1940 3 Sheets-Sheet 1

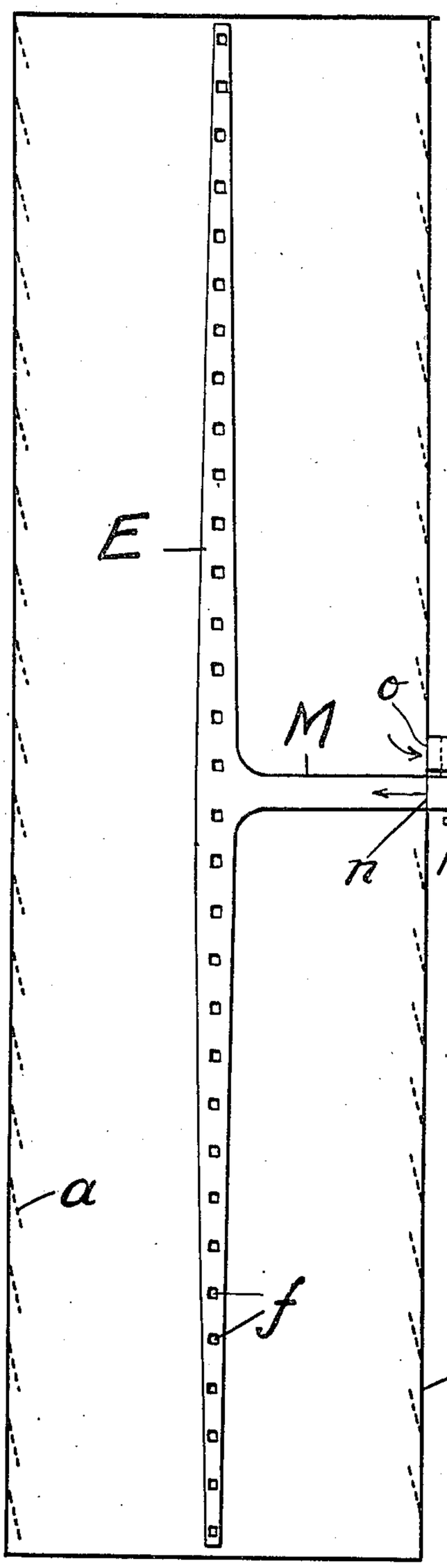

FIG. 1.

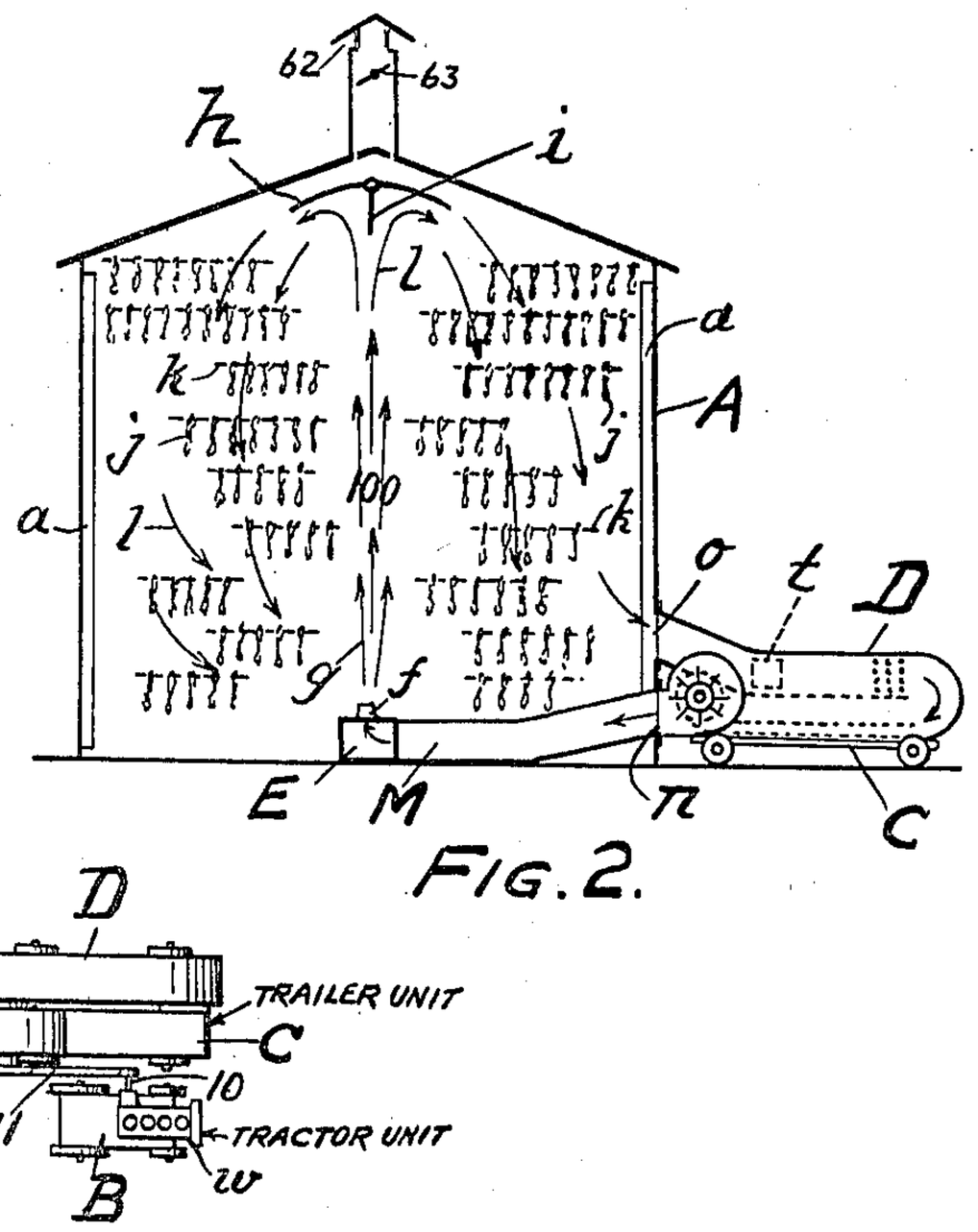

FIG. 2.

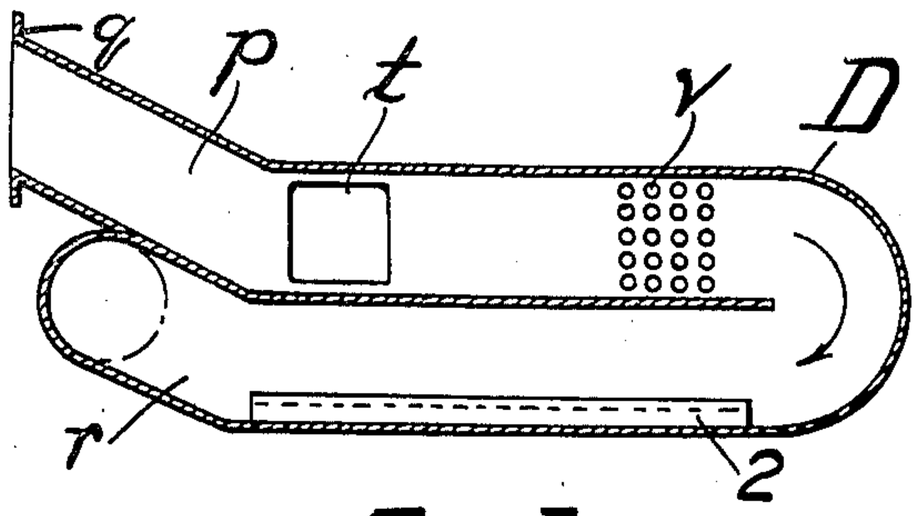

FIG. 3.

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METHOD OF CURING GREEN TOBACCO

Filed Dec. 11, 1940 3 Sheets-Sheet 2

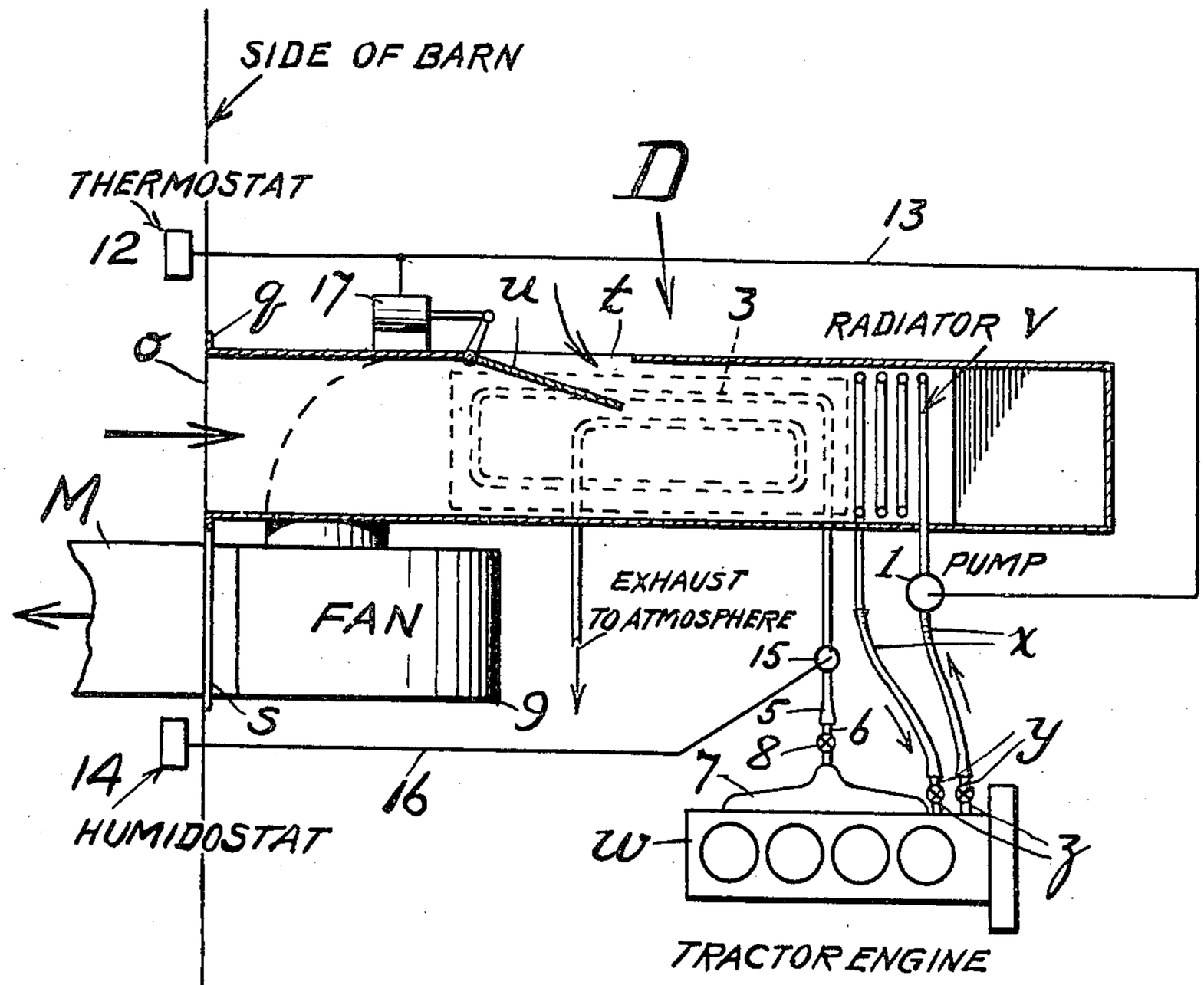

FIG. 4.

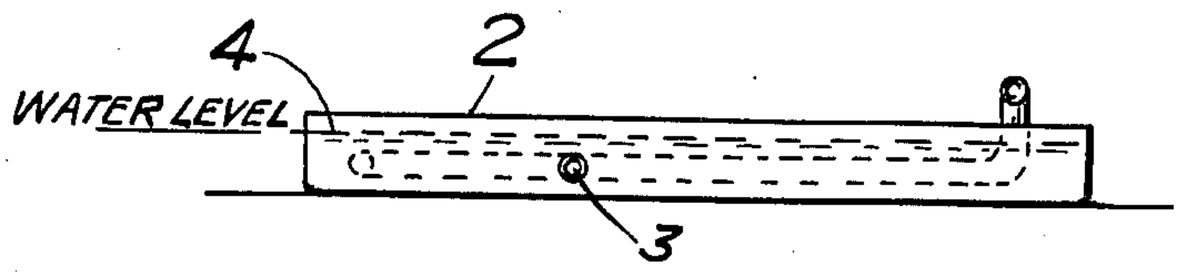

FIG. 5.

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March 7, 1944. R. D. TOUTON 2,343,345

METHOD OF CURING GREEN TOBACCO

Filed Dec. 11, 1940 3 Sheets-Sheet 3

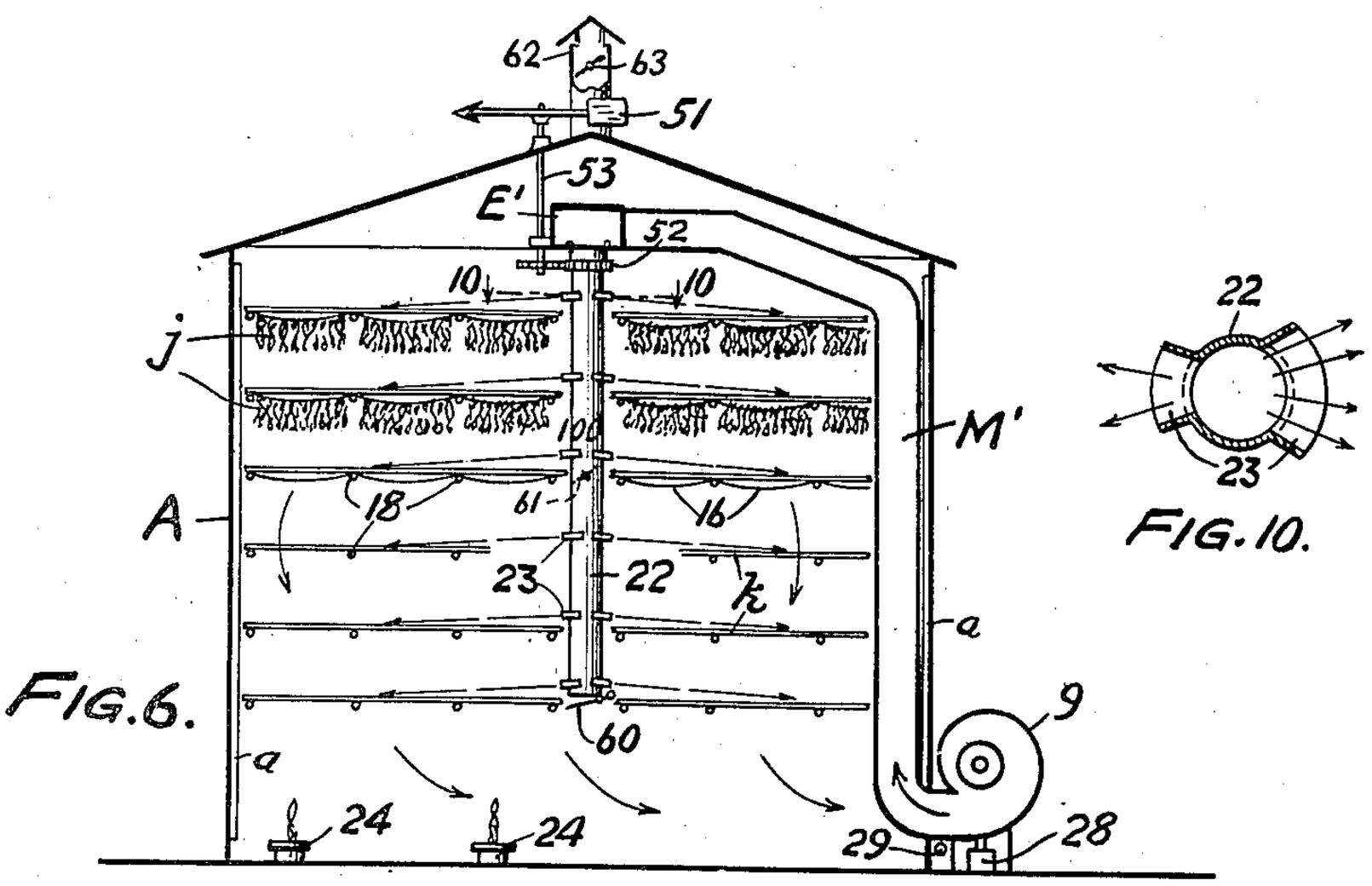

FIG. 6.

FIG. 10.

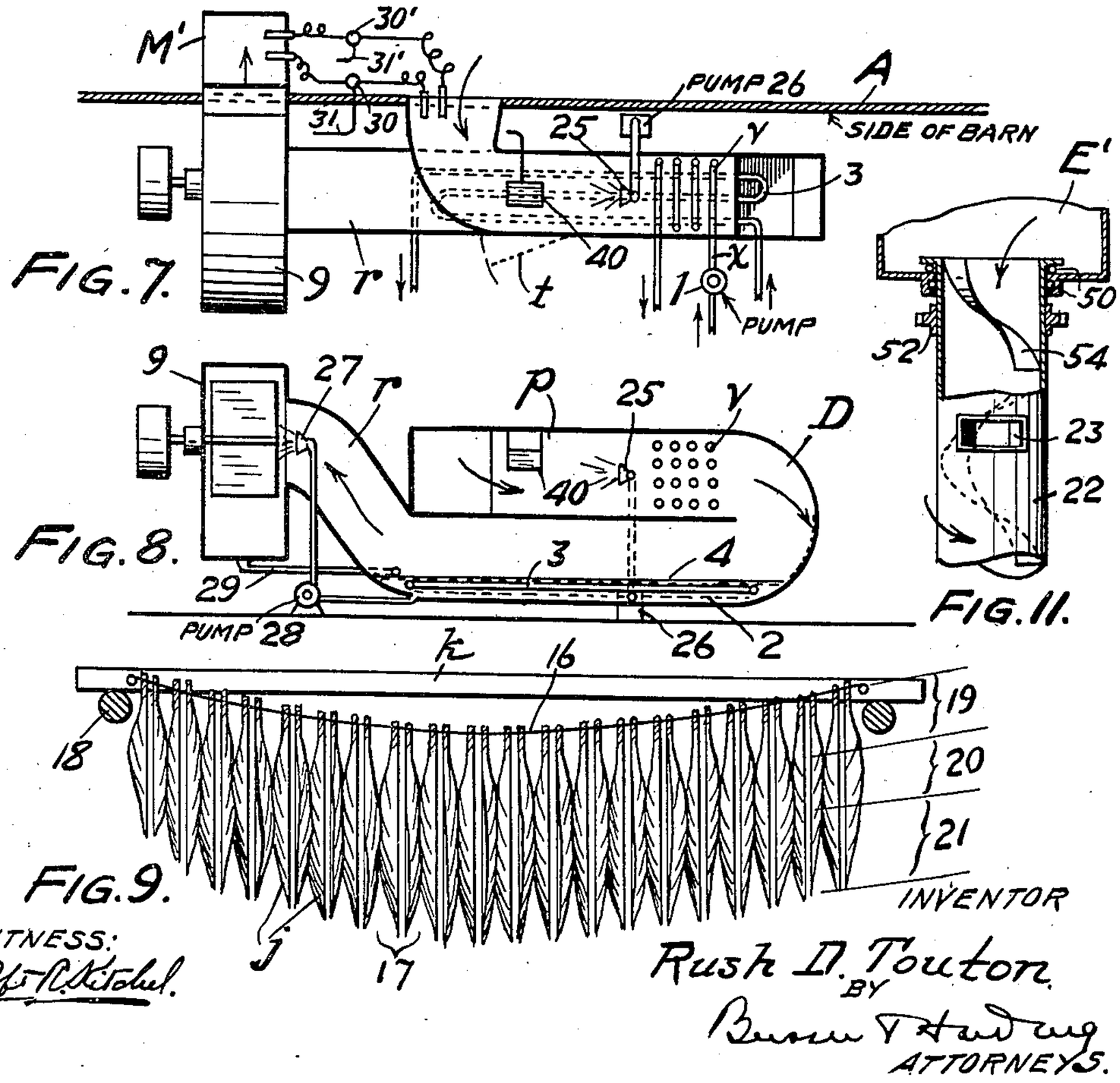

FIG. 7.

FIG. 8.

FIG. 11.

FIG. 9.

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Patented Mar. 7, 1944

2,343,345

UNITED STATES PATENT OFFICE

2,343,345

METHOD OF CURING GREEN TOBACCO

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Application December 11, 1940, Serial No. 369,652

17 Claims. (Cl. 131—140)

This invention relates to a method for curing green tobacco and more particularly relates to a method adapted for the curing of green tobacco in the field following its harvesting. The apparatus disclosed herein for use in performing said method is also disclosed in my copending application #369,653 filed Dec. 11, 1940.

As is well known, green tobacco leaves after harvesting have heretofore been strung closely in pairs and hung in banks in a dense mass for curing in so-called sheds, having a tight roof and walls formed by louvers capable of adjustment for various openings.

The curing of the green tobacco leaves in the sheds requires about 30 days, more or less, and it has been sought to obtain desired atmospheric conditions; i. e., temperature and moisture content, within the sheds by various adjustment of the louvers and the burning of charcoal pots within the sheds with respect to the prevailing temperature and moisture content of the outside atmosphere, the wind velocity and its direction with respect to the sheds.

However, it has been found that the closeness or dense packing of the leaves as they are hung in the shed results in unsatisfactory curing of the leaves near the walls of the shed and insulation of the inner leaves toward the center of the shed so that they do not receive proper treatment. This insulation of the inner leaves is particularly objectionable while the leaves are still green, starchy and distended to their full face area and at the same time contain a maximum water content.

It has also been found that non-uniformity in the curing of the tobacco in any given shed arises from the fact that curing of the tobacco in the upper part of the shed, which is placed first, starts and often proceeds substantially before curing of the tobacco in the lower part of the shed, placed last, starts.

Further, under present practice and with present equipment it is extremely difficult, if not impossible, to maintain the necessary conditions for good curing during the latter stages of the operation, as for instance, after the sixth to seventh day, due to the shrinking of the leaves which permits too great a circulation of dry air, together with the fact that the leaves no longer contain sufficient moisture to create the necessary relative humidity.

The present procedure, essentially dependent upon general atmospheric conditions, of necessity is lacking in any uniform control of the conditions under which the tobacco is cured, makes no allowance for the different characteristics of different parts of the tobacco leaf and frequently results in the production of tobacco of low quality, from the standpoint of texture, color and taste, and consequently of a value considerably less than could be expected from the nature of the green tobacco when harvested.

A careful study of the nature of the green tobacco leaf and of the requirements of proper curing shows that the butt and stem portions of the leaf are relatively coarse and sappy and contain a relatively large amount of moisture, while the median portion, containing less moisture than the butt and stem, contains substantially more moisture and is coarser than the relatively fragile tip portion. Furthermore, the maximum width of the leaves occurs in this median portion setting up an overlapping condition with a resultant impedance of circulation when the leaves are placed in the curing shed.

In the curing of the green tobacco leaf, it is the object to remove the moisture, to the desired extent, and bring the leaf to desired color, while, at the same time, retaining its texture. In general, it is usual to support in the average shed about 40,000 pounds of green tobacco leaves, of which weight some 80% is moisture. In the curing, the tobacco leaves are brought down to a weight of about 10,000 pounds, of which some 20% is moisture. In the curing the major moisture loss occurs in the first five to six days and care must be exercised, especially between the second and sixth days, to avoid rotting or "pole sweat" which is most likely to occur in the median portion of the leaf, when the leaf has partially wilted and part of the leaf cells are dead, but the leaf still contains from 50% to 70% moisture, which promotes the growth of pole sweat spores in the dead cells.

In the prior practice indicated above, as will be obvious, the tobacco leaves were essentially subjected to atmospheric air, the humidity, temperature and flow of which was subjected to variation with the physical condition of the leaves, time of day or night and local meteorological conditions under such control only as could be exercised by adjustment of the louvers forming the sides of sheds and the burning of charcoal pots within the sheds; and, again, the dense packing of the leaves prevented any approach to uniform circulation through the mass of tobacco. Also, the necessity for wide open louvers to admit sufficient air for anything like circulation in the center of the mass often causes wind damage on the leaves near the outside of the shed near the

open louvers and, in any event, subjects the outside leaves to over drastic treatment in comparison with that received by the inside leaves.

As a result of the non-uniform condition of the atmospheric air available to the shed and the inefficient control thereof, especially of the volume and direction of its flow with respect to the tobacco leaves and the different parts thereof, wide variation in the conditions occurred locally within the shed from the effect of the drying tobacco upon the air.

Now in accordance with this invention there is provided a highly efficient and economical method for the curing of green tobacco, and by the practice and use of which the curing of green tobacco in the usual shed is enabled and production of tobacco of high quality is assured.

Generally speaking, in accordance with this invention green tobacco leaves or plants are strung and hung in close relation as heretofore conventional in a curing shed of the usual type having louvers in its walls and modified only by provision for ventilation through the roof. Uniformly conditioned air or atmospheric air tempered with conditioned air to a uniform condition is introduced to the tobacco in controlled volume and direction of flow with respect to the leaves and also with respect to outside conditions, such as temperature and humidity and wind direction and velocity, so that the different parts of the leaves are subjected to air at a condition and in circulation best suited to their curing at a proper rate, with uniformity, with avoidance of rotting and with retention of texture and flavor and acquisition of desired color.

More specifically the conditioned air is introduced centrally of the mass of tobacco and circulated outwardly and downwardly therethrough. The air is variously introduced in quantity to create a positive pressure within the shed and is introduced variously in greater quantity in the lower part of the shed than in the upper part and vice versa. Again, stack effect in the shed by virtue of ventilation through the roof, which may be enhanced by the introduction of air selectively into the lower part of the shed, or by heat from the surface of ducts through which warm air is introduced, is used to promote uniformity. Again, downdraft effect may be obtained, causing an inflow of air through the ventilator desirable for the introduction of cool, normal night air to tobacco in the upper part of the shed by the introduction of cool air selectively in the upper part of the shed, or from the effect of the cool surface of ducts through which cool air is introduced into the shed.

The circulation rate will vary from one complete change in ten minutes downward to one change in forty minutes. Furthermore, during the later stages of curing, for instance, after the fourth or fifth day, a greater quantity of air may be admitted at the bottom of the shed than at the top while utilizing stack effect. Again, intermittent operation of the circulating system may be desirable, as for instance, for a total period of not over 12 hours in each 24. This may be arranged for six hours' circulation during the day and six at night with the night operation being particularly important during the early morning hours when the temperature of the ground, shed and tobacco has been lowered to the dew point of the outside air, thus causing condensation on the tobacco.

In addition, moisture from conditioning equipment may be added to the atmospheric moisture as at night to provide the essential factor in curing known as "come and go." That is, the conditioning system will be used in conjunction with the outside air. Generally, the conditioner will be so arranged that it will add not more than 30% relative humidity to the air being circulated and if used for heating or cooling the temperature increase or decrease over the outside air or that in the shed will be not over 15° F. These restricted increments will effectively prevent severe treatment of leaves next to the outlets as compared to the present system where harsh conditions are imposed upon the tobacco near the outside walls and in the lower tiers directly over the charcoal fires when such are used.

The conditioning system will be arranged so that during periods of maximum heat requirement as when the shed is initially loaded with cold, wet tobacco, additional outlets in the bottoms of the down draft ducts will automatically open, thus providing the greater amount of air necessary to carry the required number of heat units without a detrimental increase in the amount necessary in each unit of circulating air.

Also, the central portion heretofore insulated from the proper heating effect and in a stagnant air condition will receive an adequate circulation of conditioned air.

Furthermore, the air flow may be directed against the prevailing wind to establish further uniformity within the structure and the outlets will be arranged for rotation so that they may be variously directed under certain conditions to avoid any constant severe treatment of leaves next to the openings.

This application of conditioned air will be accomplished with much economy, permitting the use of a standard curing shed structure since the conditioning effect is applied in the center of the mass desirably to create a positive pressure within the shed, and in passing outward through the leaves permits maximum service before its effect is dissipated.

Having now indicated in a general way the nature and purpose of the method according to this invention, it is believed that it will be understood in detail from the following description of a form of apparatus adapted for use in carrying out the method, with reference to the accompanying drawings in which:

Figure 1 is a plan view showing an embodiment of apparatus adapted for carrying out the method in accordance with this invention.

Figure 2 is a diagrammatic sectional view of apparatus adapted for carrying out the method in accordance with this invention, taken adjacent a point of introduction of conditioned air into the mass of tobacco.

Figure 3 is a cross-sectional view showing details of the air conditioning instrumentalities included in the apparatus shown in Figures 1 and 2.

Figure 4 is a detailed view, partly in section, showing the instrumentalities included in the air conditioning apparatus in operative association with a tractor engine.

Figure 5 is a side view of humidifying apparatus included within the air conditioning apparatus shown in Figures 3 and 4.

Figure 6 is a diagrammatic end view of a tobacco curing shed equipped with a modified form of the apparatus illustrated in Figure 2.

Figure 7 is a plan view, partly in section, showing a modified form of air conditioning ap-

paratus in association with the wall of a tobacco curing shed.

Figure 8 is a side view of the air conditioning apparatus shown in Figure 7.

Figure 9 is a side view of a string of tobacco leaves as hung in a tobacco curing shed.

Figure 10 is a sectional view on line 10—10, Figure 6.

Figure 11 is a view, partly in section, showing a detail of construction.

Referring initially more particularly to Figure 9, 16 indicates a string upon which are threaded or strung a series of green tobacco leaves *j*. The string 16 passes through the butts of the leaves and the leaves, as is customary, are strung in pairs 17, the leaves of the pairs facing oppositely. In similar manner stalks may be hung. The string 16 is secured at its ends to a stick *k* adapted to be supported in the shed on rack members 18.

The tobacco leaves *j* are divided into three essential portions, as illustrated in Figure 9, namely, the butt portion 19, the median portion 20 and the tip portion 21.

Referring now more particularly to Figures 1–5, A indicates a tobacco shed, which may be of any desired size and construction, and desirably will have louvers *a* in its walls. The shed will be located in any convenient position to the tobacco fields. A ventilator or series of ventilators 62, controlled by a damper 63, are provided in the roof of the shed to afford a stack effect where desired.

B indicates a tractor of any ordinary or desired type. The tractor may be and desirably will be such tractor as may be used in connection with the growing of tobacco to be ultimately cured in the shed A.

C is a trailer unit adapted to be coupled to and drawn from place to place by the tractor B. Upon the trailer unit is an air conditioning apparatus or instrumentalities for the conditioning of air.

Within the lower part of the shed A and extending longitudinally of the center thereof is an air duct E, provided on its upper side with a series of upwardly directed nozzles *f*. The nozzles *f* are extended from end to end of the duct E and are spaced sufficiently close so that streams of air *g* issuing from the nozzles will blend and travel upwardly and outwardly within the shed, in and from a free zone 100 between or centrally of the banks of tobacco leaves, as will appear. Beneath the ridge of the roof of the shed A and extending in a line above the nozzles *f* in duct E is a curved baffle *h*, divided centrally by a vertical member *i*. The member *i* is directly in line with the nozzles *f* and adapted to divide air traveling in zone 100 therefrom when it reaches the baffle.

As will be obvious from an inspection of Figure 2, the blended streams of air *g* from the nozzles *f* passing upwardly within the shed A, in a zone 100 extending vertically of the mass of tobacco supported on stacks *k* in which the air is desirably at a positive pressure, will extend outwardly into the mass of tobacco and such as reaches the baffle *h* will be divided by the member *i* and directed oppositely downwardly by the curved baffle *h* so that a downward circulation of air will be set up within the shed, as indicated by the arrows Figure 2. By virtue of the direction of the circulation the air directed downwardly will first pass downwardly along the butts of the leaves and then along the median portions and then along the tip portions.

Leading from the duct E, a lateral duct M aligns with an opening *n* in the side of the shed. Adjacent the opening *n* with which the duct M communicates is an opening *o* in the side of the shed.

The air conditioning instrumentalities mounted upon the trailer C comprised, as shown in Figure 3, an intake duct *p* adapted to be aligned with the opening *o* in the side of the shed and provided with a flange *q* adapted to bear against the side of the shed and make a tight connection and a discharge duct *r*, adapted to connect with the opening *n* in the side of the shed with which the lateral duct M extending from the duct E communicates. The end of the discharge duct is provided with a flange *s* (Fig. 4) adapted to bear against the side of the shed and make a tight connection. The intake duct *p* is provided with an opening to the atmosphere *t*, controlled by means of a swinging closure *u*.

Within the intake duct is a coil *v*, the ends of which are adapted to be connected with the water jacket of the tractor engine *w* through the medium of flexible pipes or hose *x*, *x* connected to nipples *y*, *y*, let into the walls of the water jacket and provided with valves *z*, *z*. A pump *l* is provided for effecting circulation of water from the tractor engine water jacket through the coil *y*, with return to the water jacket.

Within the discharge duct is a pan 2 containing a coil 3 and adapted to contain water to a level 4 to cover the coil 3. The coil 3 is connected at one end through a flexible pipe 5 to a nipple 6, which extends from the exhaust manifold 7 of the tractor engine and is provided with a valve 8. The other end of the coil 3 leads to atmosphere, or preferably into a pit (not shown) adapted to absorb exhaust gases. The end of the coil connected to nipple 6 is provided with a valve 15 adapted to throttle and control the amount of exhaust gases passing from the engine manifold 7 into the coil.

As will be obvious, when exhaust gases are permitted to circulate through the coil 3, which is beneath the water level 4 of the water in the pan 2, water will be evaporated into the air passing through the discharge duct and over the pan.

A fan 9 is provided in the discharge duct adjacent its juncture with the lateral M within the shed. The fan is adapted to be driven from the power take-off 10 of the tractor through the medium of a belt 11. The fan is arranged to operate to draw air from within the shed into the intake duct in heat interchange relation with coil *v*, then over the pan 2 and discharge it into the lateral M, through which it passes to conduit E, from which it passes into the shed, as described above, through the nozzles *f*. The fan also serves to draw into the intake conduit fresh air through the fresh air opening *t*. The fan 9 may be reversed to reverse the direction of circulation which may variously be desirable.

Within the shed is positioned a thermostat 12, which operates to control the circulation of heating fluid through the coil *v* through control of the operation of the pump *l*. The control of the pump *l* by the thermostat may be of any suitable or well known type, the control connections being indicated by the line 13.

A humidostat 14 is positioned within the shed and operates to control the circulation of exhaust gas through the coil 3 by control of the valve 15. The humidostat may effect control of the

valve 15 by any known or desired means, the connection between the humidostat and the valve being indicated by the line 16.

The operation of the apparatus described above for the treatment of tobacco will, it is believed, be obvious. However, it will be noted that the humidostat and thermostat within the shed will be set for the conditions desired for the curing of leaves of green tobacco *j* hung in banks on opposite sides of the free zone 100 within the shed. The tractor and air conditioning apparatus upon the trailer having been connected together as described above and the intake and exhaust conduits of the conditioning apparatus having been moved into engagement with the side of the shed in alignment with the openings therein, the tractor engine will be started. In operation of the tractor engine, the fan 9 will be rotated and circulation of air into, within and out of the shed will be set up. The fan will be operated to deliver such quantity of air as to set up a positive pressure within the shed, which may be readily accomplished due to introduction of the air in a zone centrally of the mass of tobacco, which will act to baffle the passage of the air to the sides of the shed. The circulation within the shed will be such as described and as shown by Figure 2. The closure *u* for the fresh air opening *t* will be adjusted, as will the louvers *a* to admit atmospheric air. The adjustment of the louvers and of the closure *u* will depend upon the condition of the atmospheric air with respect to the condition desired in the shed and the direction of the wind. Variously during the curing period the louvers *a* may be entirely closed and variously when the curing has progressed the air conditioning apparatus may be shut down and the curing allowed to proceed under atmospheric air admitted through the louvers. The air passing outwardly and downwardly between the banks of leaves will be deflected downwardly within the mass of leaves by the leaves as it progresses outwardly.

Hot water from the water jacket of the tractor engine will be circulated through the coil *v*, for adjustment of the temperature of the air withdrawn from the shed together with the fresh air added thereto, by means of the pump *l*. The amount of circulation with reference to the heat of the water will be controlled by the thermostat 12, so that the air will be brought to the desired temperature. As desired, hot exhaust gas from the exhaust manifold of the tractor engine will be circulated through the coil 3 for the evaporation of water from pan 2. The amount of gas passed through the coil 3 for the evaporation of such an amount of water from the pan 2 to bring the air to the desired relative humidity will be controlled by the valve 15, under control of the humidostat 14.

As will be obvious, the air at desired relative humidity and temperature will then be returned to the shed for curing if the louvers *a* be closed or if they be open more or less to temper the atmospheric air entering through the louvers for the maintenance of desired conditions within the shed. Generally the outer portion of the mass of tobacco will act to baffle or hold the conditioned air within the mass.

In many, if not all, instances, it will be desirable variously to utilize the stack effect afforded by the ventilators 62. Thus, when the charging of the shed with tobacco is completed, it will usually be found that air heated by the sun on the roof has accumulated in the upper part of the shed and that the tobacco therein has started to cure as compared with the tobacco in the lower part. In such circumstances the damper 63 will be opened, before starting the conditioning apparatus, to release the hot air from the upper part of the shed and by the stack effect cause an updraft through the tobacco, all of which will permit curing of the tobacco in the lower part of the shed to commence and, as it were, catch up with the tobacco in the upper part of the shed, to the end that all the tobacco will be uniformly cured in the subsequent treatment involving use of the conditioning apparatus and the introduction of air to create a positive pressure within the shed. Air under positive pressure within the shed may also be used variously during any stage of the curing when it is desired to heighten the stack effect. Such may be accomplished by the introduction of atmospheric air into the shed through nozzles *f* in the preliminary stage, or conditioned air when the stack effect is used in a subsequent stage of the curing.

Referring now more particularly to Figures 6–8, which illustrate certain modifications of the showing of Figures 1–5 and in which similar parts to those shown in Figures 1–5 are indicated by similar symbols, within the upper part of the shed and extending longitudinally thereof beneath the ridge of the roof is a duct E' from which extend downwardly, at short intervals in a zone extending vertically within the mass of tobacco supported on sticks *k*, vertical ducts 22 provided at intervals with lateral, slightly downwardly extending nozzles 23 and with dampers 61 proportioned to pass some air, say about 30% when closed. The nozzles 23 on one side of the vertical ducts are desirably larger than those on the other side, as shown in Figure 10. The lower ends of the ducts 22 are closed by spring held flapper valves 60.

The vertical ducts 22 extend downwardly in the free zone 100 between the banks of tobacco and are rotatably supported from the duct E', as for example, through the medium of ball bearings 50 (Figure 11) and each of the ducts is connected to a wind vane 51, supported on the shed roof, through a 1:1 gearing 52 and a shaft 53 to which the wind vane is secured. Thus, the ducts 22 may be rotated, when there is sufficient wind force operating on the vane 51, to various positions dependent upon the wind directions. The wind vane 51 will be arranged so that the larger openings 23 will open against the wind.

Within each of the ducts 22 is arranged a spiral flange 54 (Figure 11) which, on the passage of sufficient air flow down the ducts 22, will cause the ducts to be rotated when the wind velocity is inconsequential and as a consequence the vane 51 does not exert a directing effect upon the openings in the duct 22.

The duct E' is connected intermediate its ends with the discharge of the fan 9 by a duct M'. The nozzles 23 are spaced so as to project air from the ducts 22 in zone 100 between the banks of tobacco over and downwardly upon the butts of the leaves of tobacco *j*, *j* hanging from the sticks *k*, a downward circulation of the air through the tobacco leaves from the butts to their tips, as indicated by the arrows Figure 6, being promoted by fan 9, which draws air from the lower part of the shed through outlet opening *o*. The air in effect circulates downward in a plurality of layers or blankets so that the greatest amount of air is moving downward in the lower part of the shed. The air is desirably introduced in amount

to create a positive pressure within the shed, which is made possible by insulating effect of the banks of tobacco.

Within the shed may be placed charcoal pots **24**, or other heating elements, which may be used when for any time in the curing of the tobacco a temperature higher than that obtainable with the air conditioning apparatus is desired and which, if burning, will increase the stack effect resultant from the opening of ventilators **62** when such is desired.

If desired, an auxiliary heating element **40** may be arranged within the intake duct *p* and may be controlled by thermostat **12**.

In the air intake duct *p* of the conditioning apparatus, ahead of the heating coil *v* is a water spray head **25**. The spray head **25** faces against the flow of air and is supplied with water by means of a pump **26** connected to draw water, heated as desired, from pan **2**. The air passing through the intake duct *p* receives water sprayed from the spray head **25** and on being heated in its passage through coil *v* takes up a major portion of the water, any free water being thrown out of the air and returned to pan **2** as the air strikes the curved end of duct *p* in its passage to the discharge duct *r*.

In the discharge duct *r* adjacent to its point of discharge into the casing of the fan **9** is placed a second water spray head **27** which, facing in the direction of the flow of air from duct *r* into the fan casing, discharges a spray of water into the fan casing for admixture with the air by the blades of the fan in the presence of the heat put into the air by the fan. The spray head **27** is supplied with water by a pump **28** which is arranged to draw water from the pan **2**. A conduit **29** leads from the bottom of the fan casing to the pan **2** for the return of water not taken up by the air in the fan casing.

A differential thermostat **30** is placed to operate on the difference between the temperature of the air entering the shed and that withdrawn and is connected by any suitable means **31** to control the throttle of the tractor engine W. The control by the thermostat will be such that when the temperature of the air withdrawn from the shed drops, the engine will be speeded up, causing the fan to be speeded up, supplying more circulation and heat to the coil *v* for heating the air in the conditioning apparatus. Thus, the thermostat **30** exercises control of the volume and temperature of the air circulated in the shed. Conversely, when humidifying without heating a differential humidostat **30'** operates to control the amount of moisture supplied to the shed by effecting an increase or decrease in the rate of circulation through connection **31'** to the engine throttle.

In the operation of the modified form of apparatus shown in Figures 6–8, the procedure will be essentially the same as that described in connection with the use of the apparatus shown in Figures 1–5. However, it will be noted by virtue of the arrangement of the air discharge nozzle **23**, which discharges from the duct **22**, conditioned air is supplied first to the butts and stems of the leaves containing the most moisture and then, having absorbed moisture, to the median and tip portions successively, so that proportionately less moisture is removed from the median and tip portions than from the butt portions, which are hence respectively given a gentler treatment.

The downward circulation of the air is substantially positive and the air discharged from the nozzles **23** being properly conditioned for treatment of the butts of the leaves becomes, by virtue of moisture absorbed from the butts and the cooling effect of the loss of moisture from the butts, proper for treatment of the median portion, and in turn for the tip portions. The downward circulation in which the air flows from butt to tip of the leaves insures that the air reaches the median portion of the leaves between the leaves which tend to be shielded from an upward flow of air by the form of the leaves as they are strung in pairs and by the relatively greater breadth of this median portion. Hence, rot which occurs on the shielded median portion is avoided.

By virtue of the directing effect of the wind vane **51**, if there be a wind of substantial velocity forcing air into the shed through the side walls, the ducts **22** will be positioned by the wind vane with the larger of the openings **23** discharging into the wind. Hence, the effect of excessive wind velocity will be negatived by the larger volume of air discharged against the wind as compared to with it. If the wind velocity be inconsequential the ducts **22** may be caused to rotate for average uniform delivery of air to the tobacco by the action of the downflowing air on the special flanges **54** in the ducts **22**.

The introduction of water into the air in the conditioning apparatus through spray head **25** and the introduction of a spray of water into the fan casing insures the proper humidification of the air in conjunction with the water supplied to the air by vaporization from tank **2**.

When the shed is initially loaded with cold, relatively wet tobacco and higher than average heat is required, sufficient air is delivered to ducts **22** to cause the valves **60** at their lower ends to open, thus permitting the delivery of an increased quantity of air into the shed.

It will be noted that the temperature of the air circulated through the shed will be fixed by the heat supplied to the air in passing over coil *v* and also by the heat put into the air in its circulation, as by the work done by the fan, friction in the ducts, etc., and by heating element **40**, if desired.

As more specifically illustrative of procedure according to the method of this invention for the curing of green tobacco with the use of apparatus herein described and the operation of which has been herein described in a general way, for example, it may be assumed that the shed A has been fully charged with green tobacco.

When the shed is fully charged with tobacco, it will be found generally that curing of the tobacco in the upper part has commenced, while the tobacco in the lower part of the shed has not commenced to cure. This situation arises from the fact that the tobacco is charged into the upper part of the shed first, and due to the fact that the air in the upper part of the shed is hotter than that in the lower part of the shed due variously to the heating effect of the sun on the roof.

Hence, in general, it will be desirable initially to open damper **63** and permit a stack effect upon the interior of the shed through the ventilator **62**, while introducing air into the lower part of the shed to increase the stack effect. If the air introduced is warm, radiation from the surface of duct E' will increase the stack effect.

The introduction of the air into the lower part of the shed in combination with the stack effect through the ventilator **62** will tend to hold the condition of, or slow down the curing process of the tobacco in the upper part of the shed, while

the tobacco in the lower part of the shed is being brought into condition comparable with that of the tobacco in the upper part of the shed.

When using the apparatus shown, for example, in Figure 2, an amount of air will be introduced into the lower part of the shed through the nozzles *f* and in such condition as to primarily affect the tobacco in the lower part of the shed. When using the apparatus as shown in Figure 6 the damper 61 in the vertical conduit 22 will be opened so that the major portion of the air will pass down the conduit for discharge through the nozzles 23 in the lower part of the shed.

The mass of tobacco as a whole in the shed having been brought to a substantially uniform state of curing, air will be introduced through the nozzles *f*, Figure 2, or through the nozzles 23, Figure 6, in the latter case with the damper 61 adjusted for uniform discharge of air. The air will, of course, be conditioned as has been indicated to promote the desired curing of the tobacco. During the curing, and especially during the second to sixth days, when part of the leaf cells are dead and part are still throwing off moisture, the updraft stack effect will be desirably used to carry off the evaporating moisture to avoid the formation of beads of sweat on the leaves with consequent promotion of attack by fungus.

During the treatment the louvers *a* will be opened to create a circulation of atmospheric air to the extent indicated by conditions within the shed and by the precise condition to be maintained within the shed.

A positive pressure within the shed will be readily obtained by virtue of the insulating effect of the banks of tobacco on opposite sides of the shed. By virtue of the positive pressure within the shed the air will flow outwardly from zone 100 as well as downwardly with respect to the tobacco in the banks and the leaves in the interior and throughout the mass will thus be subjected to substantially uniform treatment.

Since the tobacco in the upper part of the shed will tend variously to lose a greater amount of moisture than will the tobacco in the lower part of the shed, it may, and usually will, be desirable on the fifth or sixth day of treatment to introduce a greater quantity of air having an increased moisture content into the upper part of the shed than into the lower part of the shed, by adjustment of the damper 61 in the vertical conduit 22. Under such condition the damper 63 and ventilator 62 may be closed or adjusted to give more or less stack effect and, depending upon conditions, the louvers *a* may be closed or more or less opened. Variously the tobacco in the upper part of the shed may lose moisture more rapidly than that in the lower part due to the effect of the sun's heat on the shed roof. In such case cool, moist evening air may be introduced into the upper part of the shed through the ventilator by causing a downdraft by selectively discharging cool, moist air into the upper part of the shed and by the cooling effect of duct E′ and ducts 22, through which the cool air is introduced.

It will be appreciated that the stack effect obtained by use of the ventilator 62 and the introduction of air in varying amount in the upper or lower portion of the free zone 100, the creation of a positive pressure within the shed, the use of the louvers *a* and of the conditioning apparatus for the air supplied from zone 100 will enable the mass of tobacco within the shed to be subjected to substantially uniform ideal conditions for its curing, with avoidance of pole sweating and other negative effects on its color, texture and flavor, and with reference to the curing process as a whole. It will also be appreciated that by virtue of vertical draft up or down provided for, atmospheric air will be introduced into the shed, since the ventilator and louvers will be of sufficient size, to supplement the air from the conditioning apparatus, thus enabling good curing to be obtained with the use of a minimum of power and equipment.

The advantage of the method in accordance with this invention will, it is believed, be apparent. The apparatus, exemplified for carrying out the method, is of the greatest simplicity and for its operation and transportation from place to place requires only an ordinary farm tractor and the curing of green tobacco is enabled with accuracy of control with consideration for the changing condition of the tobacco in the course of curing and changes in the condition of outside atmosphere and of wind direction and velocity. At the same time, favorable atmospheric conditions are utilized in the usual way when they exist.

It will be understood that the method above disclosed and variously the details thereof are not limited in their application to the drying of tobacco, but variously are adapted for application to the moistening of tobacco, in which application they variously are of advantage.

It will be appreciated that it is not intended to limit this invention by the above detailed description given for illustrative purposes, since, as will be obvious, various modification in detail may be made without departing from the scope of the invention.

This application is a continuation-in-part of the application filed by me Serial No. 274,133, filed May 17, 1939, which application became abandoned December 12, 1940.

What I claim and desire to protect by Letters Patent is:

1. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in superimposed banks, opposite ends of the banks being exposed to atmospheric air and adjacent ends of the banks being separated to form a free zone and causing conditioned air from said free zone at a positive pressure therein to flow laterally outwardly into the banks of tobacco leaves whereby the tobacco leaves in the opposite end portions of the banks will be cured by atmospheric air and the tobacco leaves in the adjacent end portions of the banks will be cured by conditioned air.

2. The method of curing green tobacco leaves after harvesting which comprises supporting the green tobacco leaves in a mass in a pendent position in a chamber, setting up a flow of conditioned air from within the mass of tobacco, laterally and downwardly over the tobacco, from butt to tip of the leaves, withdrawing air from said chamber, conditioning the air with respect to temperature and humidity and returning it to said chamber for reflow therein and effecting the admission of atmospheric air at the sides of the mass.

3. The method of curing green tobacco leaves after harvesting which comprises supporting the green tobacco leaves in a chamber, in banks in a mass in a pendent position, flowing conditioned air from within the mass, at a positive pressure, outwardly and downwardly between the

banks of leaves, admitting atmospheric air to the chamber through a pair of opposite walls thereof and flowing conditioned air into the lower part of the chamber beneath the banks of leaves.

4. The method of curing green tobacco leaves after harvesting which comprises supporting the green tobacco leaves in a chamber in banks in a mass and in a pendent position and projecting streams of conditioned air of alternately varying volume laterally and downwardly between the banks of leaves.

5. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a mass in a pendent position in a chamber and introducing air under pressure laterally only into that portion of the mass of tobacco leaves which is supported in the lower part of the chamber and at the same time withdrawing air from the lower part of the chamber with stratification in the lower part of the chamber of air introduced into the lower part of the chamber.

6. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a mass in a pendent position in a chamber having an opening to the atmosphere in one of its walls, introducing conditioned air under pressure to the tobacco laterally only from a zone extending vertically within the mass of tobacco leaves and permitting exhaust of air from the top of the chamber, whereby the conditioned air introduced into the chamber will be supplemented by atmospheric air from without the chamber.

7. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a mass in a pendent position in a chamber, introducing air from a zone within the mass laterally into that portion of the mass of tobacco leaves which is supported in the upper part of the chamber and at the same time withdrawing air from the upper part of the chamber with stratification in the upper part of the chamber of air introduced into the upper part of the chamber.

8. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a mass in a pendent position in a chamber, introducing cool air from a zone within the mass laterally into that portion of the mass of tobacco leaves which is supported in the upper part of the chamber only and at the same time withdrawing air from the upper part of the chamber with stratification in the upper part of the chamber of air introduced into the upper part of the chamber.

9. The method of curing green tobacco leaves after harvesting which comprises supporting the green tobacco leaves in a chamber, in banks in a mass in a pendent position and flowing conditioned air from the center of the mass outwardly and downwardly between the banks of leaves while admitting atmospheric air to the chamber through a pair of opposite walls thereof, the flow of conditioned air being greater in rate and in a direction opposite to that of the rate and direction of the wind without the chamber.

10. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a mass in a pendent position in a chamber, introducing air into the lower part of the chamber only and affording escape for air from the upper part of the chamber until the tobacco in the chamber is at a substantially uniform state of curing, then introducing air into the mass of tobacco laterally from a zone extending vertically within the mass of tobacco to effect its curing.

11. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a mass in a pendent position in a chamber, introducing air into the lower part of the chamber only and affording escape for air from the upper part of the chamber until the tobacco in the chamber is at a substantially uniform state of curing, then introducing air into the mass of tobacco laterally from a zone extending vertically within the mass of tobacco to effect its curing and in the course of the curing affording an escape for air from the upper part of the chamber and admitting atmospheric air through a pair of opposite walls of the chamber.

12. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a mass in a pendent position in a chamber, introducing air into the lower part of the chamber only and affording an escape for air from the upper part of the chamber until the tobacco in the chamber is at a substantially uniform state of curing, then introducing air into the mass of tobacco laterally from a zone extending vertically within the mass of tobacco to effect its curing and in the course of the curing affording an escape for air from the upper part of the chamber, admitting atmospheric air through a pair of opposite walls of the chamber and introducing into the upper part of the chamber air having a moisture content greater than that of the air introduced into the lower part of the chamber.

13. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a chamber in a pendent position in a mass, subjecting vertical exterior portions of the mass directly to atmospheric air and, at the same time, introducing conditioned air under forced flow interiorly of the mass to produce and maintain a positive pressure within the mass to promote a flow of conditioned air laterally in the mass whereby tobacco leaves in exterior portions of the mass will be treated essentially by atmospheric air and tobacco leaves in interior portions of the mass will be treated essentially by conditioned air.

14. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a chamber in a pendent position in a mass, subjecting vertical exterior portions of the mass directly to atmospheric air and, at the same time, directing conditioned air under forced flow interiorly of the mass to produce and maintain positive pressure within the mass to promote a flow of conditioned air laterally in the mass, whereby tobacco leaves in exterior portions of the mass will be treated essentially by atmospheric air and tobacco leaves in interior portions of the mass will be treated essentially by conditioned air.

15. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a chamber in a pendent position in a mass, subjecting vertical exterior portions of the mass directly to atmospheric air and, during the curing of the mass, directing conditioned air under forced flow interiorly of the mass to produce and maintain positive pressure within the mass to promote a flow of conditioned

air laterally in the mass, whereby tobacco leaves in exterior portions of the mass will be treated essentially by atmospheric air and tobacco leaves in interior portions of the mass will be treated essentially by conditioned air.

16. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a mass in a pendent position in a chamber, introducing air under pressure to a portion of the mass of tobacco laterally only from a zone extending vertically within the mass of tobacco leaves while permitting exhaust of air from the upper portion of the chamber.

17. The method of curing green tobacco leaves after harvesting which comprises supporting green tobacco leaves in a mass in a pendent position in a chamber and introducing heated air under pressure laterally only into that portion of the mass of tobacco leaves which is supported in the lower part of the chamber and at the same time withdrawing air from the lower part of the chamber with stratification in the lower part of the chamber of air introduced into the lower part of the chamber.

RUSH D. TOUTON.