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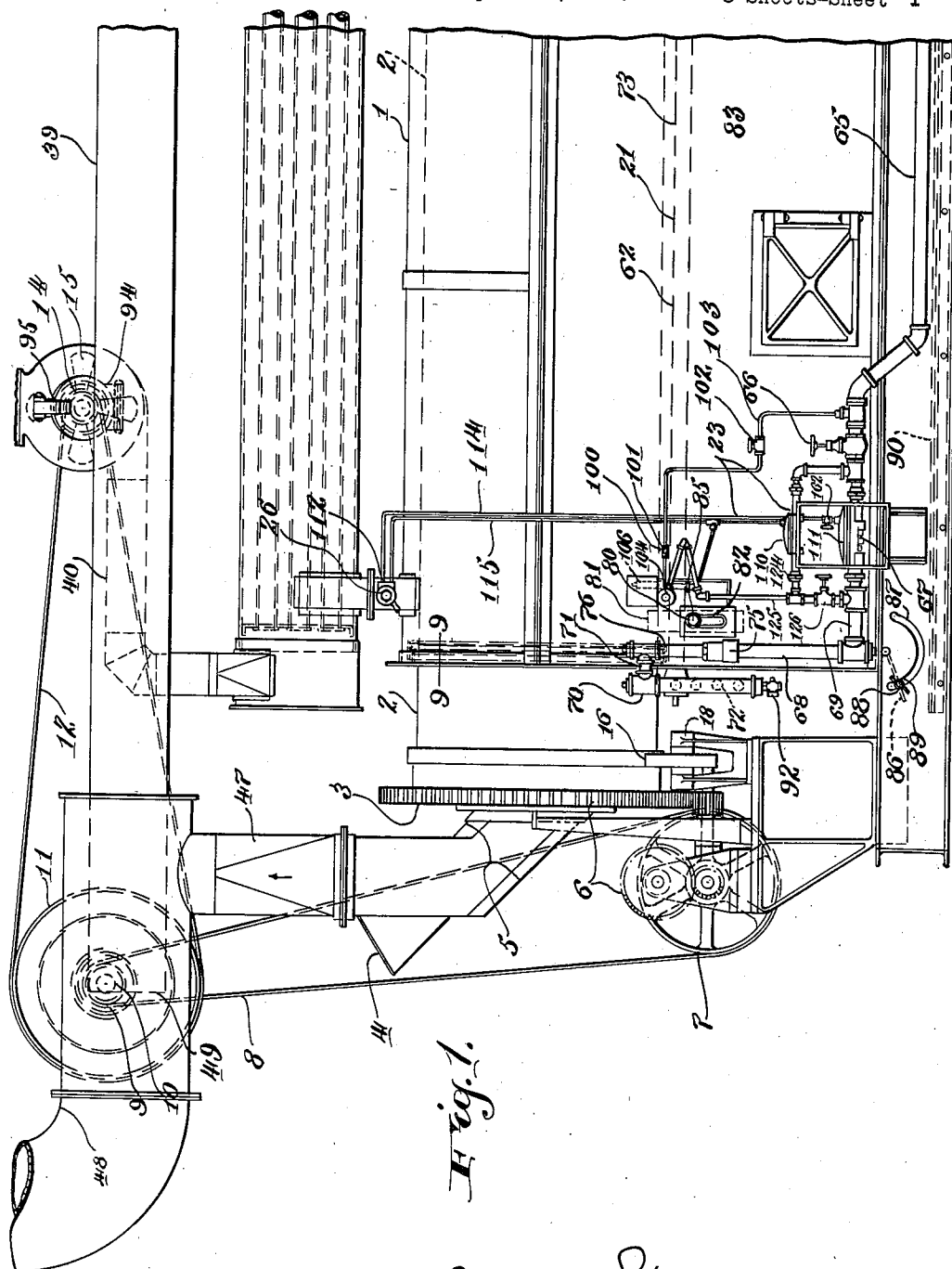
L. H. ZEUN

2,033,169

DRIER

Filed April 23, 1932

8 Sheets-Sheet 1



Louis H. Green INVENTOR
BY J. J. Dowling ATTORNEY

March 10, 1936.

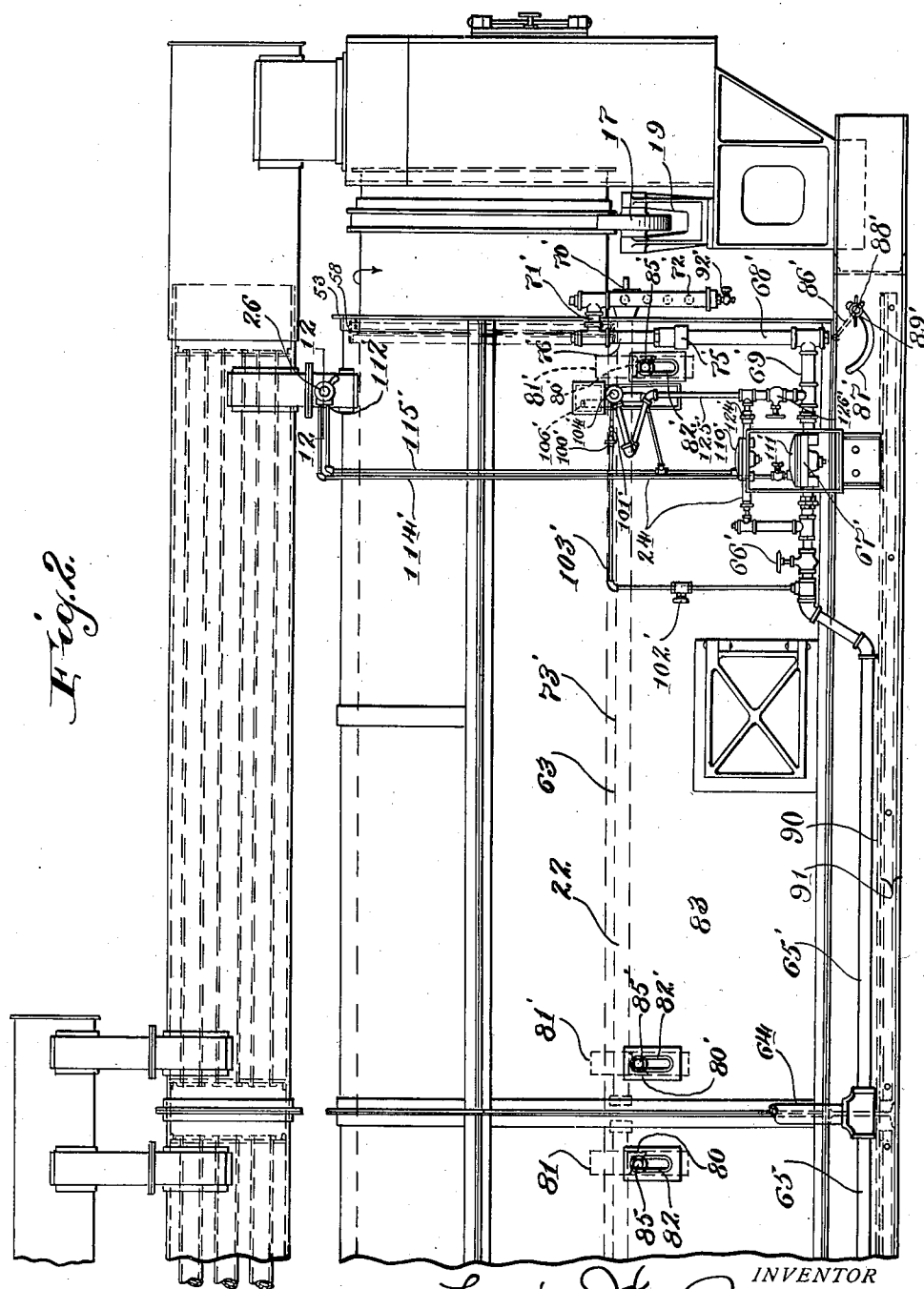
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2,033,169

DRIER

Filed April 23, 1932

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March 10, 1936.

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2,033,169

DRIER

Filed April 23, 1932

8 Sheets-Sheet 3

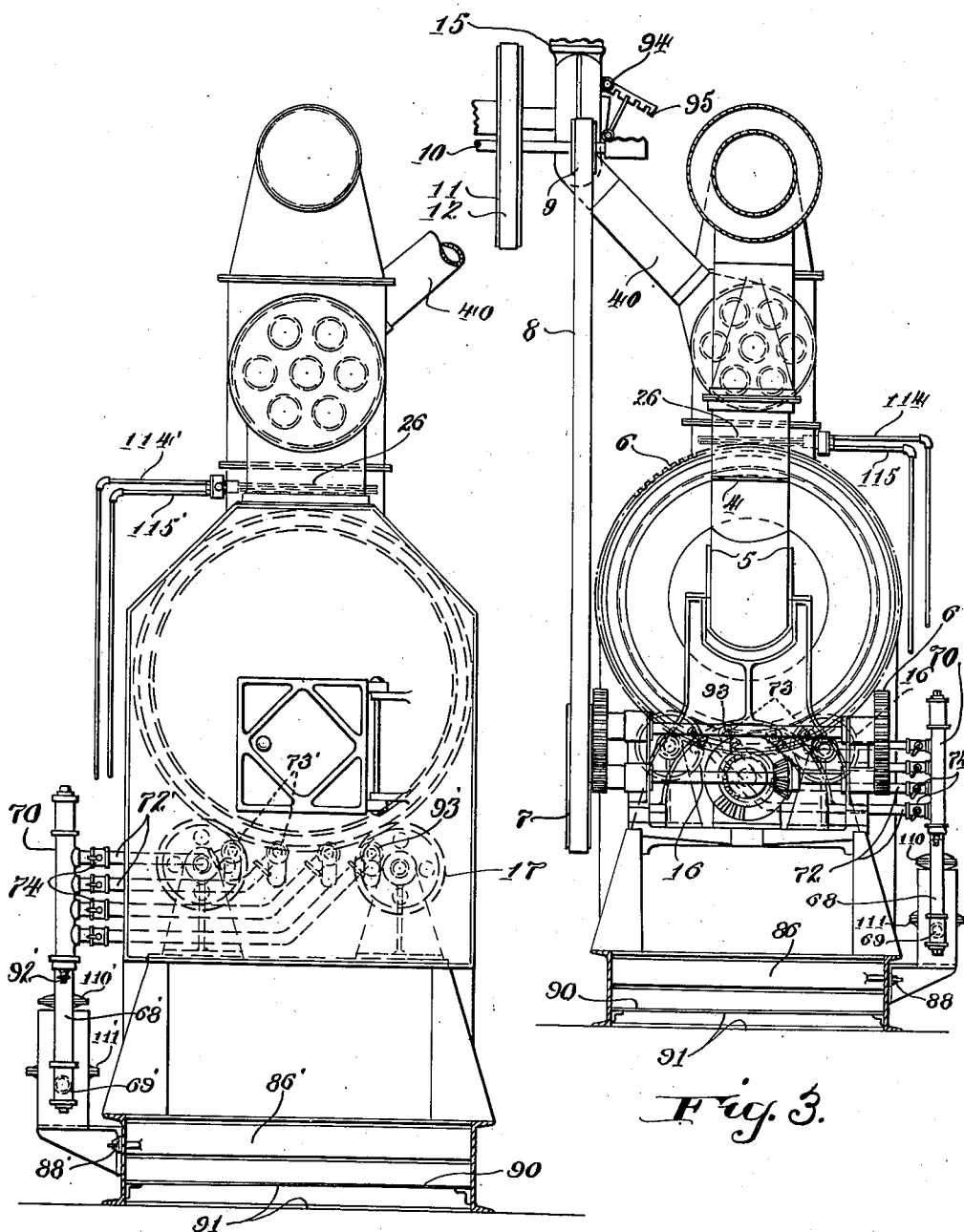


Fig. 4.

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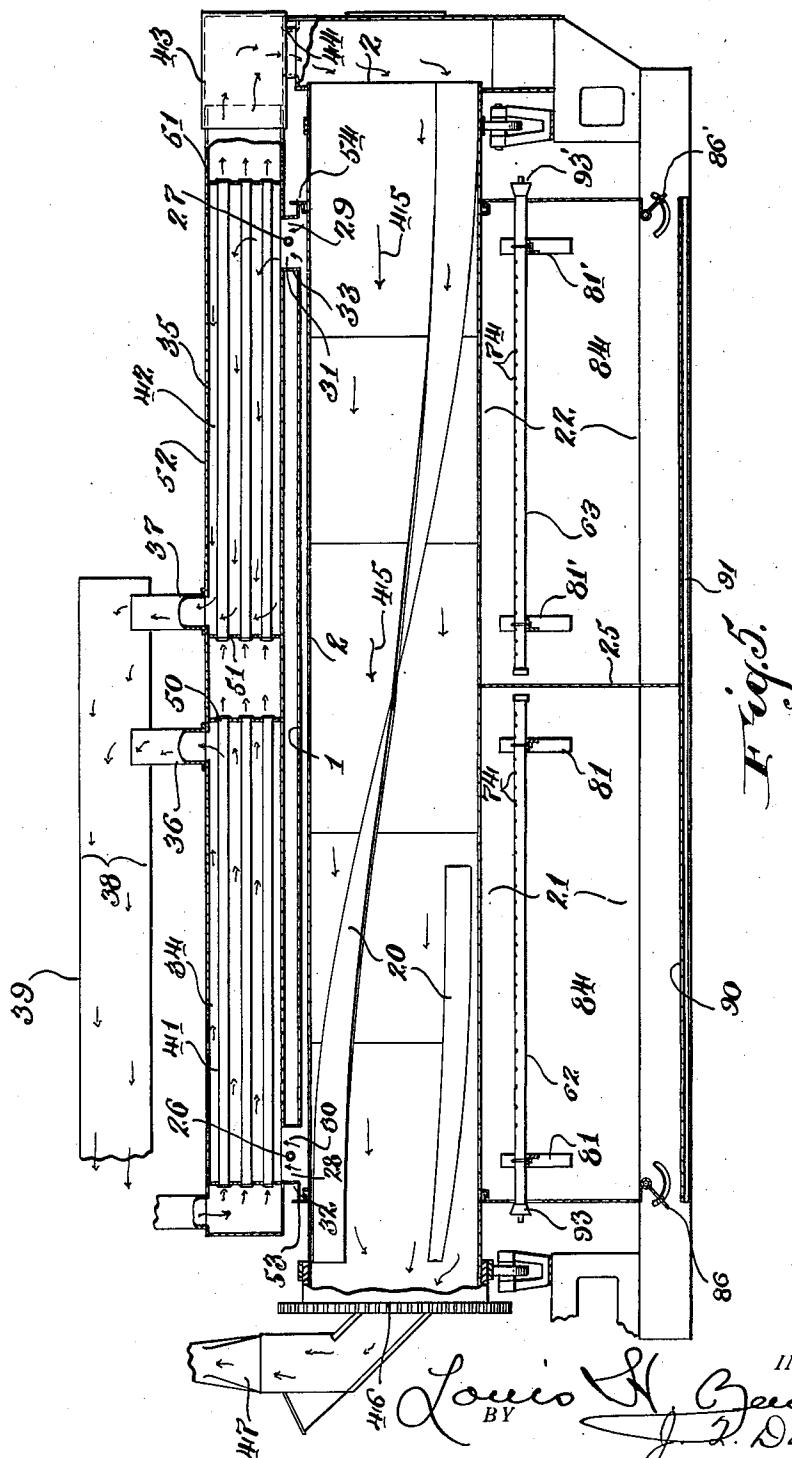
L. H. ZEUN

2,033,169

DRIER

Filed April 23, 1932

8 Sheets-Sheet 4



March 10, 1936.

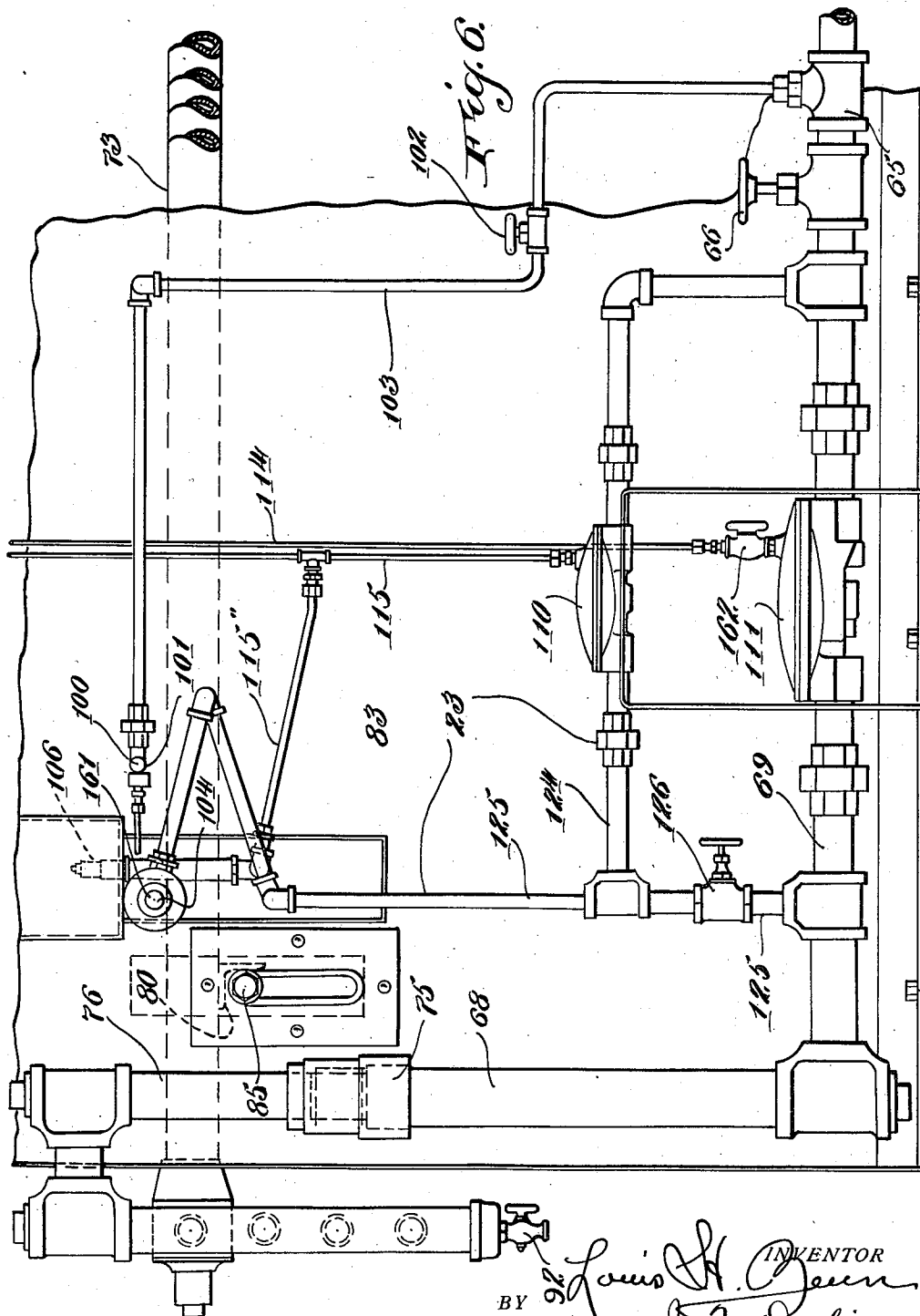
L. H. ZEUN

2,033,169

DRIER

Filed April 23, 1932

8 Sheets-Sheet 5



March 10, 1936.

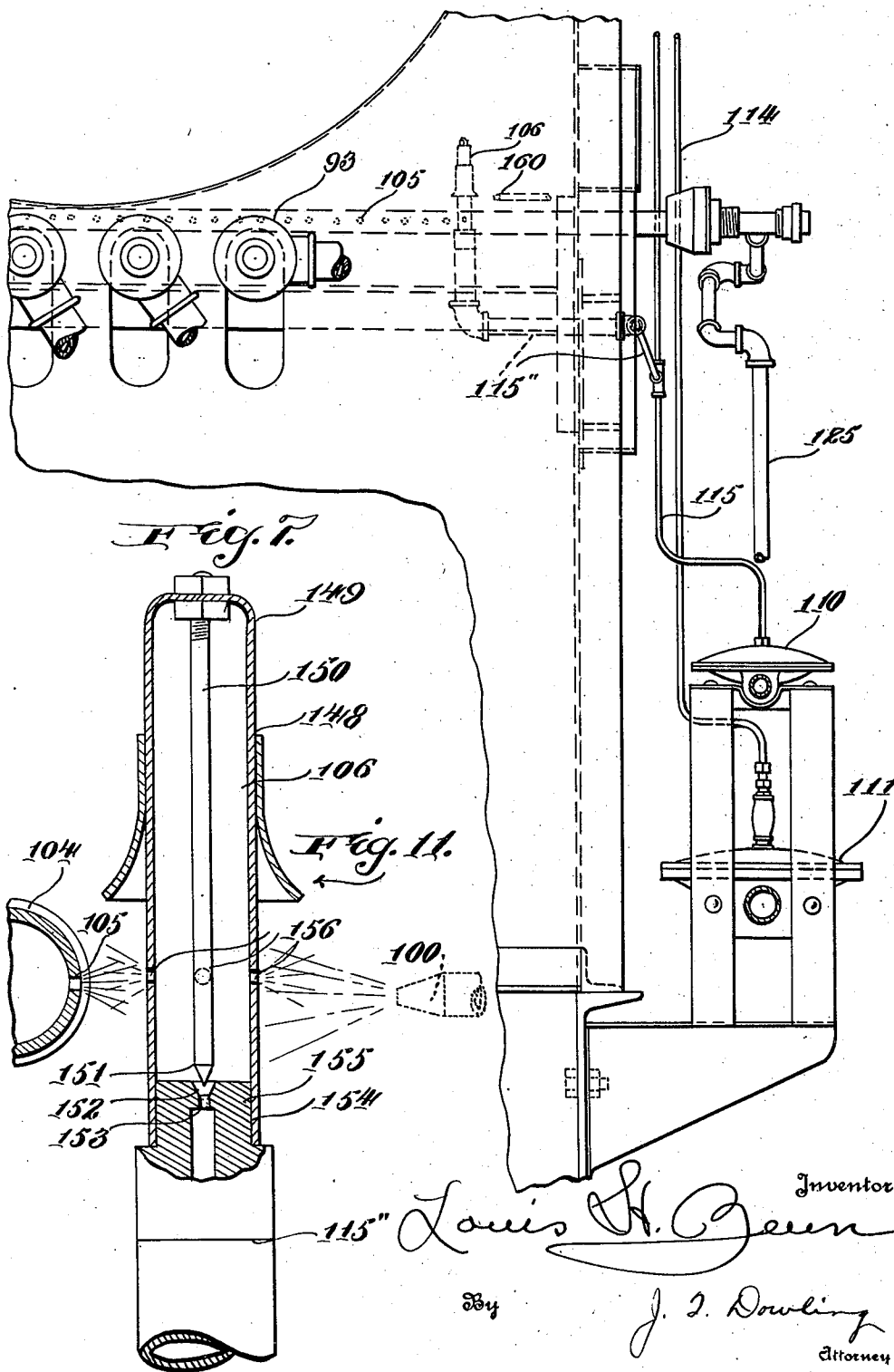
L. H. ZEUN

2,033,169

DRIER

Filed April 23, 1932

8 Sheets-Sheet 6



March 10, 1936.

L. H. ZEUN

2,033,169

DRIER

Filed April 23, 1932

8 Sheets-Sheet 8

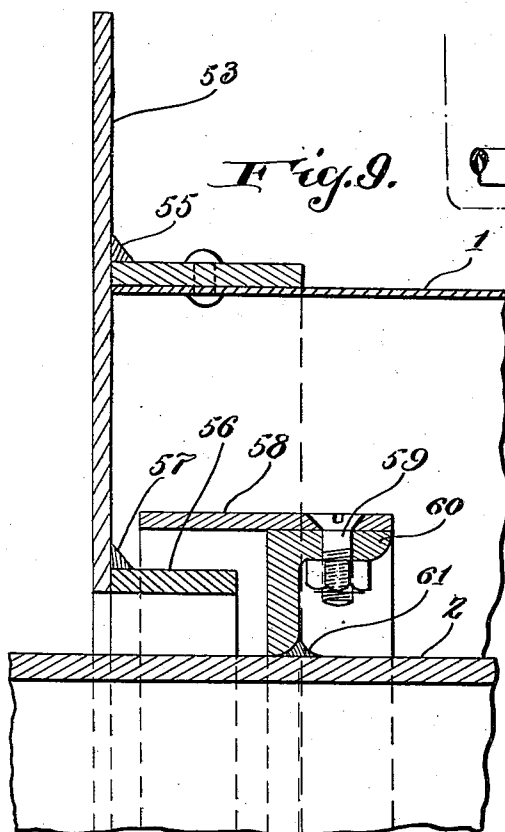


Fig. 9.

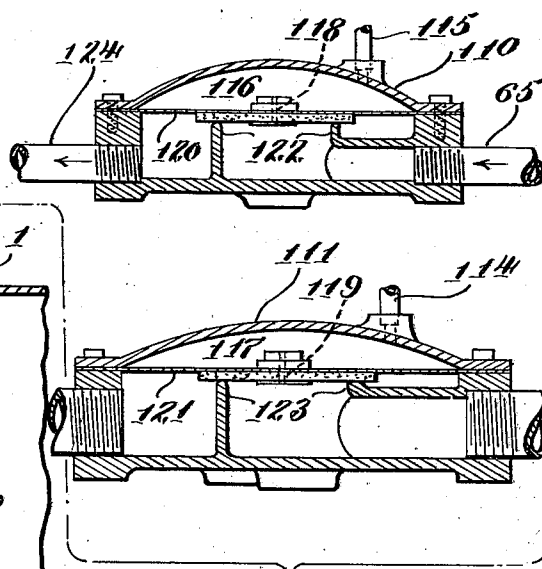


Fig. 10.

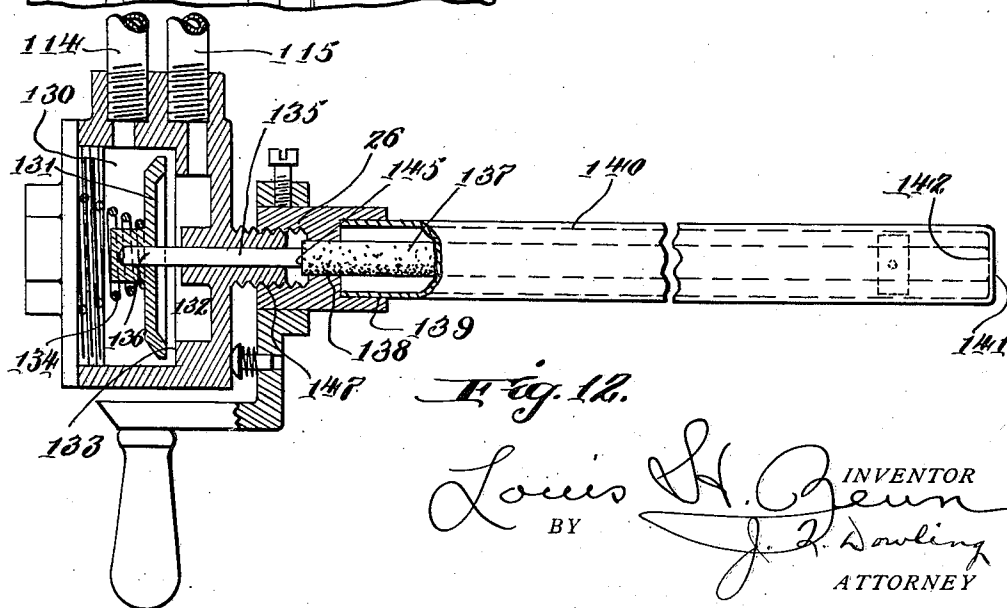


Fig. 12.

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UNITED STATES PATENT OFFICE

2,033,169

DRIER

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Application April 28, 1932, Serial No. 607,984

3 Claims. (Cl. 34—6)

The present invention relates to an improved form of apparatus and method for drying various materials in bulk such as tobacco and the like.

In the drying of certain and various kinds of materials such as tobacco and the like, it is extremely important during the drying period to extract only a certain and predetermined quantity of the moisture from the material being dried.

It has been found with the present type of commercial rotary driers now being used, particularly for the drying of tobacco and the like, that these driers do not maintain their temperature at the desired degree of heat needed for a given condition of drying, are not economical in their consumption of fuel, are inefficient in their operation, in that too great or too small an amount of moisture is extracted from the material, particularly when tobacco is being dried, also it may be scorched, burned, or unevenly dried in certain portions in other instances, thus partially if not wholly defeating the original purpose of such a drier.

The inefficient functioning of these machines may be fully appreciated when it is known that the material to be dried is, as a rule, introduced originally to the drier in a substantially wet condition, when the same enters the drier through the feed hopper. For this reason it is found necessary to maintain a very high initial degree of heat at the feed end of the cylindrical drier. As this material is conveyed through the slowly revolving cylinder by means of spiral flights fixed to the inner wall thereof, it is being constantly elevated and then dropped back to the bottom of the shell through the action of the revolving cylinder and its spiral flights. This progressive agitation of the material being dried causes each particle to repeatedly come into intimate contact with the highly heated wall of the cylinder shell. This together with the preheated stream of drying air passing through the cylinder creates a condition with tremendous possibilities for inefficient operation, unless these various heating or drying mediums are properly controlled. It may also be readily seen that as the material, such as tobacco, progresses through the machine and a greater portion of the moisture has been extracted therefrom, it is not necessary to maintain the same high degree of heat at that portion or end of the machine where the material is partially dry and nearing the point of delivery from the machine. For this purpose the applicant has provided at various positions along the length of the drier shell a plurality of independent co-oper-

ative heating units or furnaces having means for controlling and maintaining a predetermined independent degree of heat in each of said furnaces, thus enabling the application of the proper specific degree of heat at various points along the drier shell to cope efficiently with the moisture content of the material at any given point in the dryer.

For purposes of increasing the effectiveness of the drying function of the commercial type of drier on the market today it is well known that preheated air is introduced within and circulated through the drying shell or cylinder of the machine for purposes of allowing the same to intermingle with the material being dried, thus acting as auxiliary means for extracting the moisture content from the material. However unless this preheated air is controlled as to its degree of heat, it will tend to cause the overheating of the drying chamber, when combining with the external heating means for the shell, and produce a dried material that is indefinite as to its moisture content. With this in mind, it is an important feature of the present invention to provide means for controlling the temperature of this preheated air, and in a manner that is co-operative with the external heating furnaces for the drier shell. This co-operative control feature for the heat, enables the drier to produce material such as tobacco and the like having a predetermined moisture content.

Still another object of the present invention is to provide a drier of the type described, having means for controlling the mean temperature of both the preheated air and external heating means of the drier shell.

Another object of the invention is to provide means whereby either a single or a plurality of heating furnaces may be used in a co-operative manner for drying purposes, together with the air preheated thereby, in a co-operative manner and each of said furnaces having means for controlling the heat therefrom in an independent manner.

Another object of the present invention is to provide means in combination with the above described heating and drying furnaces, whereby the burners of the gas fired type may be controlled manually for the purpose of intensifying the heat, by moving the burners toward or away from the drier shell for purposes of controlling the impinging of the flames therefrom against the shell.

Still another object of the present invention is to provide means whereby the temperature of

the waste gases from each of the above described furnaces may be controlled automatically and independently of each other.

Still another object of the present invention is to provide means for force feeding preheated air at controlled temperatures through the drier shell of the machine in predetermined quantities for the purpose of more readily controlling the evaporation of moisture from the material being dried.

Still another important feature of the present invention is the provision of means for controlling the flow of gas to the gas burners of the drier heating furnaces, in that each heating unit or furnace has means for automatically controlling the flow of gas to its respective burners, together with means for preventing the flow of gas through the burners when the pilot burner is not burning.

Another object of the present invention is to provide means whereby a predetermined minimum and maximum flow of gas to each of the furnaces may be had for the purpose of controlling the minimum and maximum size of the gas flame from each of their respective battery of gas burners.

Still another object of the present invention is to provide a drier of the type described having means whereby the moisture laden air carried off from the drier by means of a vapor discharge stack will not become condensed therein but be carried off into the atmosphere without precipitation.

In the performance of the method of the invention, the wet or moisture laden material to be dried is placed within the rotary drying shell of the machine at the feed end, thence conveyed at a predetermined speed through the drier shell. During the passage of the material through the drier shell, it is being constantly subjected to a predetermined degree or degrees of controlled heat from the outside of the shell, while a continuous blast of preheated air at a predetermined degree of heat is passed through the shell and caused to intermingle with the moisture laden material, thence carrying off the moisture extracted from the material by its action to a vapor discharge stack, having means for introducing this saturated or moisture laden air to the atmosphere without precipitation.

In the accompanying drawings I have illustrated a drying apparatus of the rotary shell type, the same being an embodiment of my invention insofar as it relates to the apparatus and being capable of operation in the performance of the method of the invention, the apparatus being controlled for this purpose either automatically or by hand.

In the drawings,

Figure 1 is a fragmentary elevation of substantially one half my improved rotary drier disclosing the feed or left end of the machine;

Figure 2 is a similar view to Figure 1 of my improved rotary drier disclosing the other half or discharge end of the machine;

Figure 3 is an end elevation of the feed end of my rotary drier;

Figure 4 is an end elevation or view of the discharge end of my rotary drier;

Figure 5 is a somewhat diagrammatic fragmentary sectional view of the drier taken on the line 5-5 of Figure 3, illustrating the independent heating furnaces, direction and travel of the gases therefrom, and the method of preheating the fresh air introduced to the drier shell;

Figure 6 is a fragmentary detail assembly view

in elevation of one of the heat or gas controlling units;

Figure 7 is a fragmentary end elevation of one of the heat or gas controlling units, as shown in Figure 6;

Figure 8 is a fragmentary plan view of the heat or gas controlling unit shown in Figures 6 and 7;

Figure 9 is a sectional view of the line 9-9 of Figure 1, disclosing the shell and housing structure for preventing the ready escape of the heat from the drier housing at this point;

Figure 10 is a fragmentary sectional view of both the minimum and maximum diaphragm gas flow control valves, taken substantially on the line 10-10 of Figure 8;

Figure 11 is a fragmentary sectional view of the safety pilot member, taken substantially on the line 11-11 of Figure 8; and,

Figure 12 is a fragmentary sectional view of the thermostatic gas control unit, taken on the line 12-12 of Figure 2.

Referring to the drawings by numerals, each of which is representative of the same or similar parts throughout the various figures, the invention consists of a drier housing 1 having positioned therein a rotatable cylindrical drier shell 2 in which the material to be dried is placed.

For purposes of introducing the moist material or wet material to the drier shell 2 the same has positioned at its feed end 3 the feed hopper 4 having a conduit or passage 5 leading to within the drier shell 2. This same end of the machine is provided with means for rotating the drier shell 2, in the form of reduction gearing 6, and drive pulley 7, which in turn may receive its driving power through the belt 8 and the driving pulley 9 mounted on the power shaft 10. Power shaft 10 also carries and has mounted thereon the drive pulley 11 having a belt 12 for purposes of driving the blower fan member 15 by means of its drive pulley 14. The function of this blower fan member 15 is broadly for the purpose of creating a forced draft of fresh air through the drier shell member 2 and will be more fully hereinafter described.

For purposes of rotatively mounting the shell member 2 and for directly carrying the weight thereof, the same is provided with supporting rollers 16 at the feed end of the drier and 17 at the discharge end. These rollers in turn are carried by supporting brackets 18 and 19 at the feed and discharge ends of the drier respectively.

Referring particularly to Figure 5 of the drawings, it will be noted that the inner portion of the cylindrical drier shell member 2 is provided with a plurality of spiral flights 20 for the purpose of enabling the constant agitation of the material to be dried during its progress through the drier. These flights through the revolutions of the cylinder constantly elevate and drop the material and thus through this constant agitation each particle is brought into intimate contact with the heated shell and the stream of preheated air, which will be hereinafter explained, many times during its passage through the machine, thus resulting in a uniformly dried product. As may be readily seen by controlling the ratio of speed of the drive mechanism 6 to the pitch of the spiral flights 20 any desired speed of travel of the material through the drier shell may be attained.

The present type of cylinder, as disclosed in the drawings, is provided with two heating furnaces or units 21 and 22, which in the present instance are of the gas fired type. An important feature

of the invention is the utilization of the heat from these heating units or furnaces at a predetermined degree or ratio of heat to the moisture content of the material being sent through the machine proper for purposes of being dried. Referring particularly to Figures 1 and 2 of the drawings, which are representative of the two halves of the machine, I have provided a gas and heat control apparatus 23 at the feed end of the machine and 24 at the discharge end. The control mechanism indicated at 23 is for the purpose of controlling the temperature of the heat directed against the drier shell member 2 at the feed end of the machine, whereas the heat control mechanism indicated at 24 is for the purpose of controlling at a predetermined temperature the heat directed against the drier shell 2 from the furnace structure indicated at 22 at the discharge end of the machine. These two heating elements or gas furnaces are separated one from the other by means of the heat chamber dividing plate 25, see Figure 5, thus enabling the complete separation of the furnaces 21 and 22 for the purpose of enabling two separate and independent degrees of heat to be directed against different portions of the drier shell at the same time.

The separate and independent predetermined degrees of heat derived from the furnaces 21 and 22 are thermostatically controlled by the thermostat members 26 and 27 of the furnace control mechanism 23 and 24, respectively. These thermostats are mounted at the upper or top portion of the drier housing 1 at 28 and 29, respectively, of the feed and discharge ends of the machine. The gas or hot air passages 30 and 31 formed by the upright columns 32 and 33, in which the thermostats 26 and 27 are positioned respectively, are so arranged as to enable substantially all of the hot air and burned gases derived from the furnaces 21 and 22 to pass through the passages 30 and 31, provided for the furnaces 21 and 22, respectively. The hot air and burned gases passing through the passages 30 and 31 are directed in turn through the air heating chambers 34 and 35, respectively, thence by means of the upright passages 36 and 37 to a common outlet or cylindrical passage 38 formed by the common gas and hot air discharge pipe 39.

The purpose of the two separate and independent furnaces 21 and 22, which may be readily seen, enables the use of a high initial degree of heat at the feed end of the drier shell where the material that is introduced into the drier has its maximum degree of moisture content. Thus for purposes of expediting the drying operation an initial high degree of heat may be introduced at this point without running the risk of either scorching or burning the material being dried. It is understood that as the moisture content of the material is driven out of the same, particularly in the vicinity of the discharge end of the drier shell, it is important that the initial degree of heat be lessened to the desired amount so that the final drying out of the material can be done without the possibilities of either burning or scorching the material. This may be readily done in the present type of structure due to my dual heating feature in that a high initial degree of controlled heat may be introduced to the wet material at the feed end of the machine and a low degree of heat introduced to the material being dried at the discharge end of the machine where the moisture content of the material is very low, by means of my two separate and independently

operated and controlled heating furnaces 21 and 22.

With this present type of structure, it should be understood that wide variations of the application of the drying heat or heats may be possible, such as, when using two independent heating furnaces for a given drying operation, the wet material may have an initial low degree of heat introduced thereto for the first operation, then a very high degree of heat applied thereto for the final drying operation. Still other variations of the drying operation may be had by using three heating furnaces, such as introducing the wet or moisture laden material to an initial degree of high heat, then a somewhat lower degree of heat, then a final drying heat of a high degree, or this combination of various degrees of heat may be changed at will to suit the conditions encountered, such as, the first or initial heat may be a low degree, the second heat may be a high degree, and the final heat may be a low degree again. Thus it may be seen, any variation of drying heats and combinations thereof is possible with the present type of drier.

For purposes of introducing a continuous supply of preheated fresh air under a forced draft, I have provided the blower fan member 15. The forced air or draft from this blower member is directed through the piping 40, as shown in Figure 1, thence through the battery of air heating tubes 41 and 42 positioned respectively in the air heating chambers 34 and 35, thence to the discharge end or opening of the drier cylinder 2 by means of the horizontal cylindrical air passage 43 and the vertical piping member 44 connecting the same to the discharge header of the drier proper. This preheated fresh air is thence passed through the drier shell in the direction indicated by the arrows 45, which is the opposite direction to the feed of the material being directed through the machine to the feed end of the drier shell, thence by way of the upright pipe member 47 to a common discharge pipe 48, which in turn is also used for purposes of discharging the hot air and unburned gases emanating from the furnaces 21 and 22 after they have served their purpose of preheating the incoming forced draft of fresh air.

If it is found desirable the fresh air introduced into the shell member 2 may be introduced in such a manner as to cause the same to move in the direction of the traverse of the material being dried.

It will be noted, particularly in Figure 1, that the gas and hot air discharge pipe 39 has its discharge end 49 positioned at a point in advance of the passage or pipe 47 for the moisture laden air coming from the drier shell. This design of structure is specifically for the purpose of enabling the hot air or gases in their effort to escape through the discharge pipe 48, which in turn leads directly to the atmosphere to create a vacuum which enables the ready discharge of the moisture laden air that may be discharged from the pipe member 47 into the piping 48. This structure also serves another purpose in that the same enables the thorough intermingling of the hot gases with the vaporized or moisture laden air being discharged in the pipe 48, thus causing expansion thereto and preventing condensation of the moisture carried in the discharged air from the material being dried, enabling the same to be wholly discharged into the atmosphere without precipitation of the moisture carried therein.

Referring to Figure 5, it will be seen that the two sets or batteries of air heating tubes 41 and 42 are each in turn provided with headers 50 and 51, respectively, which in turn form the hot air or gas chambers 34 and 35, also enabling the entire blocking off of the hot air or burned gases passing through the same from intermingling with the incoming forced draft of the fresh air passing through the horizontal cylindrical shaped member 52. As may be seen from Figure 5, the preheating of the forced draft of the fresh air passing through the two sets or batteries of air heating tubes 41 and 42, which in turn are heated by the hot air or gases emanating from the furnaces 21 and 22, respectively, may be preheated to a degree of heat which would be determined by the mean temperatures of the hot gases impinging on the two thermostat members 26 and 27 of the furnaces 21 and 22, respectively.

It has been found from long experience, particularly in drying tobacco, that unless the temperature of the heating medium used for purposes of carrying away a portion of the moisture content of the tobacco is controlled to a predetermined degree of temperature proportionate to the moisture content of the tobacco being dried, that the same will be deprived of its sweet flavor due to its not having its natural moisture content.

The natural or sweet flavor that is found in good tobacco is largely dependent on the manner in which the same is dried. When excessive heat is used and particularly without proper control of the same, the natural moisture of the tobacco is carried away causing the same to become dried and to lose its freshness and natural sweet flavor.

Referring to Figure 9 of the drawings, I have shown a cross sectional view of the manner in which the drier shell 2 and the drier housing 1 are so related at the point where the housing 1 of the drier terminates in relation to the drier shell 2 for purposes of preventing the ready escape of the hot gases from the furnaces 21 and 22 at either the feed or discharge end of the drier shell. The drier housing 1 carries at each end thereof, end plates 53 and 54, which in turn may be fixed thereto by welding or the like, as shown at 55 in Figure 9. The portion of the housing and end plate 53, that is in juxtaposition to the drier shell 2, has an inwardly directed flange member 56, which in turn may be welded to the end plate, as shown at 57. Overlapping and concentrically related to the end plate flange 56, I have provided a circumferential flange 58, which in turn is integrally mounted on the drier shell member 2, by means of the bolts 59 and circumferential angle iron 63, which in turn may be fixed to the outer surface of the drier shell by means of welding, as shown at 61.

As may be readily seen from the drawing in Figure 9, a certain amount of impedance is set up to the ready passage of the hot air or gases from that portion of the furnace chambers where the end plates 53 and 54 are in cross relationship with the rotating shell member 2. It has been found by experience in actual practice and in the construction of the present invention that the resistance set up by this type of concentric overlapping non-frictional connection is sufficient to prevent the ready escape of the gases from the respective furnaces therethrough, particularly in view of the fact that the gases from the furnaces 21 and 22 ordinarily seek a passage of escape from the housing 1 at a point of less resistance, which in the present instance would be the passages indicated at 28 and 29 at the feed

and discharge ends of the drier housing, respectively.

The furnaces 21 and 22 are each of the gas fired type and totally independent one from the other in that each has positioned in juxtaposition to the underside of the drier shell member 2 a battery of gas burners 62 and 63, respectively, together with their respective control mechanisms 23 and 24, for purposes of enabling the respective batteries of gas burners 62 and 63 to be independently controlled as to their degree of temperature heat output.

For purposes of supplying the furnaces with the necessary amount of gas, I have provided a main gas supply pipe or connection 64, which in turn has connected thereto the gas supply pipes 65 and 65' for the heat control mechanisms 23 and 24, respectively, which in turn each has gas control valves 66 and 66' for purposes of manually controlling the maximum amount of gas that is permitted to reach the burners 62 and 63 of their respective furnaces. Referring particularly to Figures 1, 2, and 6, of the drawings, it will be seen that the gas supply pipes 65 and 65' each has positioned therein gas flow control diaphragms 67 and 67', which in turn are each connected to upright piping members 68 and 68' by means of the piping 69 and 69'. These upright piping members 68 and 68' are each in turn connected to the respective gas headers 70 and 70' by means of the pipe connections 71 and 71' of the respective furnace heat control elements 23 and 24. These respective gas headers 70 and 70' are each connected by means of the two respective sets of gas burner pipes 72 and 72', as shown particularly in Figures 3 and 4 of the drawings, to the respective batteries of gas burner pipes 73 and 73' of the furnaces 21 and 22, respectively. The gas burner pipes 73 and 73' are each provided with a plurality of openings 74, at which points or openings the gas burner flames are respectively formed.

For purposes of manually fixing the maximum size of the thermostatically controlled flames of the gas burner pipes 73 and 73', I have interposed and provided in the gas pipes 72 and 72' the gas valves 74'.

Referring particularly to Figures 1, 2, and 6, of the drawings, I have provided gas packing joints 75 and 75' in the upright pipe members 68 and 68' for the purpose of enabling the manual raising and lowering of the respective batteries of gas burner pipes 73 and 73' by enabling the movement or sliding of the respective pipe connections 76 and 76' within their gas packing joints 75 and 75'.

The batteries of gas burner pipes 73 and 73' in their respective furnaces 21 and 22 are each in turn supported laterally by means of angle irons 80 and 80', together with their respective slot abutting end members 81 and 81', which may be fixed to the ends of said angle irons by welding or the like. For purposes of rigidly holding the burner pipes by means of their respective supporting angle irons 80 and 80', in fixed relation to a predetermined position in their respective sets of positioning slots 82 and 82', respectively, in the side walls 83 and 84 of the furnace or drier housing 1, I have provided the slot engaging bolts 85 and 85', respectively, the threaded ends of which may engage the slot abutting end members 81 and 81' for purposes of drawing the same tight up against their respective slots for purposes of positioning the batteries of gas burner pipes. As may be readily seen by merely loosening up

the respective bolt members 85 and 85', the burners of either or both furnaces may be adjusted either farther away or closer to the outer wall of the drier shell. In combination with this feature by either closing off entirely any number of the gas header valves 74', or adjusting their openings to the desired degree, fixed maximum gas flames may be obtained with a predetermined fixed position of the same in relation to the drier shell 2, thus the size of the desired flames may be fixed to any degree together with the amount of impinging of the said flames against the underside of the drier shell. Upon the determining of the desired size of the gas flames of the various burners and their most favorable position in relation to the underside of the drier shell 2, the heat from said burners and their respective furnaces will be controlled and maintained to the desired temperature required by my heat control mechanisms 23 and 24, respectively, hereinafter described.

For purposes of admitting air to the respective furnaces 21 and 22 in desired quantities, I have provided each furnace with air inlet dampers 86 and 86', having means for fixing the position of their openings in the form of segmental slots 87 and 87' with slot engaging butterfly nuts 88 and 88', threadedly engaged to bolts 89 and 89', which are integrally mounted on the damper doors 86 and 86'. To lessen the fire hazard due to the heat from the furnaces, I have provided the same with a closed bottom 90, spaced somewhat away from the floor proper forming the air space 91.

To dispose of any moisture formed by condensation within the gas burner headers 70 and 70' the same are each provided with drain cocks 92 and 92', respectively.

To introduce the necessary amount of air to the respective gas burners, atmospheric mixers 93 and 93' may be provided at the point of entrance to their respective furnaces of the batteries of gas burners 62 and 63. These mixers may be of the design of any of the well known type of atmospheric mixers.

For purposes of controlling the amount of air forming the forced draft of hot air passing through the drier, due to external atmospheric conditions, blower fan member 15 has an air inlet door or damper member 94, see Figures 1 and 3 of the drawings, the open and closed position of which may be fixed by the notched bracket 95 to various positions, as shown.

As may be readily seen, particularly from Figures 1 and 2 of the drawings, each of the heating units or gas fired furnaces 21 and 22 are provided with heat and gas flow control mechanisms 23 and 24, as hereinbefore referred to, the purpose of which is to enable the heating of various portions of the drier shell simultaneously with different independent degrees of controlled heat to suit the proportionate moisture content of the material being dried as it passes various different heat zones during its passage or travel through the drier shell 2. This feature as previously pointed out is extremely important for the efficient operation of a drier of this character. Particularly where tobacco or the like is being dried by having a specific amount of its moisture content removed by heat without the usual hazards of burning the material or extracting too much moisture therefrom.

It should be understood that my invention is of such a design that any desired number of independent heat or gas fired furnaces, each with their independent gas flow and heat control mechanisms

for purposes of supplying various independent degrees of heat simultaneously at various points or heat zones along the drier shell, may be used to great advantage. As an example, four or five or even six different heat zones of varying temperatures may be used effectively and advantageously to meet a particular drying condition efficiently.

Referring to Figures 1, 2, and 6 of the drawings, the gas flow and heat control units or mechanisms 23 and 24, each is provided with manually controlled gas pilots 100 and 100', which upon being ignited burn continuously during the period of operation of the drier as a whole. These gas pilots may be of the well known button valve type, that burn continuously with a small flame, but upon pressing their quick opening valve buttons 101 and 101' an increased flow of gas is immediately available, thus increasing the size of the pilot flame, the purpose of which will hereinafter be described. The fixed size of both the small and large pilot flames is controlled by the pilot gas valves 102 and 102' in the pilot gas supply pipes 103 and 103' of the furnace control units 23 and 24, respectively. These pipes in turn are each respectively connected to the main gas supply pipes 65 and 65'.

The two sets or batteries of gas burner pipes 73 and 73' are each provided with master igniting pilots 104 and 104', each of said master pilots being provided with gas burner openings 105. For purposes of igniting the master pilots, safety gas pilots 106 and 106' are provided and these pilots are each heat controlled units, the construction of which will be hereinafter more specifically described. Both of these safety pilots are in turn initially actuated and ignited through the manually controlled pilot 100.

An important feature of my invention is the provision of means, which will now be fully described, for producing a predetermined amount of heat most desirable for a given specific drying operation. To this end it has been found the provision of my invention for enabling the two batteries of gas burners to burn continuously at all times during the drying function of the machine, and to cause the numerous gas flames from said burners to constantly fluctuate from a predetermined maximum size to a predetermined minimum size, with said fluctuations under constant thermostatic control has proven to be a most efficient means of heat control for driers of the present type.

For purposes of obtaining the above described function I have provided valves 66 and 66' in the main gas supply lines 65 and 65' for the two respective gas control structures and furnaces. As may be readily seen, the valves 66 and 66' allow for the control of what may be termed the maximum flow of gas to the furnace heating units. Thus the degree of opening of these valves when the drier is operating is representative of the maximum flame from the batteries of gas burners within the furnaces. However for purposes of controlling this maximum flow of gas to each individual gas burner pipe which goes to make up the batteries of gas burners, I have provided the individual gas control valves 74', as hereinbefore described. These valves, see particularly Figures 3 and 8 of the drawings, may also be used to completely shut off the supply of gas to any one of the burner pipes, thus enabling the furnaces to operate with any desired number of burner pipes functioning for purposes of producing the desired amount of heat, by controlling the maximum

height of the flames produced by any particular burner pipe. As it is somewhat impractical to maintain a predetermined substantially fixed degree of heat in any of the gas fired furnaces used in the present instance, I have found it necessary to provide means, as hereinbefore referred to, to cause these maximum gas burner flames to be automatically reduced to a predetermined minimum height or size. Thus reducing the temperatures of the various furnaces used herein, and maintaining a constant control of the various heats at all times. To this end I have provided minimum and maximum gas control diaphragm valves for the respective gas furnaces shown, indicated at 110 and 110' for the minimum gas flow and 111 and 111' for the maximum gas flow. The maximum gas flow diaphragm valves 111 and 111' are each in turn controlled by thermostat units 26 and 27 in the respective furnaces. These units are positioned in the heat air passages 28 and 29, and each in turn are connected to the maximum gas flow diaphragm valves 111 and 111' by the tubing 114 and 114', respectively. The other lines of tubing 115 and 115' connected to the thermostatic units as at 112 and 112', respectively, are each in turn connected to both the minimum gas flow diaphragm valves 111, 111', and the pilots 106 and 106', as shown. The purpose and function of which will be hereinafter described.

Referring particularly to Figure 10 of the drawings, it will be noted that the thermostatic tubing 114 and 115 are connected to the upper chambers 116 and 117 of the minimum and maximum diaphragm valves 110 and 111. For purposes of illustration the valves 110 and 111 only are shown in detail and will be described as the other valves 110' and 111' are similar in structure and function. The upper chambers 116 and 117 are each in turn connected to the gas supply by way of the piping 65 by means of the openings 118 and 119 in the diaphragm valves 120 and 121. These diaphragm valves function in a manner to control the minimum and maximum flow of gas to the burners, by way of the openings 122 and 123, respectively. The minimum gas flow control diaphragm valves 110 and 110' also control the flow of gas to the master burner pilots 104 and 104' by way of the piping 124, 124', and 125 and 125', respectively. The valves 126 and 126', in the gas line pipes 125 and 125', control the minimum flow of gas to the burners, and thus allow for determining the size of the minimum gas burner flame. The gas lines 125 and 125' are each connected to the maximum gas flow lines 69 and 69', as shown.

The gas tubing 114, 115, 114', and 115' are connected to the minimum and maximum diaphragm control valves as shown, and are connected at their opposite ends to the thermostats 26 and 27, respectively. As both of the present described thermostatic controls are similar in construction only the thermostat referred to by reference numeral 26 will be described in detail.

Referring to Figure 12 in the drawings, in which a cross section of thermostatic control unit 26 is shown, it will be seen that the gas tubing 114 and 115 are connected thereto, 114 to the chamber 130 formed above the valve member 131 and tubing 115 connected to the chamber 132 formed beneath the valve member 131. For purposes of closing the valve 131 and holding the same against the seat 133, i. e., in closed position, a compression coil spring 134 is provided. The valve stem 135, which is fixed at one end to the valve 131 at 136, and is in constant engagement

at its opposite end 145 to a carbon rod member 137, as shown. The carbon rod 137 in turn is slidably supported in the adjustable collar shaped member 137 at 138. Carried and integrally engaged to the collar member 137 at 139, and fully enclosing the carbon rod, is a cylindrical shaped member 140, closed at its opposite end 141, which in turn engages the end 142 of the carbon rod 137. The cylindrical shaped member or shell 140 is preferably made of any of the well known metals that readily respond, in the form of expansion and contraction, to the influences of heat and cold. The length of the carbon rod 137 is sufficient at all times to maintain the valve 131 in open position as long as the thermostat shell member 140 remains at a predetermined low degree of temperature. For this reason it may be readily understood that the valve 131 is constantly raised from its seat 133 during normal heating of the thermostat shell. However as soon as the shell member is introduced to an excessive amount of heat which by way of illustration in the present instance, is over and above the predetermined degree of heat desired, the thermostat shell member 140 is immediately caused to expand, particularly as to the present design of shell member, in a direction parallel with its axis. Thus allowing for the carbon rod, which is substantially unresponsive to the heat action in the present case, to move away from the valve stem at 145 due to the outward movement of the end 141 of the shell 140. This thermostatic action causes the valve 131 to close and shuts off the circulation of gas passing through the thermostatic valve structure 26 by way of the tube 114, valve chambers 130 and 132, and thence through the tubing 115. The purpose of which will be hereinafter explained. For purposes of adjusting the thermostat to function at various degrees of heat, the same may be provided, as shown, with a handle and bracket member 146 for advancing or retarding the position of the shell 140 and the carbon rod 137 therein in relation to the valve structure 131 by means of the threaded portions 147.

Referring to Figure 11 of the drawings, disclosing a fragmentary cross sectional view of the thermostatic pilot member 106, the same consists of a cylindrical shell shaped member 148 composed of metal having similar thermostatic qualities as that in the expanding and contracting shell member 140 of the thermostat unit 26. The top 149 of the thermostatic shell 148 is closed, the same carrying a depending rod 150, the lower end of which is tapered at 151 and acts as a valve against the valve seat 152, formed in the opening 153, which in turn receives a supply of gas through the pipe and connection 115''. The lower end 154 of the shell 148 is fixed to the extension 155, as shown, of the base portion of the pilot 106. Pilot burner openings 156 are provided in the shell, the same being so positioned as to cause the ignition of gas flowing through the master pilot member 104 by way of its openings 105. The safety pilot 106, when the drier is not operating and the pilot is cool, is to be normally closed. However upon operation of the drier, this safety pilot member 106 is normally open and burning constantly during the operation of the drier and the burners therefor. The purpose and operation of the safety pilot is as follows:—Upon the initial introduction of gas to the safety pilot by means of the metal tubing 115'', the same is in closed position due to the shell 148 being cool and in a

contracted position thus lowering the position of the valve 151 to closed position against its seat 152. For purposes of causing this safety pilot to ignite it is necessary to preheat the thermostatic functioning shell member 148 by means of the pilot 100. Upon the same becoming sufficiently hot the shell structure will become elongated in its expansion action, thus raising the top portion 149 and thence the valve 151, admitting the supply of gas within the shell which becomes ignited at the burner openings 156, thus allowing for the ignition of the master pilot 104 upon the introduction of gas thereto. As may be readily seen, the safety pilot 106, will upon its initial preheating and lighting remain in an open position and burn continuously due to its own burner heat keeping the shell sufficiently hot to hold the valve 151 in open position. Should the gas flames from the safety pilot be inadvertently blown or put out or the gas supply thereto shut off from its original source, the safety pilot will become cool and close permanently until the same is preheated again. The importance of this feature in combination with my structure and invention will be fully described hereinafter.

The operation of my invention of improved rotary drier, together with the various steps necessary to be taken to initially start my machine will now be described, with particular reference being made to Figures 1, 2, 6, 8, 10, 11 and 12, of the drawings.

For descriptive purposes, the gas flow control mechanism at the feed end of the machine indicated by reference numeral 23, only will be described in detail as to initial starting, and functioning of the control valves, etc.; as that portion of the drier furnace, its gas flow and heat control mechanism indicated by reference numeral 24 at the discharge end of the machine, is substantially similar in structure and operation as that shown at the feed end of the machine, and which is now to be described in detail as to the co-related functioning of the various units involved in controlling the heat, flow of gas, etc., for the complete furnace structure at the feed end of the machine.

To initially start the machine or drier, it is preferable to have the cylindrical drying shell 2 revolving, the first battery of gas burners indicated at 62 are positioned at a predetermined distance from the shell 2, as shown, the thermostat 26 is then set at a point to give the maximum amount of heat desired, valves 66, 74', 126, and 162 are set to closed position, gas cock 102 in the gas line 103 for the preheating gas pilot 100 is then turned to "on" position, the pilot 100 is then ignited, this may be more readily done by pressing on the push button of the quick acting push button valve 101. The flame from this pilot, upon operating the push button valve, is caused to become impinged against the safety pilot or valve 106, the purpose of which is to preheat the shell 148 of this pilot and cause the valve 151 within the shell to be lifted from its seat, as heretofore described in detail, during this preheating operation of the safety pilot the gas supply valve 66 in the main gas line 65 may be opened to a predetermined point, thus introducing gas to both the minimum and maximum diaphragm valves, 110 and 111, respectively. Due to the closed position of the gas cock 162 for the maximum gas flow diaphragm valve 111 this valve 111 is caused to remain in closed position, the action and function of which will be hereinafter de-

scribed. The fact that the gas cock 162, together with the initially closed position of the safety pilot valve 151 also causes the minimum gas flow diaphragm valve 110 to remain in closed position. However upon the opening of the safety pilot valve 151, due to the preheating operation, the minimum gas flow diaphragm valve 110 immediately opens, causing a supply of gas to be introduced to the safety pilot 106 this pilot then becomes ignited and the next operation to initially start the furnace is ready to take place.

Upon the opening of the diaphragm valve 110, gas is also immediately introduced by way of piping 124 and 125 to the master or main pilot 104 through its control valve member 161, which has previously been opened to a predetermined amount, the pilot burner 104 then becomes ignited, and burns continuously together with the safety pilot 106, while the drier is operating.

With the master pilot 104 burning it is safe to open up the gas cocks 74 to each of the burner pipes 73. The minimum gas flow control valve 126 in the line 125 may now be opened to the desired amount representative of the size of flame necessary as the minimum flame. Gas will then immediately be introduced to the burner pipes 73, and become ignited through the burning of the master pilot 104. Upon determining the size of the minimum flame desired by regulating the valve 126 to a final fixed position, the maximum gas flow diaphragm valve 111 may be brought into active service by opening the gas cock 162 connected thereto, which releases this diaphragm valve and permits gas to flow therethrough. Immediately upon the functioning of this valve the gas burner flames increase in size and begin to burn at their maximum rate. These maximum flames may in turn be reduced and fixed at a desired size by varying the openings in the burner valves 74'. The thermostat unit 26 having been previously set to function at a given high degree of heat the furnace apparatus at the feed end of the machine is now ready to operate indefinitely for purposes of creating and maintaining a predetermined degree of heat for drying purposes.

For purposes of placing the furnace structure or apparatus in action, shown at the discharge end of the machine, it is only necessary to substantially repeat the same or similar operation for this furnace apparatus indicated at 22 and 24, by manipulating the various duplicate valves, cocks and pilots, as hereinbefore described for the furnace structure at the feed end of the machine or drier.

Referring again to the furnace control mechanism 23 at the feed end of the machine, and to Figure 12 of the drawings, it may be readily understood, upon the furnace gases or heat that pass in the vicinity of the thermostat unit 26 reaching a given degree of high heat, this valve which is normally open will function in a manner as hereinbefore described, by closing its valve member 131.

The closing function of the valve 131, as may be seen, causes a blocking off of the circulation of gas through the gas tubing 114 and 115, by way of the thermostat chambers 130 and 132, thus permitting the gas pressure to accumulate above the diaphragm 121, of the diaphragm valve 111, in the chamber 117 by way of the diaphragm pass opening 119. Upon the pressure becoming equalized both above and below the diaphragm 121, the same will seat itself, closing off the incoming maximum gas flow by way of the passage 123,

causing the burner flames to immediately diminish in size to the minimum flame. The burners will then depend wholly on the diaphragm valve 110 for their source of fuel. Upon the thermostat 26 cooling off the same will function as heretofore described, in a manner as to cause the valve 131 to open, thus releasing the blocking effect of the gas in the tubing 114 and 115. This action in turn releases the gas pressure in the diaphragm valve chamber 117, permitting the diaphragm valve 121 to open, introducing the maximum flow of gas to the burner pipes 73 and causing the burner flames to immediately increase in size for purposes of producing the maximum amount of desired heat.

Referring to the action of the minimum gas flow diaphragm valve 110. This valve responds and functions in a manner similar to its co-operative diaphragm valve 111. However this minimum gas flow diaphragm valve responds by automatically cutting off the passage of gas there-through only when the flow of gas through the tubing 115 and 115' is blocked off. This may be brought about in the present instance by the safety pilot 106 being inadvertently put out, causing the same to cool off, and as heretofore explained, resulting in the closing of the pilot valve 151. Thus blocking off the circulation of gas through the tubing 115 and 115' and causing the complete closing of the minimum gas flow diaphragm valve 110. Simultaneously with this action, the maximum gas flow diaphragm valve 111 is also caused to close down, as this valve is also dependent on the flow of gas by way of the safety pilot before the same may finally function, i. e., to remain in open position. Thus an important safety measure is accomplished. As may be seen, not only the burner pipes 73 but the master pilot 104 is also deprived of its flow of gas. Thus all the gas burner outlets are cut off from the gas supply, for the safety provision, that when the pilot is relit for purposes of starting the furnace up again there will be no dangerous accumulation of gas within the furnace housing to cause an explosion upon the reigniting of the pilots. It is understood the small pilot flame from the preheating pilot 100 could also cause an explosion should the gas accumulate sufficiently to reach this very small flame. This source or possibility of gas explosion is also cut off by the action of the valve 110, 111 and 151.

It is fully understood, as hereinbefore referred to, that the furnace structure at the delivery end of the machine, together with its control and safety features, is similar to those just described for the furnace structure at the feed end of the machine.

I have thus described my invention specifically in detail in order that its nature and operation may be fully understood, however the specific terms herein are used descriptively rather than in their limiting sense and the scope of the invention is defined in the claims.

Having thus described my invention, what I claim as new is:

1. A rotary drier of the class described, having a rotating cylinder, said drier having dual heating means connected therewith in the form of a plurality of independently operated and controlled producing furnaces for purposes of introducing dual heats to said cylinder in a simultaneous manner, the said furnaces being provided with a gas burners, said burners producing gas flames, manually controlled means cooperative with said heating means for regulating the horizontal plane of said gas burners and the amount of impinging of the said flames from said gas burners against the wall of said rotating cylinder, and means for controlling the oxygen consumption of said flames.

2. A drier of the type described having a rotary cylinder, a plurality of heat chambers thereunder, gas burners within each of said chambers for producing heat, means for regulating the distance of said burners from the rotary cylinder of said drier for the purpose of controlling the amount the flames from said burners will impinge upon the rotary cylinder, and means for thermostatically controlling the heat produced in each of said chambers in a manner independent one from the other for the purpose of introducing in a simultaneous manner different degrees of heat upon the said rotating cylinder at different areas thereof.

3. A rotary drier of the class described, having a rotary cylinder, a plurality of separate and independent heating furnaces thereunder, independently controlled gas burner heating units within each of said furnaces, means for conveying the waste gases from each of said furnace heating units to separate fresh air heating chambers for purposes of preheating the said fresh air previous to its being introduced into the rotary cylinder of said drier, means within said heating chambers for maintaining complete separation of the fresh air passing therethrough and the said waste gases within said chambers, means for forced feeding said fresh air through and to said air preheating means, and dual means for thermostatically controlling the mean temperature of said preheated fresh air before the introduction of the same into the rotary cylinder.

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