June 2, 1931. H. A. WADMAN 1,808,192

DRIFT CONTROL FOR LEERS

Filed Aug. 29, 1929 2 Sheets-Sheet 1

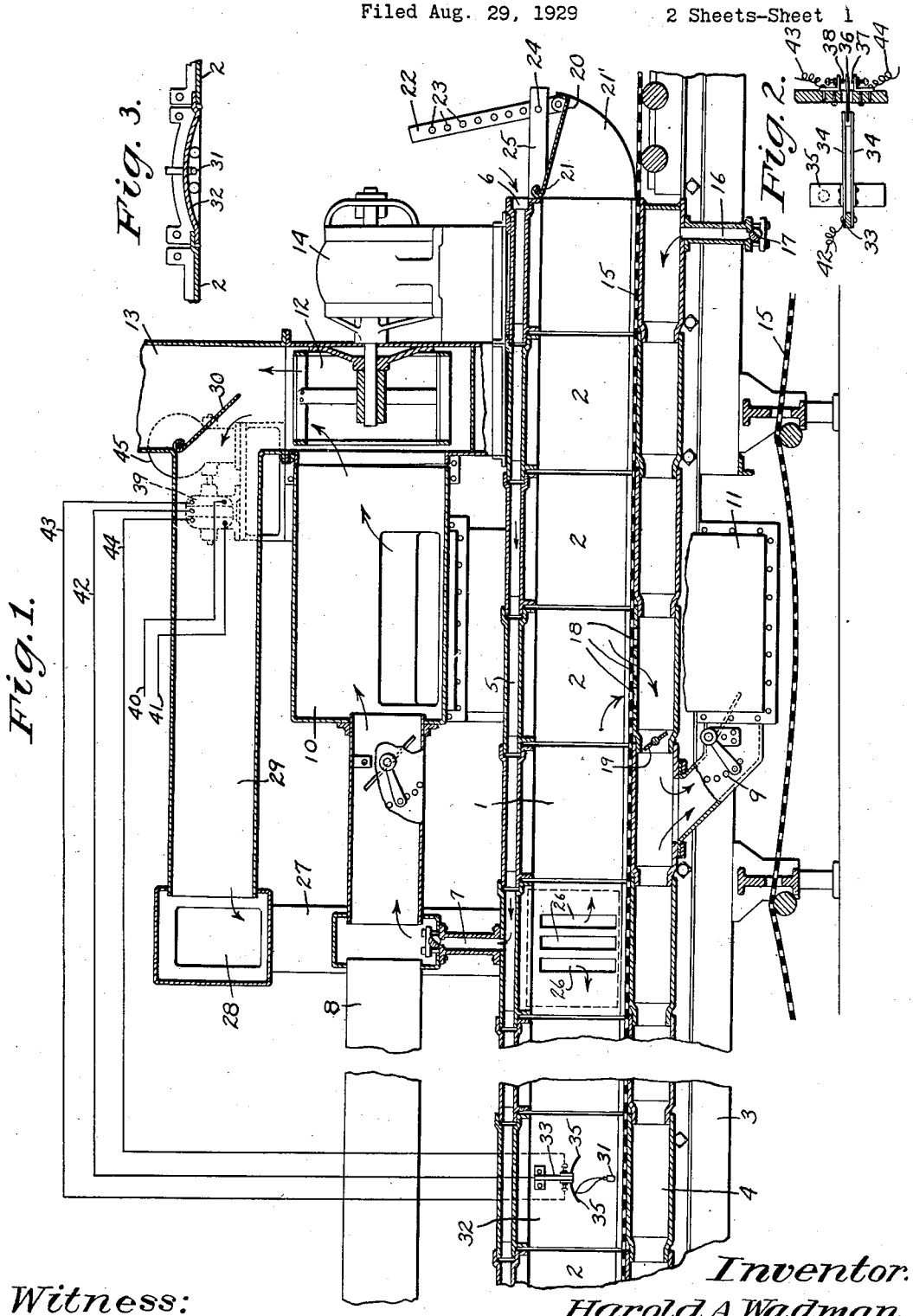


Fig. 1.

Fig. 3.

Fig. 2.

Witness:
S. S. Grotta

Inventor:
Harold A. Wadman
by Burns & Parham
Attorneys.

June 2, 1931. H. A. WADMAN 1,808,192

DRIFT CONTROL FOR LEERS

Filed Aug. 29, 1929 2 Sheets-Sheet 2

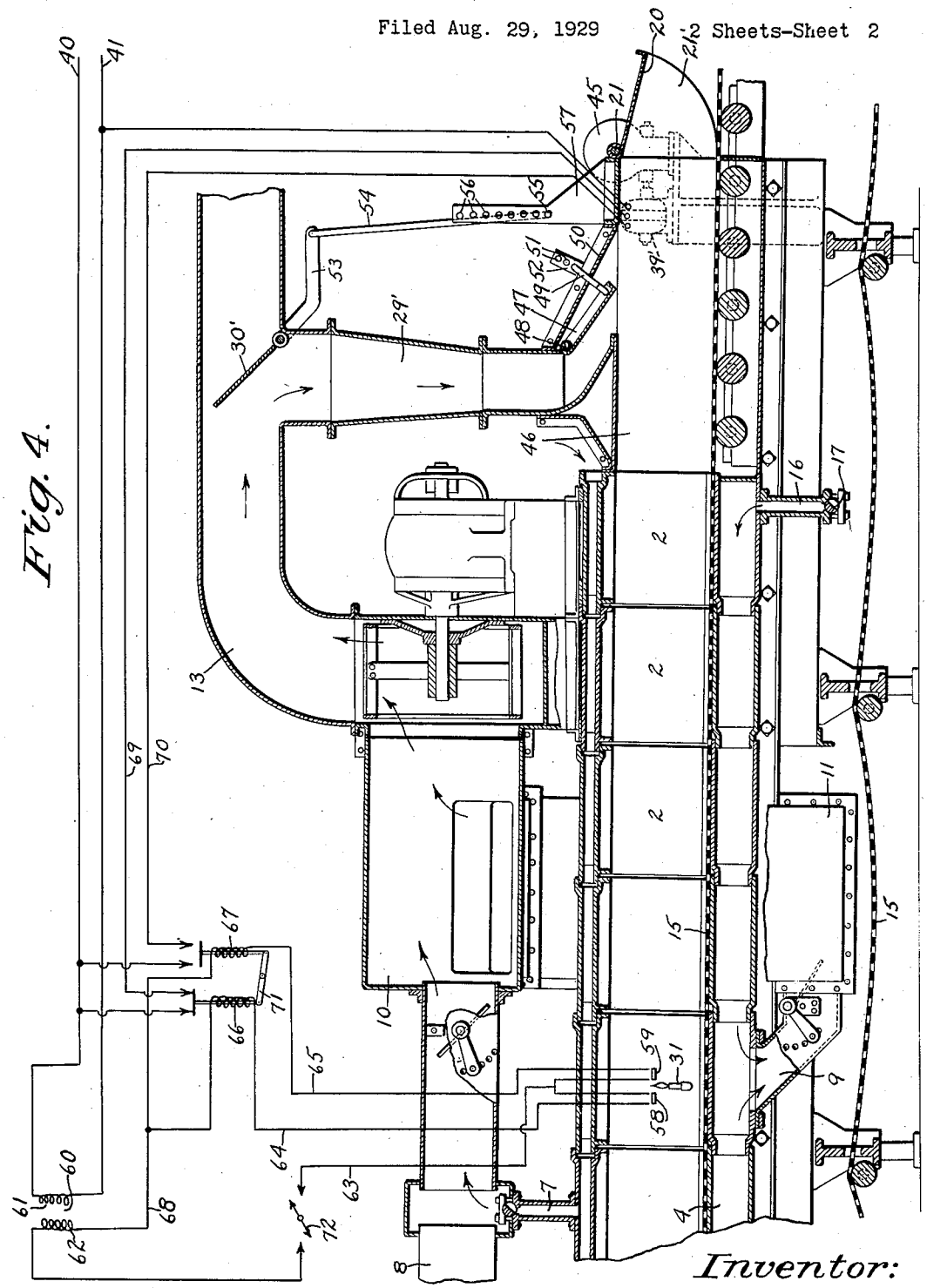


Fig. 4.

Witness:
S. S. Grotta

Inventor:
Harold A. Wadman
by Brown Parkam
Attorneys.

Patented June 2, 1931

1,808,192

UNITED STATES PATENT OFFICE

HAROLD A. WADMAN, OF HARTFORD, CONNECTICUT, ASSIGNOR TO HARTFORD-EMPIRE COMPANY, OF HARTFORD, CONNECTICUT, A CORPORATION OF DELAWARE

DRIFT CONTROL FOR LEERS

Application filed August 29, 1929. Serial No. 389,118.

This invention relates to leers for annealing glassware of the type in which the glassware is passed continuously through an elongate tunnel and is subjected to a succession of gradually varying temperature environments in its passage therethrough.

The invention includes the method of operating such leers specifically with respect to controlling the stray currents or "drift" therethrough, so that the temperature control means is uninterrupted and uninfluenced by the direction of the wind and other undesirable air currents from any source.

The invention also relates to apparatus by which the methods above referred to may be performed, and also to a specific type of drift responsive device, which is arranged to respond to currents of air of an order of magnitude much less than that to which ordinary draft responsive devices will respond.

In tunnel leers of the general type here shown and which are shown and described more particularly in the patent to Mulholland, Patent No. 1,560,481, issued November 3, 1925, the temperature in the tunnel is controlled by muffle flues through which gases at a desired temperature are passed, the temperature gradient of the gases in the flue being accurately controlled by means described in that patent. It has been found, however, in the operation of such leers, that the temperature control in the ware is interfered with to a greater or less extent by stray currents of air passing through the tunnel caused by wind or other causes, unless suitable precautions are taken to prevent such action. These currents sometimes have a velocity as low as 10 feet a minute and as such are too small and too slow to cause any appreciable variation in any of these well known types of draft responsive devices.

A primary object of my invention is to provide a device sufficiently sensitive to be responsive to currents of air or gas moving at velocities of the general order of magnitude above referred to. I have found that gases flowing at this rate will vary the angular position of a slow upwardly moving current of hot gas such as a flame of the size and character of a free burning candle flame, and that if the gases are flowing at such slow rate as not to vary the angular position of such a flame appreciably, the deleterious effect of such a gaseous flow on the annealing of glassware is negligible. I have, therefore, devised a device which is responsive to the variation in the angular position of a flame of substantially the character above described.

A further object of my invention is to provide a drift indicating and controlling means, which will be substantially independent of the surrounding temperature conditions and to changes in the temperature of the surroundings. In leers of the type above described, the amount of ware passing through the leer sometimes varies within relatively wide limits and the temperature at a given point in the leer sometimes is quite different from what it is at others. Therefore, a device especially of the thermostatic variety, which is preferred in view of the use of the flame above discussed, must be so arranged as to be operable substantially independently of the temperature of the surroundings but merely dependent upon relative changes in temperature due to the angular position of the flame or upwardly moving current of hot gas. The provision of such a "differential thermostat" as it may be called, is a further object of the invention.

A still further object of the invention is to provide means for adjusting the drift responsive device, so that it will establish an equilibrium condition in which there is a predetermined variable drift in either direction or substantially no drift at all, at the will of the operator.

A further object of the invention is to provide simple and efficient means for controlling the drift which may be cheaply and easily constructed and applied in a leer of the character described without interfering harmfully with the temperature control therein, specifically by setting up sufficient counter currents or establishing such differential pressures at various points in the tunnel that the resultant drift in the annealing portion may be controlled as desired.

A further object is to accomplish the end

described in the last paragraph with the use of a minimum of additional mechanism.

Further objects and advantages of my invention will be apparent as the description proceeds and will be set forth in the appended claims.

In the drawings:

Figure 1 is a view substantially in longitudinal vertical section of a tunnel leer embodying my present invention;

Fig. 2 is a plan view of the differential thermostat and adjusting means shown in Fig. 1, the wall of the leer tunnel being shown in section;

Fig. 3 is a horizontal section of a portion of the wall of the leer constructed to accommodate a drift responsive device; and

Fig. 4 is a view generally similar to Fig. 1 showing a somewhat different construction of drift control, drift responsive device and thermostatic control, and also of the wiring by which the electrical impulses are transmitted to the controlling motor.

The leer as shown, Figs. 1 and 2, comprises a tunnel 1 built up of a plurality of substantially interchangeable sections 2 which may be suitably secured together in any desired manner and which are supported upon longitudinally extending rails 3, preferably as shown in the Mulholland patent above referred to. The tunnel 1 is provided with one or more longitudinally extending flues 4 therebeneath which are adapted to be supplied with hot gases at a point adjacent to the ware-entering end of the tunnel, this end and the supply means not being shown in the present drawings. The temperature control of the gases in the flues may be preferably as is shown and described in the Mulholland patent. The tunnel 1 is further provided with a flue or flues 5 in the roof thereof which are open to the outer atmosphere at the exit end as shown at 6 and which are provided with one or more spaced outlet ducts 7 communicating with a conduit 8 for withdrawing cooling air from the flues 5. An inclined passage 9 communicates with the flues 4 and with a wind box 10 through the saddle pipes 11, one on each side of the tunnel, the conduit 8 also communicating with wind box 10. A suction fan 12 is used to withdraw gases from the wind box 10 and direct such gases out the stack 13, the suction fan being driven in any suitable manner as by the electric motor 14. The ware is conveyed through the tunnel preferably continuously on a reticulated woven wire mesh belt 15, which is driven in a suitable manner, not shown, but preferably as in the Mulholland patent above referred to.

Inasmuch as the construction so far described is all substantially identical with the construction shown in the Mulholland patent and of itself is not a part of the present invention, further detailed description is believed to be unnecessary.

The portion of the flue 4 to the right of the inclined passage 9 (Fig. 1) is used as a cooling portion and is provided with an air inlet passage 16 controlled by a damper 17. This portion is provided with one or more ports or passages 18 communicating with the interior of the tunnel, so that when suction is applied by the fan 12 through the wind box 10, saddle pipes 11, inclined passage 9 and the flue 4, air or gases will be withdrawn from the tunnel 1 through the passages 18 and through the foraminous or reticulated belt. The rate of withdrawal of air from the tunnel may be controlled by the adjustment of the damper 19, inasmuch as the rate of air inlet through passage 16 is independently controlled by the damper 17.

The withdrawing of air through the passages 18 would, if nothing else intervened, cause an indraft at both ends of the tunnel. The indraft through the exit end of the tunnel may be controlled by the adjustment of the back door 20, which is provided with side wings 21′ of sector shape, so as to confine the path of the incoming air to the spaces between the articles and the space between their tops and the lower edge of the upper portion of the door 20. The door 20 is pivoted at 21 to some suitable part on the frame of the leer and is provided with one or more loose links 22 having a plurality of holes 23 therein, through any one of which a pin 24 may be inserted into a suitable aperture in a rigid extension 25 of the leer frame. It is intended that the amount of suction and the back door 20 be so controlled that the desired amount of air passes in the back door to effect a predetermined cooling of the ware between the withdrawal point at the passage 18 and the exit end of the leer, this cooling air passing counter-current to the direction of movement of the ware and thus being gradually heated up as it meets warmer and warmer articles. In this way the cooling action is arranged so as to have no ill effects upon the glass. Furthermore, the cooling by direct counter-current flow of air into the tunnel is somewhat more advantageous than cooling through the withdrawal of heat from the ware into the gases in the upper cooling flue 5 and the right hand portion, as seen in Fig. 1, of the flue 4 inasmuch as the air comes into direct contact with the ware and thus will abstract heat more quickly therefrom.

The use of a counter-current flow of air in the tunnel, even when it is caused by a withdrawing of tunnel atmosphere at a point spaced somewhat from the exit end will, however, tend to cause air currents through the hotter or annealing portion of the tunnel, which is distinctly undesirable. It is therefore contemplated to offset the effect of the suction between the withdrawal openings 18

and the hotter or annealing portion of the tunnel in some manner, so that the flow or drift through the hotter portion of the tunnel may be controlled at will, and in the usual case may be reduced to a negligible amount.

I preferably accomplish this by supplying a desired amount of gases to the tunnel at a point adjacent to the withdrawal point at the passages 18 but spaced somewhat toward the ware-entering end of the tunnel therefrom, namely at 26. The passages 26 are preferably formed by one or more elongate slots in each of sides of the tunnel, which communicate through lateral pipes, one of which is shown at 27, with a wind box 28, which communicates in turn through the conduit 29 and the outlet stack 13 with the fan 12. I may provide any suitable means for heating the gases, which are passed into the tunnel through the ports 26. Such means may comprise a heater (not shown) of any desired type interposed in the passages 27, 28 or 29, or a substantially similar result may be accomplished by enlarging the conduit at the point of contact with the side wall of the leer tunnel as indicated by the dotted lines, Fig. 1, so that the heat conducted through such wall will be effective to preheat the entering gases to a point where injury to the ware due to the introduction of the gases at temperatures much lower than that of the ware in the corresponding part of the tunnel will be prevented. A deflecting damper 30 is provided to control the amount of gases deflected from the outlet 13 through the conduit 29 and into the tunnel through the openings 26. The adjustment of the damper 30 may be manual if desired and be made to compensate to any desired amount for a flow of any magnitude through the passages 18 controlled by the damper 19, so that for example, if the damper 19 be fixed at a point at which the desired amount of air is sucked in through the exit end of the leer to effect a predetermined desired rate of cooling of the ware, the damper 30 may be adjusted to supply just enough gases through the inlet ports 26 to exactly balance or feed the suction from the outlet passages 18 toward the entrance end of the leer, so that the portion of the leer to the left, as seen in Fig. 1, of the inlet ports 26 will have any desired drift or none at all.

This method of controlling the drift is contemplated by my invention either manually or automatically in a manner hereinafter to be described. Furthermore, if the adjustment of the damper 19 be changed, the adjustment of the damper 30 must be correspondingly changed to effect the same or some other desired drift in the hotter or annealing portions of the tunnel. As above stated, the usually desired relation is when the drift is minimized, or negligible in the annealing portions of the tunnel.

I provide means adapted to respond to drift through the tunnel, which preferably includes a means for causing a slow upwardly moving current of hot gases such as a flame emitting device, in this case the nozzle of a gas burner 31, which is preferably located in a bay 32 formed in one of the side walls of the leer at a point far enough away from the inlet passages 26 as not to be affected by eddy currents set up in the tunnel by air or gases supplied to the tunnel. The bay is also constituted sufficiently long to provide for a stream-line flow therethrough. The burner serves to emit a flame from one to three inches long, preferably a substantially blue flame but without substantial force, so that it will be blown one side or the other by drift through the tunnel. If desired, a suitable observation opening (not shown) may be provided in the side of the tunnel opposite the flame and the flame adjusted to the yellow color which may be observed so that manual adjustments of the several dampers may be used to effect the drift control as above described. While I have here shown a gas burner to provide a flame, any means by which an upwardly moving current of hot gases is provided is deemed within the scope of my invention.

While an upwardly directed flame is here shown, it is contemplated that a current of gases at a temperature materially different from that in the leer, which normally moves in a direction lying in a plane transversely of the tunnel may be used, thus permitting the current of gases to be deflected in one direction or the other by draft through the tunnel.

I prefer, however, to use an automatic drift control responsive to the angular position of the flame. This control includes a differential thermostat device, which is supported from a fixed bracket 33, Figs. 1 and 2. To the fixed bracket 33 are secured at one end a pair of metallic strips 34, preferably of the same size and composition. Strips 34 preferably of brass are each provided with a wing 35 of good heat conducting material extending in arcuate form above the flame and longitudinally of the leer, the center of the arc preferably being the point of emission of the flame, as seen in Fig. 1. Thus, when the flame is blown to one side, as seen in Fig. 1, the wing 35 on that side will be heated to a greater extent than the one on the other side and will conduct this heat to the strip 34 to which it is affixed, which will expand that strip (on the left Fig. 1) to a greater extent than the other strip and thus cause the index member 36 of the thermostat to move to the right, as seen in Fig. 1, or downwardly as seen in Fig. 2. This will complete an electrical contact between the index member 36 and one of the contact points 37 and will break contact, if it had already existed, between the index 36 and

the other contact point 38. The contact points are preferably constructed as set screws which may be clamped in any adjusted position by suitable jam nuts and which are tipped with suitable material which will resist corrosion or melting away due to arcing action caused by repeated making and breaking of the electrical contact. In the form of the invention shown in Fig. 1, I use a reversible motor 39, of some well-known commercial type, which receives current through line wires 40 and 41 and which is provided with three wires 42, 43 and 44 connected to the thermostat, wire 42 being connected to the index point 36, wires 43 and 44 respectively being connected to the contact points 38 and 37, the contact points being insulated from the leer in any suitable manner. The motor is so arranged that when the index point 36 makes a contact between wires 42 and 43, the motor 39 will be driven to move the damper 30 in one direction through the speed reducing gearing 45, and when the wires 42 and 44 are brought into contact by movement of the index 36 in the opposite direction, the motor 39 will move the damper 30 in the opposite direction. The reducing gearing 45 and the speed of the motor are such that the damper 30 will not be moved too fast to permit conditions in the leer to come to equilibrium before a substantial overrun of the damper 30 is had.

By making the contact points 37 and 38 adjustable, I am enabled to adjust the equilibrium conditions in such a manner that a slight drift in one direction or the other may exist, if such condition is desired.

Referring now to Fig. 4 wherein I have shown a somewhat different form of both drift control, thermostatic means, and electric circuit, similar reference characters refer to corresponding parts as far as is practicable. In this instance, however, I provide a passage 29′, communicating between the outlet pipe or stack 13 and an extension 46 of the leer tunnel 1. This passage 29′ is controlled as to the width of the orifice into the tunnel by a swing plate 47 pivoted at 48 to any suitable part inside the passage, the plate 47 being provided with a rod 49 pivotally connected thereto at a point remote from the hinge 48 and extending through an aperture in the upper wall 50 of the nozzle, the rod 49 having its upper end bent over at an angle and adapted to be received in any one of a plurality of apertures 51 formed in a bracket 52 secured to a suitable part of the apparatus.

The flow through the passage 29′ may be further controlled by a suitable deflecting damper 30′ similar to the damper 30 and provided with an extended arm 53 which may be integral therewith or fixed thereto, and which is provided at its outer end with a rod 54 similar to the rod 49 and having its lower end 55 bent at an angle and adapted to be received in any one of a plurality of apertures 56 formed in a bracket 57 secured to the frame of the leer. Thus it will be seen that the rate of flow of the gases into the tunnel is manually controlled rather than automatic as was the case in the form of the invention shown in Fig. 1.

In this case I use the backdoor 20 as the complementary control by connecting it through a speed-reducing gearing 45 with a reversible motor 39′. It will be obvious that the backdoor could be manually controlled and would effect a drift control in the hotter portions of the tunnel in the same manner that such control is effected by the automatic control presently to be described.

With a predetermined inflow into the tunnel through the duct 29′, there will be a tendency for outflow of gases through the rear end of the leer under the backdoor 20, which, were the door open wide, would have the effect of inducing an inflow through the hot or entering end of the leer. However, the door 20 may be closed to a sufficient extent to cause a building up of pressure inside the leer, which will tend to cause air or gases, supplied through the duct 29′, to flow out the entrance end of the leer. Thus by a suitable control and regulation of the position of the backdoor, the tendency for inflow at the entrance end of the tunnel may be balanced exactly or in any desired manner against the tendency for outflow, and the drift in the hotter or annealing portion of the leer may thus be controlled at will.

In the form of device shown in Fig. 4, I have shown a somewhat different type of controlling means for governing the movements of the motor 39′. In this instance, I use a flame-emitting device 31 as in the form shown in Fig. 1, but instead of using a differential type of thermostat as is there shown, I employ two independent thermostats 58 and 59, each controlling a switch in an electric circuit. This construction is not independent of variations in the surrounding temperature as is the differential type of thermostat above described, but is useful in many instances as where the rate of supply of glass to the leer does not vary greatly and consequently the surrounding temperature at a given point in the leer is substantially constant.

When the flame from the device 31 is blown one way or the other, it will influence the thermostats 58 or 59 and cause either one or the other to complete the circuit of the two wires shown leading thereto (Fig. 4).

The circuit shown in Fig. 4 includes a transformer 60, the primary winding 61 of which is connected across the line wires 40 and 41. The secondary winding 62 of the transformer 60 is connected to one side of each of the switches controlled by the thermostats 58 and 59, by the wire 63. The other sides of each of these switches are connected respec-

tively by wires 64 and 65 with the ends of the solenoid coils 66 and 67, the other ends of both coils being connected by the wire 68 with the other terminal of the secondary winding 62 of the transformer 60. Thus when either of the thermostats 58 or 59 are influenced by the blowing of the flame in one direction or the other, the solenoid windings 66 or 67, as the case may be, will be energized and the cores thereof will be moved to make contact between line wire 40 on the one hand and wires 69 or 70 on the other according to which of the solenoids is energized, either of these latter contacts being arranged to drive the motor 39′ in one direction or the other according to which of the solenoids is energized. The cores of the solenoids 66 and 67 are preferably connected by a mechanical bridging device 71, which insures that one of the cores is retracted when the other is urged forwardly to make contact between the wire 40 and the wire 69 or 70 as the case may be.

In order to prevent the motor over-running and more quickly to bring about an equilibrium condition, it may be desirable in some instances to use a make-and-break device which will only permit the motor to operate, at most, a few seconds out of each minute, or at least a small proportion of the time and at stated intervals. For this purpose I prefer to employ a device generally indicated at 72, which comprises a rotary element, having opposite contact points connected together and adapted to be continuously rotated in any suitable manner, as, for example, by connecting it with the means for driving the conveyor. This device 72 may be interposed in the wire 63 so as to complete a circuit through this wire for, say, three seconds every minute.

Operation

Taking up first the operation of the device as shown in Figs. 1 and 2, assuming that there is a drift toward the left, as shown in Fig. 1, which will blow the flame to the left of the center as is shown in full lines in that figure, heat will be conducted through the wing member 35 seen at the top in Fig. 2, to the associated strip 34, which will bend the index member 36 downwardly as seen in Fig. 2, connecting the wires 42 and 44. This will cause the motor 39 to operate in the proper direction to move the damper 30 toward its closed position or in a direction which will reduce the amount of air admitted to the tunnel 1 through the ports or passages 26. The suction through the passages 18 remains constant as no variation has been made in the adjustment thereof, and the influence of this suction will, therefore, be relatively greater with respect to the effect of the incoming air through the ports 26, which will tend to stop a drift to the left and create one in the opposite direction, the eventual drift depending on the degree of movement of the damper 30. In the latter case, the flame will be blown to the right as seen in Fig. 1, and wires 42 and 43 will be connected to rotate the motor 39 in the opposite direction and to move the damper 30 toward a more open position, which will tend to increase the amount of air admitted through the ports 26 and as a result have the opposite influence on the drift in the tunnel. These actions will take place until equilibrium is established, this equilibrium being determined by the adjustments of the contact screws 37 and 38.

Referring now to the form of the invention shown in Fig. 4 and assuming that a drift exists in the leer tunnel, which will blow the flame from the device 31 to the left and heat the thermostat 58 to make contact between the wires 63 and 64, nothing will happen until the make-and-break device 72 completes contact between the two parts of the wire 63 leading from the secondary winding 62 of the transformer 60. A circuit will then be completed from the secondary winding 62 of the transformer 60 through the wire 63 and make-and-break device 72, through the switch controlled by thermostat 58, wire 64, solenoid 66, and wire 68 back to the secondary winding 62, this circuit serving to energize the solenoid as is indicated in Fig. 4 and to make contact between wires 40 and 69, which will serve to operate the motor 39′ in such a direction as to move the door 20 toward its open position. This action will take place only as long as the make-and-break device 72 keeps the circuit closed through the secondary winding 62 of the transformer 60.

Thereafter, the core of solenoid 66 will be withdrawn to open the motor circuit by a suitable spring (not shown). If, when the make-and-break device 72 again makes contact, undesired drift conditions as above assumed have not been rectified and the thermostat 58 still makes contact between wires 63 and 64, the door 20 will be opened a little further as above described. If, however, the door has been opened too far and drift exists to the right, so that the flame will heat thermostat 59, a circuit will be completed through the secondary 62 of the transformer 60 and the solenoid 67, which will connect the wires 40 and 70 and operate the motor 39′ in the opposite direction and thus move the backdoor 20 toward a closed position. These actions will be continued until the desired equilibrium conditions have been established, at which time, no further action will take place until the equilibrium is again disturbed in some manner.

If desired, limit switches (not shown) may be used to cut off the motors 39 or 39′ when the damper 30 or the backdoor 20 of Figs. 1 or 4, respectively, are in their terminal positions in one direction or the other.

While I have shown and described a meth-

od and but two embodiments of my invention, it is understood that many changes may be made therein and certain of the individual features may be used in other combinations. I do not wish to be limited therefore except by the scope of the appended claims.

Among the possible variations of the flow responsive device broadly is the use of a current of air or gas either hotter or colder than the tunnel atmosphere, but of a materially different temperature therefrom, for influencing some temperature responsive device such as that shown; also there is contemplated the use of any desired fluid having materially different physical and/or chemical properties from those of the gases flowing through the passage, where the flow of such fluid will be deflected one way or the other by drift or flow through such passage and wherein such different physical and/or chemical properties influence some kind of detecting or indicating device. Among the possibilities under this head are the use of a flame, in combination with a pair of photoelectric cells wherein the color or brilliancy of the flame is used to vary the currents passing through the cells, the use of some added gas, such for example, as carbon dioxide, which will vary the chemical and physical properties of the gas in the tunnel, which may be withdrawn through openings one on either side of the inlet for the carbon dioxide. By the use of two CO_2 meters of any well known type and of either chemical or physical character, the flow in one direction or the other may be determined. This may be done either in response to the variation in the thermal conductivity of the gas withdrawn from the tunnel which is influenced by the proportion of CO_2 therein or by the variation in its chemical properties. It is also contemplated to use some character of sensitive support to hold a mirror, such as that used in a galvanometer, in such a way that the mirror would be deflected either by translation, or rotation, or both, so as to reflect differently a beam of light, which might be received differently according to the position of the mirror by a pair of photoelectric cells, the drift thus influencing the currents passing through the cells differentially. Many other possible drift responsive devices might be used, in each of which there is some drift responsive means, a separate and independent detecting means, and a means responsive to the detecting means for effecting a mechanical movement of some other mechanism in response to the drift in one direction or the other.

I claim:

1. Apparatus for annealing glassware comprising a tunnel through which a gaseous fluid may flow, a device providing for a current of a gaseous medium at a temperature materially different from that in said passage, positioned therein and adapted when there is no flow through said passage to direct said medium in a direction lying in a plane transverse to the flow to be controlled, an electric circuit, means to make and break said circuit, and means responsive to a deflection of the flow of said medium to operate the last named means to make and break said circuit.

2. Apparatus for annealing glassware comprising a tunnel through which gaseous fluid may flow, a source of heat positioned therein and adapted when there is no flow through said passage to direct a current of hot gases in a direction lying in a plane transverse of said passage, an electric circuit, means to make and break said circuit and a thermostatic device responsive to the variations in the direction of said current of gases caused by a flow through said passage for operating the last named means to make and break said circuit.

3. Apparatus for annealing glassware comprising a tunnel through which gaseous fluid may flow in either direction, a flame emitting device positioned therein and adapted when there is no flow through said passage to direct a flame in a direction lying in a plane transverse of said passage, a pair of electric circuits, means to make and break said circuits and arranged to break either one circuit before making the other, and a differential thermostatic device associated with the last named means and positioned so as to be acted on by the flame and responsive to variations in the angular position of the flame, whereby said circuits will be respectively made and broken in response to a flow through said passage in one direction or the other.

4. Apparatus for annealing glassware comprising a tunnel through which gaseous fluid may flow in either direction, a flame emitting device positioned therein and adapted when there is no flow through such passage to direct a flame vertically upward, a pair of electric circuits, a differential thermostat including two expansible elements of similar characteristics positioned above said flame emitting device, a common wire from each of said circuits being connected to the moving parts of said thermostat, the other contacts of each of said circuits being spaced from the moving element of said thermostat, and heat conducting members extending from the elements of said thermostat longitudinally of the passage above the flame, whereby the flow in one direction or the other in said passage will cause a change in the angular position of the flame longitudinally of the passage and expand the thermostat elements differentially to make contact through one or the other of said circuits, and whereby the thermostat as a whole and the control thereby is

independent of the temperature changes in said passage.

5. Apparatus for annealing glassware, comprising an elongate tunnel, means for moving the glassware therethrough, means associated with said tunnel for controlling the temperatures therein, and means for controlling the drift in the hotter portions of said tunnel including a passage communicating with said tunnel at a point spaced from the exit end thereof, means for withdrawing gases from said tunnel through said passage thereby tending to create a draft from either end of the tunnel toward said passage, means spaced along said tunnel from said passage for supplying a gaseous medium to said tunnel to offset the tendency of inflow from the hotter end of the tunnel through the first named passage, and means independently to control the gaseous flow through the inlet and outlet passages to the tunnel, whereby the drift in the hotter portion of the tunnel may be varied at will.

6. Apparatus for annealing glassware, comprising an elongate tunnel, means for moving articles of glassware therethrough, means associated with the tunnel at a point spaced from the exit end thereof for withdrawing gases from the tunnel at such point, means for supplying a gaseous medium to the tunnel at a point adjacent to but spaced along the tunnel from the first named point, the rate of flow caused by one of the last two named means being predetermined to cause definite flow along one portion of the tunnel and the flow caused by the other being adjustable to effect a desired flow through a selected zone in the tunnel, whereby the drift in said zone may be controlled at will.

7. Apparatus for annealing glassware, comprising an elongate tunnel, means for moving articles of glassware therethrough, means for controlling the temperatures in said tunnel, means associated with the tunnel adjacent to but spaced from the exit end thereof for withdrawing gases therefrom, means for manually controlling the rate of gas withdrawal from the tunnel by the last named means, means for supplying a gaseous medium to the tunnel at a point adjacent to the point of withdrawal of gases therefrom but spaced toward the entrance end of the tunnel therefrom, and automatically controlled means for variably determining the amount of gases supplied to the tunnel in accordance with the desired flow through the hotter portions thereof.

8. Apparatus for annealing glassware comprising an elongate tunnel, means for moving articles of glassware therethrough, means for controlling the temperatures in said tunnel, means associated with the tunnel adjacent to but spaced from the exit end thereof for withdrawing gases therefrom, means for manually controlling the rate of gas withdrawal from the tunnel in proportion to the desired amount of cooling of the ware between the point of gas withdrawal and the exit end of the tunnel, means for supplying a heated gaseous medium to the tunnel at a point adjacent to the point of gas withdrawal but spaced toward the entrance end of the tunnel therefrom, and means for controlling the rate of supply of the heated gaseous medium to the tunnel in response to the drift at a selected point in the hotter or annealing portion of the tunnel.

9. Apparatus for annealing glassware comprising a tunnel, means for moving articles of glassware therethrough, means associated with said tunnel for causing a flow of gaseous medium therethrough in either direction and at a desired velocity, and a single means for controlling both the direction and the velocity of such flow, whereby the drift in the tunnel may be controlled as desired.

10. Apparatus for annealing glassware comprising an elongate tunnel, means for moving articles of glassware therethrough, means for causing a current of gaseous medium to flow through the tunnel in either direction and at a desired velocity, and means to control both the direction and the velocity of the current through the tunnel in response to the drift therethrough at a selected point therein, the drift responsive means being sensitive to a drift through the tunnel of the order of magnitude of a gaseous current which will cause an appreciable variation in the angular position of a candle flame.

11. Apparatus for annealing glassware comprising an elongate tunnel, means for moving articles of glassware therethrough, means for causing a current of gaseous medium to flow through the tunnel in either direction and at a desired velocity, a flame emitting device positioned in said tunnel at a selected point at which the angular position of the flame will be influenced by drift through the tunnel, and thermostatic means responsive to the angular position of the flame for controlling the direction and velocity of the gaseous current in the tunnel.

12. Apparatus for annealing glassware comprising an elongate tunnel, means for moving articles of glassware therethrough, means for causing a current of gaseous medium to flow through the tunnel in either direction and at a desired velocity, a flame emitting device positioned in said tunnel at a selected point at which the angular position of the flame will be influenced by drift through the tunnel, a differential thermostat positioned to be influenced by the flame from said device, and means operating in response to the movements of said thermostat for controlling both the direction and velocity of the gaseous flow through the tunnel, the thermostatic device being independent of changes

in the surrounding temperature in the tunnel, whereby to control the drift as desired irrespective of the variation in the amount of glass being annealed and the annealing conditions.

13. Apparatus for annealing glassware, comprising an elongate tunnel, means for moving articles of glassware therethrough, means for causing a current of a gaseous medium to flow through the tunnel in either direction and at a desired velocity, a flame emitting device positioned in said tunnel at a selected point at which the angular position of the flame will be influenced by the drift through the tunnel, a differential thermostat position to be moved by a variation in the angular position of the flame, a damper for controlling the direction and velocity of the drift through the tunnel, a reversible motor connected to operate the said damper, a circuit for operating the motor in each direction, said thermostat being connected in the circuits, so as to operate the motor in one direction or the other according as the drift in the tunnel varies from the predetermined desired drift.

14. Apparatus for annealing glassware comprising an elongate tunnel, a temperature controlling flue extending longitudinally therebeneath and adapted to be supplied with hot gases adjacent to the ware-entering end of said tunnel, a fan for drawing gases from said flue at a point adjacent to the exit end of the tunnel, a passage communicating between said flue and the interior of the tunnel, means associated with said flue and passage for controlling the amount of the tunnel gases withdrawn therefrom through the flue by said fan, and means to supply a gaseous medium to said tunnel to offset and balance the suction toward the hot end of the leer, whereby the drift in the hotter or annealing portion of the leer may be controlled as desired.

15. Apparatus for annealing glassware, comprising an elongate tunnel, means for moving articles of glassware therethrough, a temperature controlling flue associated with said tunnel and having an opening to the atmosphere adjacent the ware exit end thereof, a suction fan for withdrawing air from said flue, a passage communicating between the tunnel at a point adjacent to but spaced from the exit end and said fan on the suction side thereof for withdrawing gases from the tunnel and for causing an indraft at the exit end thereof to cool the ware, and means to supply a gaseous medium to the tunnel at a point adjacent to but spaced from the withdrawal point tending to counteract the effect of the suction which tends to draw air into the tunnel through the ware-entering end thereof.

16. Apparatus for annealing glassware, comprising an elongate tunnel, means for moving articles of glassware therethrough, a temperature controlling flue extending longitudinally of said tunnel and adapted to be supplied with hot gases adjacent to the ware-entering end thereof, a suction fan for withdrawing gases from said flue, a passage extending between said flue and the interior of said tunnel for withdrawing gases from the tunnel through the flue to the fan, means for controlling the amount of gases thus withdrawn from the tunnel, a passage extending between the outlet side of said fan and said tunnel adjacent to but spaced from the first named passage, and means to control the flow of gases through the last named passage to said tunnel, whereby the drift in a selected portion of said tunnel may be regulated at will.

17. Apparatus for annealing glassware comprising an elongate tunnel, means for moving articles of glassware therethrough, a longitudinally extending temperature controlling flue associated with said tunnel and having an inlet opening to the atmosphere adjacent to the ware exit end thereof, a suction fan for withdrawing air from said flue, a passage communicating between the interior of said tunnel at a point spaced from the exit end thereof and the suction side of said fan, means to control the flow of gases through said passage, a passage communicating between the outlet side of said fan and a point in said tunnel toward the entrance end thereof from the first named passage but adjacent thereto, and means to control the flow of gas through last named passage, whereby the drift in the hotter or annealing region of said tunnel may be varied at will.

18. Apparatus for annealing glassware, comprising an elongate tunnel, a reticulated wire mesh belt for moving articles of glassware therethrough, a longitudinally extending temperature controlling flue beneath said tunnel and adapted to be supplied with hot gases at a point adjacent to the ware-entering end of said tunnel, a suction fan communicating with said flue at a point adjacent to but spaced from the exit end of said tunnel, a passage communication between the interior of said flue and the atmosphere at the end of said flue adjacent to the exit end of the tunnel, a passage communicating between said flue at a point between the communication with the fan and the exit end of the tunnel and the interior of the tunnel, means for manually controlling the amount of gases withdrawn from the tunnel for controlling the rate of cooling of the ware between the withdrawal point of the gases and the exit end of the tunnel by controlling the amount of air drawn into said exit end thereof, a passage communicating between the outlet side of said fan and the interior of the tunnel at a point adjacent to but spaced toward the ware entering end thereof from the withdrawal point, and automatic means respon-

sive to the drift in the hotter or annealing portion of the tunnel for controlling the amount of air supplied to the tunnel to regulate the drift in said annealing portion.

19. Apparatus for annealing glassware comprising an elongate tunnel, means for moving articles of glassware therethrough, means for causing a current of gaseous medium to flow through the tunnel in either direction and at a desired velocity, a flame emitting device at a selected point in the tunnel at which the angular position of the flame will be influenced by drift through the tunnel, thermostatic means responsive to the angular position of the flame for controlling the direction and velocity of the gaseous current in the tunnel, and means for adjustably varying the control by said thermostatic means to vary the condition of equilibrium established thereby as to both direction and velocity of the gaseous current in the tunnel.

20. Apparatus for annealing glassware comprising a tunnel through which gaseous fluid may flow, a flame emitting means therein and adapted when there is no flow through said passage to project a flame in a direction lying in a plane transverse of said passage, an electric circuit, means to make and break said circuit, and means responsive to the deflection of the flame caused by drift through said passage to actuate the last named means to make and break said circuit.

21. Apparatus for annealing glassware comprising a tunnel through which gaseous fluid may flow, means in said passage adapted to be acted upon by a flow of gaseous fluid through said passage in one direction or the other, detecting means responsive to the first named means, and means responsive to said detecting means for effecting a mechanical movement.

22. Apparatus for annealing glassware, comprising a tunnel through which a gaseous medium may flow, means for moving the ware to be annealed through said tunnel, means arranged to be moved in response to a flow of gaseous medium through said tunnel, means for controlling the flow of gaseous medium through said tunnel, and operative connections between the last two named means, whereby movement of the first of said last two named means acts to modify the flow of gaseous medium through said tunnel.

23. Apparatus for annealing glassware, comprising a tunnel through which a gaseous medium may flow, means for controlling the flow of gaseous medium through the tunnel, means for projecting a stream of gaseous medium at a temperature substantially different from the temperature of the first named gaseous medium in the tunnel and in a direction substantially in a plane transverse of the tunnel, means responsive to a deflection of said stream of gaseous medium as caused by the flow of the first named gaseous medium in the tunnel, and connections between the last named means and the means for controlling the flow of the first named gaseous medium in the tunnel for regulating said flow in accordance with the deflection of said stream of gas.

Signed at Hartford, Connecticut, this 28th day of August, 1929.

HAROLD A. WADMAN.