Jan. 26, 1937. D. G. MERRILL 2,068,923

METHOD OF AND APPARATUS FOR ANNEALING GLASSWARE

Filed Nov. 8, 1935 5 Sheets-Sheet 1

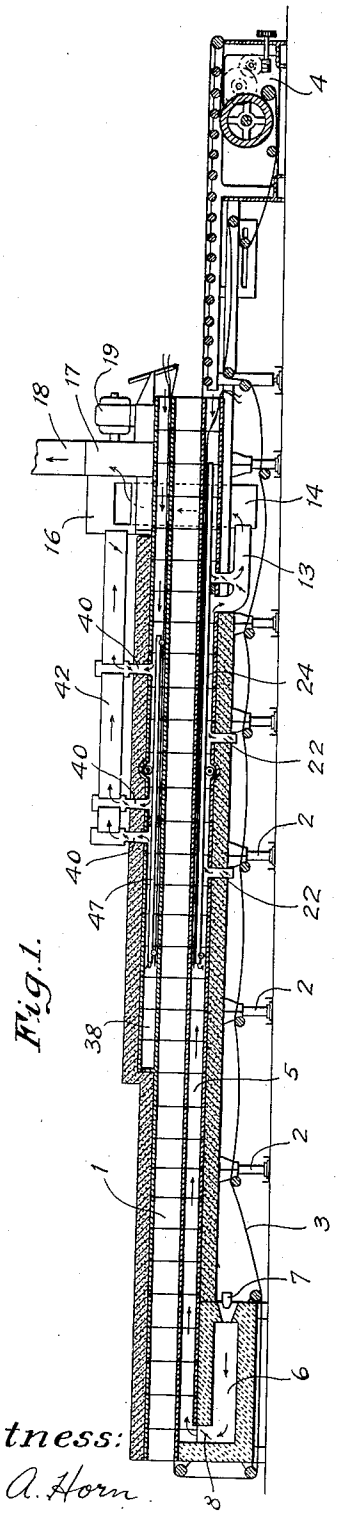


Fig. 1.

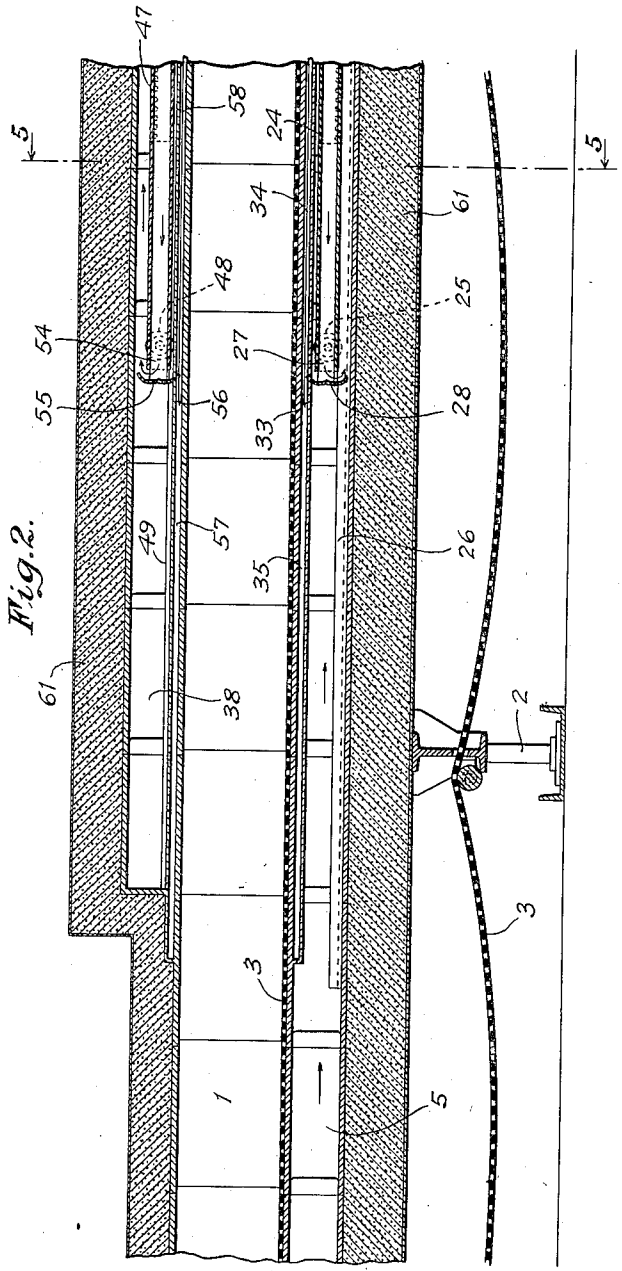


Fig. 2.

Witness:
A. A. Horn

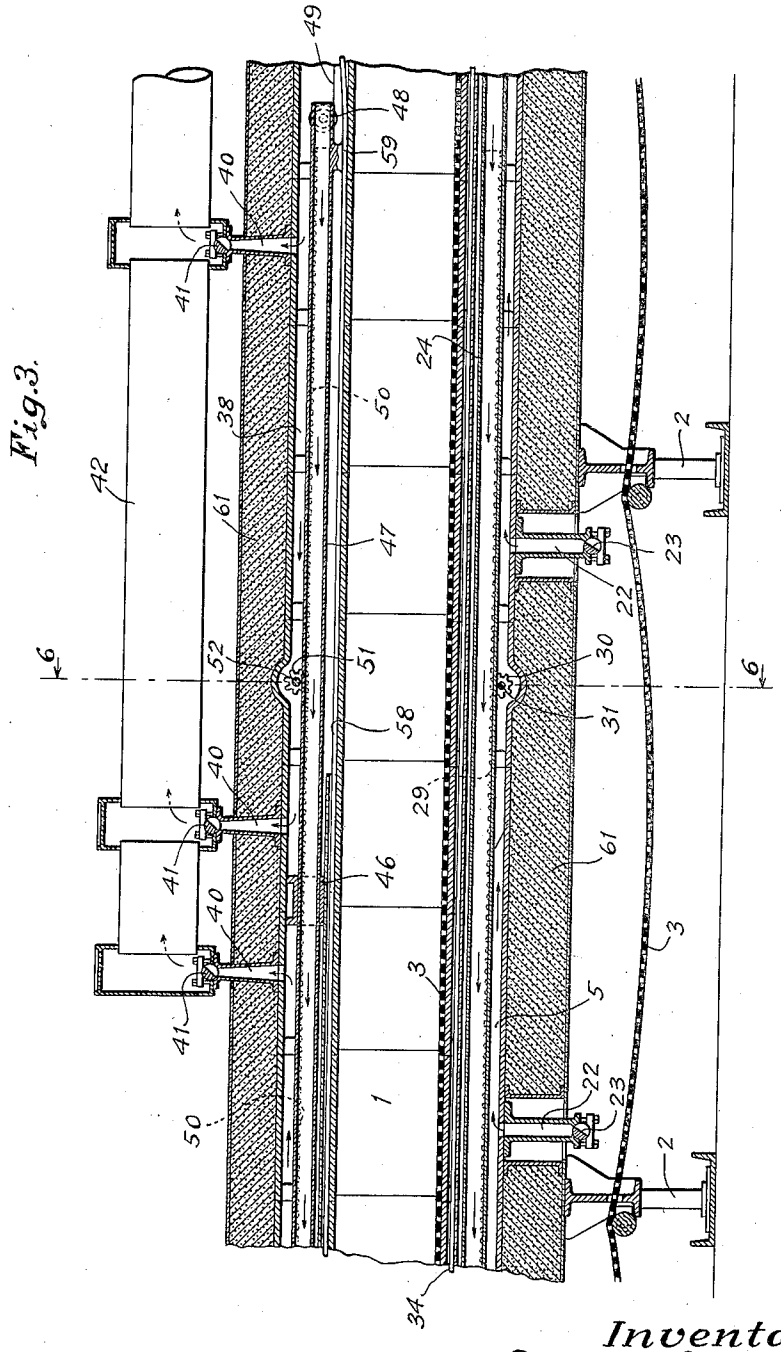
Inventor:
Donald G. Merrill
by Brown & Parkam
Attorneys

Jan. 26, 1937. D. G. MERRILL 2,068,923

METHOD OF AND APPARATUS FOR ANNEALING GLASSWARE

Filed Nov. 8, 1935 5 Sheets-Sheet 2

Fig. 3.



Witness:
R. Horn

Inventor:
Donald G. Merrill
by Brown & Parkam
Attorneys.

Jan. 26, 1937. D. G. MERRILL 2,068,923

METHOD OF AND APPARATUS FOR ANNEALING GLASSWARE

Filed Nov. 8, 1935 5 Sheets-Sheet 3

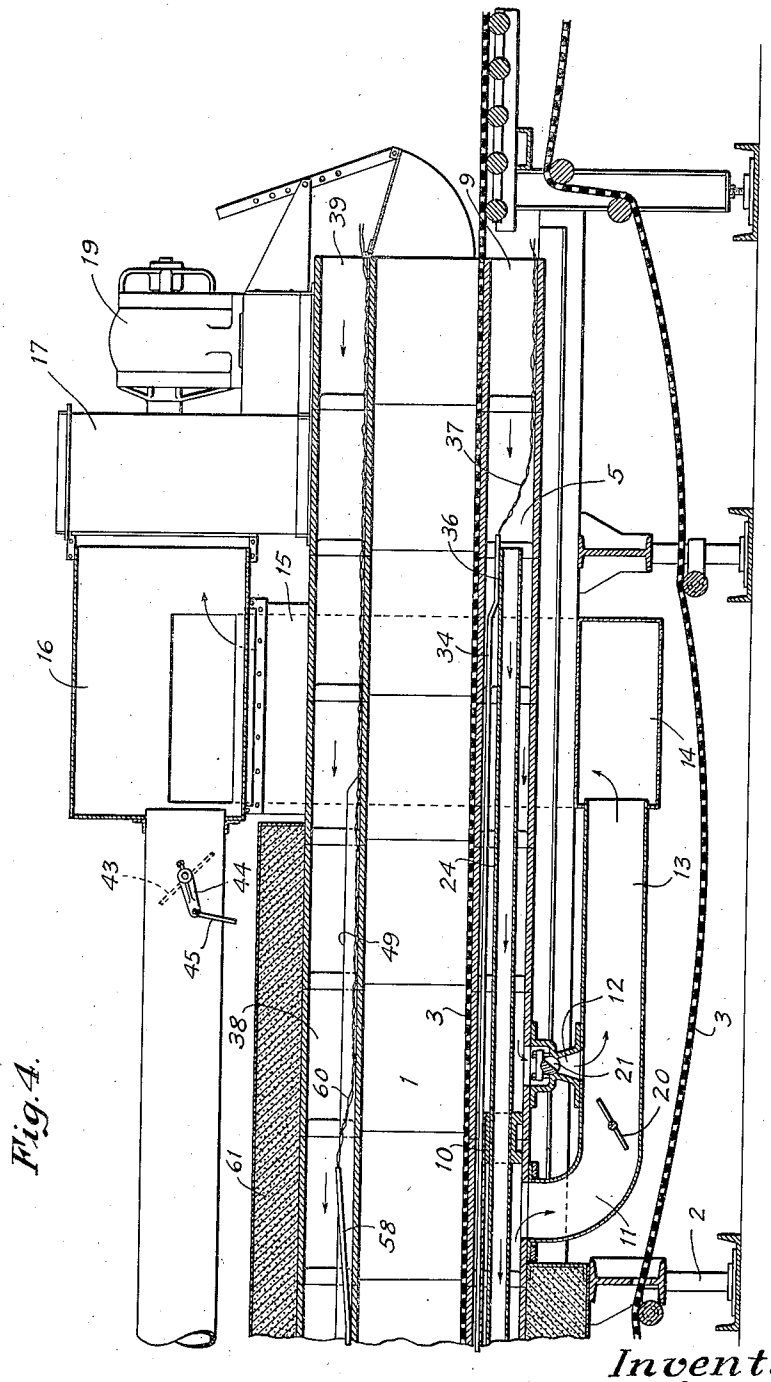


Fig. 4.

Witness:
A. A. Horn.

Inventor:
Donald G. Merrill
by Brown & Carlson
Attorneys.

Jan. 26, 1937. D. G. MERRILL 2,068,923

METHOD OF AND APPARATUS FOR ANNEALING GLASSWARE

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Fig. 5.

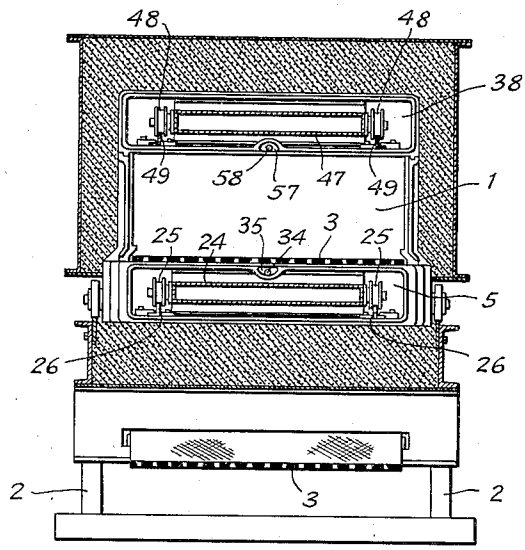
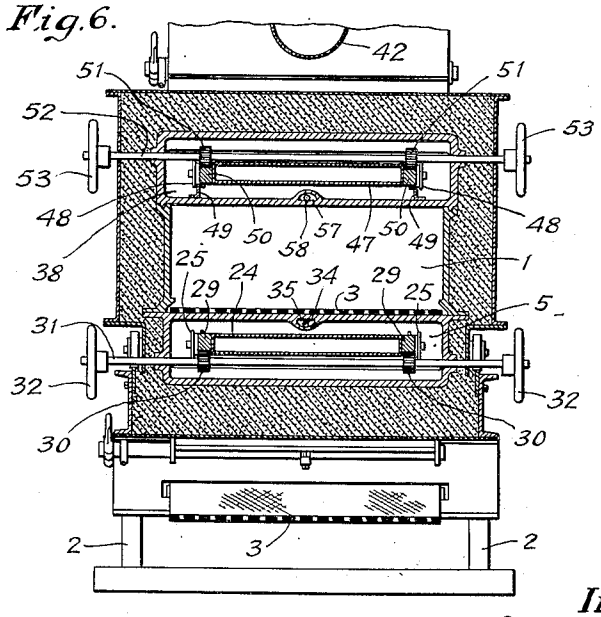


Fig. 6.



Witness:
A. A. Horn

Inventor:
Donald G. Merrill
by Brown & Parkinson
Attorneys.

Jan. 26, 1937. D. G. MERRILL 2,068,923

METHOD OF AND APPARATUS FOR ANNEALING GLASSWARE

Filed Nov. 8, 1935 5 Sheets-Sheet 5

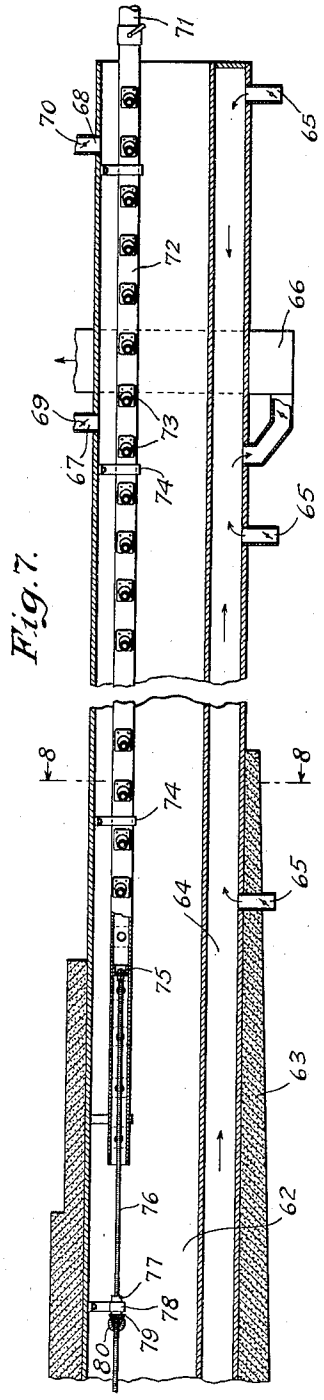


Fig. 7.

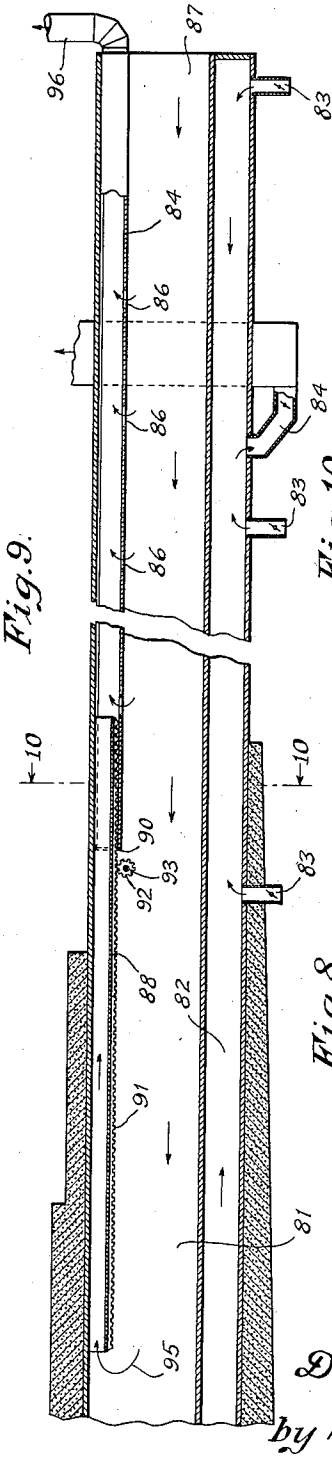


Fig. 9.

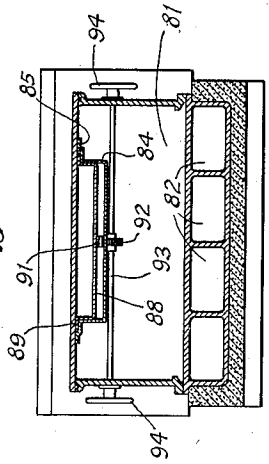


Fig. 10.

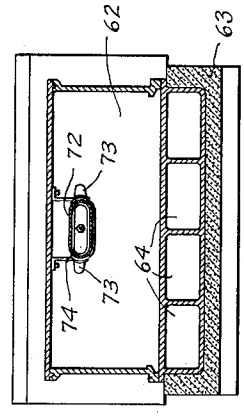


Fig. 8.

Witness:
A. A. Horn

Inventor:
Donald G. Merrill
by Brown & Parkam
Attorneys.

Patented Jan. 26, 1937 2,068,923

UNITED STATES PATENT OFFICE

2,068,923

METHOD OF AND APPARATUS FOR ANNEALING GLASSWARE

Donald G. Merrill, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn., a corporation of Delaware

Application November 8, 1935, Serial No. 48,799

15 Claims. (Cl. 49—47)

This invention relates to a method of and apparatus for the annealing and more particularly the cooling of glassware and has particular relation to glassware annealing lehrs and provisions for use therewith for controlling the distance to which cooling currents of air pass from the rear toward the front of the lehr prior to their flow in the reverse direction, thereby controlling the point along the lehr tunnel at which the cooling of the glassware is accelerated.

In order to obtain the maximum annealing capacity from a continuous glassware annealing lehr it is necessary to apply rapid cooling to the ware as soon as possible after the slow cooling through the critical range of temperature, that is, once the ware has cooled to the point below which permanent strains cannot be reintroduced, or as it is often called the "low annealing point". It is desirable in order that the process of cooling be speeded up to the maximum allowable rate, that the rate of cooling of the glass be accelerated. This rate of cooling can be accelerated only to the point where the temporary strains set up, due to the changing temperature of the ware, are not so great as to rupture the articles.

However, it has been found in practice with present commercial lehrs that the point in the length of the lehr where the glassware will be cooled down to or below the "low annealing temperature" is variable, so that in the more modern lehrs it has been the practice to provide for the variation in the point along the lehr where positive or forced cooling is applied. One way this has been done is to provide a muffle cooling flue extending part way along the top of the lehr from the exit end, the flue being open to the atmosphere at such end and the gases being withdrawn from the flue at a plurality of spaced points through tap-off passages. Thus, by closing one or more of these passages toward the entrance end, the distance that the cooling air passes toward the entrance end is varied.

This construction, however, suffers the disadvantage that at the point along such cooling flue where a tap-off is provided there is inevitably a considerable localized loss of heat. If the lehr is being used with a fairly heavy loading (usually expressed in ounces of glass per minute), or, because of size, a high belt speed is necessary to accommodate the volume of ware, it has been found that the ware does not reach and pass through the lower annealing temperature until it has traveled along the tunnel a greater distance than in cases where the loading is lighter, or belt speed slower. For this reason, the provision of the above mentioned tap-offs far enough toward the entrance end of the lehr to bring the cooling toward the front sufficient to accommodate light loadings causes localized heat losses from the tunnel at such points and hence from the ware when heavier loadings are used at portions of the lehr where the ware has not reached its "low annealing temperature". This tends to cause trouble in the annealing.

Among the objects of my present invention therefore is to provide a method and apparatus by which the distance which cooling air is carried from the exit end toward the entrance of the lehr may be controlled in a manner which will not be subject to the difficulties above referred to.

A further object of the present invention is to provide for the controllable cooling or a control of the point at which accelerated cooling is initiated in conjunction with and preferably in response to the temperature of the ware or that in the tunnel substantially at the point along the tunnel where accelerated cooling is to be initiated.

A further object of the present invention is to provide for the specific application or one or both of the above named principles both to a cooling flue and to a heating flue, in the case of a heating flue the result being effected by the introduction of atmospheric air into the flue to mix with, dilute and cool gases therein at a point adjustable longitudinally of the lehr while at the same time eliminating the inlet or outlet openings from such portions of the flue or flues which have been sources of localized losses of heat.

Further and more detailed objects of the present invention include the provision of specific apparatus for carrying out the above principles including the provisions of ducts or passage forming means arranged within and longitudinally movable in respect to the heating and/or cooling flues in a lehr and to provide for the adjustment of these means from outside the lehr in such manner that the adjusting means will be arranged in the cooler end of the lehr at points where the temperature is so low that insulation is either not required, or that any heat losses incident to the provision of the adjusting means do not adversely affect the temperature control within the lehr.

Other and more specific objects of the present invention will become apparent from a reading of the specification and appended claims all when taken in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic view substantially in vertical longitudinal section of a glassware annealing lehr embodying my invention;

Figs. 2, 3 and 4 when placed together in numerical order constitute an enlarged view in longitudinal vertical section of approximately two-thirds of the lehr shown generally and diagrammatically in Fig. 1 showing in detail the application of my invention thereto;

Fig. 5 is a view in transverse vertical section on the line 5—5 of Fig. 2;

Fig. 6 is a view in transverse vertical section taken substantially on the line 6—6 of Fig. 3.

Fig. 7 is a view of a portion of a lehr illustrating a modified form of my invention, many parts including the conveyor being omitted and the view being taken substantially in longitudinal vertical section;

Fig. 8 is a view in transverse vertical section of the device of Fig. 7 taken on the line 8—8 thereof;

Fig. 9 is a view similar to Fig. 7, showing another modified form of lehr to which my invention is applied; and

Fig. 10 is a view in transverse vertical section of the device shown in Fig. 9, taken on the line 10—10 of that figure.

My invention as hereinafter set forth may be applied to various different types of glassware annealing lehrs, including both muffle and direct fired lehrs and also including lehrs in which the cooling air is used both in muffles and directly in the tunnel in contact with the ware therein. I have shown several forms of my invention, one in Figs. 1 to 6 inclusive, a second in Figs. 7 and 8, and a third in Figs. 9 and 10, the second and third forms of my invention being those in which the cooling air comes into direct contact with the ware, while in the first form the cooling air is always contained in a muffle.

In the first form of my invention shown in Figs. 1 to 6 inclusive and as a basis for the constructions shown in the other figures, I have illustrated and will hereinafter describe a lehr similar in many respects to that shown and described in the Mulholland Patent 1,560,481, granted Nov. 3, 1925. Reference may be had to this patent for a specific description of certain constructional details not included in the following description of the several forms of the lehr shown in the accompanying drawings.

Referring to the form of the invention shown in Figs. 1 to 6 inclusive, the lehr comprises an elongate tunnel 1, which is made up of a plurality of metallic sections suitably secured together and supported at spaced intervals upon logs or pedestals 2. The ware is carried through the lehr tunnel 1 upon an open-work conveyor 3, preferably of woven wire mesh. The working strand of the conveyor 3 passes through the tunnel sliding upon the floor thereof while the return or idle strand returns to the entrance end of the tunnel beneath the same. Means generally indicated at 4 (Fig. 1) are provided for drawing the conveyor through the tunnel, these means being shown and described in greater detail in the Mulholland patent above referred to.

Beneath the tunnel 1, there is provided a longitudinally extending heating flue, generally indicated at 5, this flue being in good heat transferring relation with the interior of the tunnel and the ware passing therethrough for substantially the entire length of the lehr. Means are provided for supplying hot gases, in this case products of combustion, to the flue 5, such means including the firse box diagrammatically indicated in Fig. 1 at 6, which is arranged beneath the entrance end of the tunnel and is provided with a burner indicated diagrammatically at 7 for supplying a combustible medium thereto in the usual manner. The firebox 6 communicates with the flue 5 as indicated, the communication being shown as controlled by a damper 8, although in practice this damper may be omitted at this point and an equivalent control secured by one or more dampers provided at other and cooler parts of the flue system.

As shown best in Fig. 4, the flue 5 is open at its exit end to the atmosphere at 9. A short distance from the cooler end of the flue 5 there is provided a partition 10 extending across this flue, except as hereinafter provided and for a purpose which will later become apparent. The two portions of the flue 5 on opposite sides of the partition 10 are connected by passages 11 and 12 respectively with a common outlet conduit 13, which communicates through a wind box 14 and saddle pipes 15, one on each side of the lehr, with an upper wind box 16, the latter communicating with an exhaust fan 17 by which the gases are directed to a stack 18, Fig. 1. The fan 17 is driven by a suitable prime mover, such as an electric motor 19. Flow through the passage 11 is controlled by a damper generally indicated at 20, while flow through the passage 12 is controlled by a damper indicated at 21. The detailed construction of the damper 21 will be found in the Mulholland patent above referred to. For the present, it is sufficient to say that this damper operates to control the flow through the passage 12 by the usual rotative adjustment.

At spaced intervals along a portion of the flue 5, there are provided air inlet openings 22 (Fig. 3), each controlled by a damper 23 similar in construction to the damper 21. As the entire flue system just described is maintained under a slight sub-atmospheric pressure due to the operation of the exhaust fan 17, the opening of any one or more of the dampers 23 will cause an influx of air at the several points which will mix with, dilute and cool the products of combustion passing along the flue 5, so that the temperature gradient of the gases in the flue and hence the temperatures in corresponding portions of the tunnel may be controlled thereby.

However, at each of the points where an air inlet such as those shown at 22 is provided, there is a localized heat loss from the tunnel through the walls of the inlet passage and due to the gap in the insulation about the tunnel and flue at such points, as shown in Fig. 3. In the cooler portions of the lehr, this additional cooling at localized points has practically no harmful effect, but if these air inlet openings be carried up toward the hotter end of the lehr, so as to be located in a portion of the tunnel through which glassware is passing at temperatures above its "low annealing temperature", that is, within the critical range, then the localized cooling may affect the ware in such manner as to introduce permanent strains thereinto which will not later be removed and which hence cause poor annealing in the finished articles. At the same time, it is desired particularly when using light loadings to initiate cooling or accelerated cooling of the glassware at points earlier in the tunnel than would be possible with the air inlet openings, as shown positioned beyond the point at which heavy loadings of glassware would get down to their "low annealing temperature". For this reason, I have provided a means for introducing cooling air into the flue 5 at points nearer

the hotter end of the tunnel than the first of the air inlet openings 22 and in such manner that at the point of introduction of such air, which is preferably a variable distance from the hot end of the tunnel, there are no breaks in the insulation around the tunnel and flue.

For this purpose, I provide a passage forming means or duct 24 of somewhat smaller dimensions than the inside of the flue 5 and mounted for longitudinal adjustment within this flue, as shown best in Figs. 2, 3 and 4. The duct may be supported in any suitable manner, but I have shown it as supported in part by the partition 10 (Fig. 4) through which it passes with a substantially air-tight fit, although this fit is such as to enable the easy adjustive movement of the passage forming means or duct 24 longitudinally of the lehr. The forward end of the passage forming means 24 is provided with a pair of rollers 25 arranged to roll and be guided on rails 26, the details of this construction being best seen in Figs. 2, 5 and 6. If desired, any additional supporting means which may be found necessary can be used for properly supporting the duct or passage forming means 24, the one shown being merely conventional.

The air from the atmosphere entering the flue 5 at 9 at the rear end of the lehr passes in two paths, first in a path surrounding the passage forming means 24 to the outlet 12 and thence through the passages 13, 14, 15 and 16 to the fan 17, this air being controlled by the damper 21. Another portion of this air entering at 9 passes through the duct or passage forming means 24 to the forward end of the same, shown in Fig. 2 at 27, where it is deflected toward the rear end of the lehr by a deflector shown at 28, this deflector being suitably shaped as shown for this purpose. The air then reverses its direction of flow and passes between the duct or passage forming means 24 and the walls of the flue 5 along with the products of combustion, to the outlet 11, where its flow is controlled by the damper 20, and thence through the passageways 13, 14, 15 and 16 to the fan 17. The air passing out of the duct or passage forming means 24 at 27 will mix with, dilute and cool the products of combustion passing along the flue 5 and thus initiate the accelerated cooling of the ware at that point.

There is preferably provided a means for adjusting the duct or passage forming means 24 longitudinally of the lehr, such means in the present instance comprising a pair of racks 29 suitably secured to or formed on the side portions of the duct 24 and meshing with a pair of similar pinions 30 which are mounted on a transverse shaft 31 extending through the lehr, as shown best in Fig. 6, and provided on one or both ends outside the lehr with suitable hand wheels 32.

I preferably provide a temperature responsive device to afford an indication of temperature according to which the manner of operation of the lehr and particularly the adjustment of the position of the duct or passage forming means 24 may be controlled, so as to control the point along the lehr at which the cooling of the glassware is accelerated. In the past, thermocouples or other temperature responsive devices have been placed in lehrs for various purposes, but always as far as I know in a particular location with respect to the lehr, so as to be responsive to the temperature at that point only. However, if the tempereture at but one point were ascertained, it might be determined that this point was either too high or too low, or the proper point for cooling to be accelerated, but nothing more. What is desired is to know not only that a particular point is or is not the proper point and in which direction the proper point for the acceleration of cooling lies, but also to know exactly where the proper point is.

For this purpose, I have provided a temperature responsive device or thermocouple shown at 33, Fig. 2, which is located close to the point of reversal of flow of the air passing through the duct or passage forming means 24 and is preferably adjustable therewith, so as always to be substantially at the point where cooling is to be accelerated. Thus, if it is found that the glassware is too hot, according to the thermocouple, it is not desired to accelerate the cooling as soon and the passage forming means or duct 24 may be moved to the right as shown in Figs. 2, 3 and 4; while if it is found that the ware at the variable index point is too cool, the reverse adjustment may be made, so that the end 27 of the passage forming means 24 may be located substantially at the desired point and the lehr operated at its maximum efficiency.

The thermocouple 33 has its wires passed through a substantially rigid member 34 which extends through a suitable slot or cored opening 35 formed in the bottom plate for the lehr over which the conveyor 3 passes, the member 34 being rigidly secured as at 36 to the duct or passage forming means 24 so that it is at all times moved therewith. The lead wires 37 to the thermoccuple may pass out through the flue opening 9 to a suitable point. It will be understood that the lead wires 37 to the thermocouple 33 will be connected to a suitable instrument (not shown) for the indication of the temperature to which the thermocouple is exposed.

It is contemplated, that if desired, automatic means of any known type could be employed for adjusting the position of the passage forming means or duct 24 in response to the temperature indicated by the temperature responsive device or thermocouple 33. I have not shown such means in the accompanying drawings as the application thereof will be obvious to those skilled in the art and also the adjustment may be effected manually in response to the indicated temperature.

Above the lehr and extending from the exit end thereof part way toward the entrance end, there is provided a cooling flue 38 substantially as in the Mulholland patent above referred to, this flue being open at 39 to the atmosphere at the exit end of the lehr. Communicating with the flue 38 are a plurality of tap-off passages 40 each controlled by a damper 41 and all communicating with a take-off conduit 42, which in turn communicates with the wind box 16 and that with the exhaust fan 17 as above set forth. Flow through the take-off conduit 42 as a whole is controlled by a damper 43 which is connected to be operated from some suitable easily accessible position by the provision of an arm 44 secured to the damper and a link 45, a part only of which is shown.

Intermediate the ends of the flue 38 and preferably between the first two tap-off openings 40 from the hotter end of the lehr is a partition 46 dividing the flue 38 into two portions similar to the partition 10, so that the portion of the flue 38 to the left, as seen in Figs. 2 and 3 of the portion 46, has but one tap-off passage 40 as shown in Fig. 3.

I preferably provide means, similar to the means previously described for the lower flue 5

for controlling the point of admission of cooling air to the flue **38** and hence the distance of travel of the cooling air toward the forward or hotter end of the lehr. These means comprise a duct or passage forming means **47**, similar to the duct or passage forming means **24**, and arranged within the flue **38** for movement longitudinally thereof. The duct **47** passes in a fairly air-tight fashion through the partition **46** and as shown is provided with a plurality of wheels or rollers **48** at each of the four corners thereof and which roll on rails **49**.

Means are provided for adjusting the position of a duct or passage forming means **47** longitudinally of the lehr, such means being similar to those disclosed for the corresponding purpose in the lower flue and including racks **50** secured to either side of the duct or passage forming means **47** and arranged to mesh with a pair of similar pinions **51** mounted upon a transverse shaft **52** and provided at one or both of its ends outside the lehr with suitable adjusting hand wheels **53**. As in the case of the lower flue, the transverse shaft **52** is located in a cooler portion of the lehr, so that any heat lost by conduction along the shaft penetrating the insulation shown about the lehr tunnel will not harmfully affect the glassware passing through this portion of the lehr.

The air entering the upper cooling flue **38** may travel in two main paths, first along the flue **38** to one or another of the tap-off passages **40** to the right of the partition **46** as shown in Figs. 3 and 4, and second, through a portion of the flue **38**, thence through the duct or passage forming means **47** to the end **54** thereof nearer the hotter end of the lehr where the air will be deflected toward the rear of the lehr by a deflector **55**, thence in the portion of the flue **38** intermediate the duct or passage forming means **47** and the flue walls to the passage **40** to the left, as seen in Fig. 3 of the partition **46**, where it will be drawn off past the damper **41** of this tap-off passage and through the duct **42** and wind box **16** to the fan **17**.

It will be seen that the further the duct or passage forming means is moved to the left, as seen in Figs. 1 to 4, the further will the cooling air be carried toward the entrance or hotter end of the lehr and the sooner will the accelerated cooling of the glassware be initiated in the same manner as previously described for the lower flue.

Associated with the upper cooling flue and with the member **47** as in the case of the lower cooling flue, I provide a temperature responsive device, here shown as a thermocouple **56**, which is located in a manner similar to the lower thermocouple **33** in a cored opening or slot **57** formed in the roof on the lehr tunnel **1**. The thermocouple **56** is shown as located adjacent to the end **54** of the duct or passage forming means **47** and is maintained in the same relation thereto by having the lead wires thereof passed through a substantially rigid member **58** extending through the groove or passage **57** and secured at **59**, Fig. 3, to a downward extension of the duct or passage forming means **47**, so as to move therewith upon the adjustment of the member **47** by the hand wheels **53**. The lead wires **60** to the couple **56** may be carried out through the open end **39** of the flue **38** as shown, and connected to a suitable indicating instrument (not shown) by which the temperature at the point where the thermocouple **56** is for the time being located may be indicated and/or recorded.

I contemplate in this case also that the adjustment of the duct or passage forming means **47** by the hand wheels **53** may be manual or automatic as desired in response to the temperature of the thermocouple **56** to the end that the cooling of the ware may proceed as fast as possible once the ware has passed through its "low annealing temperature."

It is noted that in both the upper and lower flues, there will be no break in the insulation **61** adjacent to the probable positions of the ends **27** and **54** of the ducts or passage forming means **24** and **47** respectively, so that there will be no localized cooling of the glassware in this zone as shown in Figs. 1, 2 and 3. Thus the glassware may be properly annealed under all circumstances and the annealing may be carried on at the maximum rate and efficiency.

Referring now to the form of the invention shown in Figs. 7 and 8, there is illustrated a lehr tunnel **62**, the cooler end portion only of which is shown. This lehr may be substantially the same as or similar to that disclosed in the Mulholland patent above referred to with the exception that an essentially different cooling means is provided as hereinafter to be described. The construction and mounting of the tunnel, the insulation **63** thereof, the heating flue system **64** including the dampered air inlet openings **65** and the gas removal passage **66** thereof may be substantially as in the aforesaid Mulholland patent, as may also be the means for conveying the ware therethrough, which means is not shown in the accompanying drawings.

The cooling means including the flue above the tunnel shown in the Mulholland patent has been omitted in the device shown in Figs. 7 and 8 and a different type of means provided for cooling the glassware, specifically for initiating the acceleration of the cooling of the ware at a desired point which is adjustable along the lehr. In this form of the invention the cooling air is circulated around, and in direct contact with, the ware in the tunnel and then exhausted from the tunnel in any suitable manner as through one or more exhaust passages as illustrated at **67** and **68**, these passages being controlled by suitable dampers as shown at **69** and **70** respectively. Air under suitable pressure is supplied through a pipe **71** to an elongate header **72** which, as shown, may be provided on both sides with a plurality of nozzles **73**, the header being suitably supported as by brackets **74** from the roof of the tunnel.

Means are provided for controlling the distance traveled by air passing into the header **72** from the pipe **71** toward the entrance end of the tunnel before it reverses its direction of flow and passes again toward the exit end of the tunnel to exhaust through one or the other of the exhaust passages as shown at **67** and **68**. For this purpose I provide a stopper member **75** slidably mounted within the header **72** and having a substantially air tight fit therewith. This member is mounted upon one end of a shaft **76** on which is threaded a collar **77**, which is swivelly mounted in a fixed bracket **78** and thereby prevented from endwise movement. The collar **77** is provided with a beveled gear **79** rigid therewith and meshing with a beveled gear **80** on a transverse shaft extending through the side wall of the tunnel and provided outside the tunnel with suitable adjusting means as a hand wheel (not shown). Thus by rotating the shaft carrying the beveled gear **80** by the adjusting means therefor outside the tunnel, the collar **77** will be rotated and the shaft **76** and

stopper member 75 adjusted longitudinally within the header 72. As will be seen from the drawings, the farthest point the air may pass within the header 72 toward the entrance or hotter end of the tunnel is that point occupied by the stopper member 75, so that the air must be supplied to the tunnel through the nozzles 73 which are to the right of the adjusted position of this stopper member as seen in Fig. 7. In this way I secure by the provision of a member adjustable longitudinally of the lehr an adjustment of the point of reversal of flow of air entering adjacent to the exit end of the tunnel and thereby control the point at which cooling of the glassware passing through the tunnel is first accelerated.

It will be obvious that a suitable temperature responsive device similar to that described above in connection with Figs. 1 to 6 may be provided to be adjustably moved by and in conjunction with the movement of the stopper member 75 for the purposes described above. I have not illustrated this arrangement as the application of it to the construction here described will be obvious to those skilled in the art in view of the description of the embodiment of my invention shown of Figs. 1 to 6.

In Figs. 9 and 10 are shown a further modified form of my invention. In this case also the cooling air comes into direct contact with the articles passing through the tunnel of the lehr. The form of lehr shown in Figs. 9 and 10 is essentially the same as that of Figs. 7 and 8 with the exception of a particular cooling means. This lehr comprises generally a tunnel 81 having a bottom heating flue system 82, which may be arranged to be supplied with hot gases in the same manner as disclosed in the Mulholland patent above referred to and is provided with dampered air inlet openings 83 and a takeoff passage 84 leading to some suitable exhaust point, which may include a suction fan as in the Mulholland patent above referred to. Here gain the various parts not specifically disclosed may be substantially the same as those disclosed by Mulholland, as stated above for the form of the invention shown in Figs. 7 and 8.

For accelerating the cooling of the ware according to the form of my invention of Figs. 9 and 10, I provide for the inflow of air into the exit end of the tunnel and the withdrawal of air from the tunnel first at a plurality of fixed points adjacent to the exit end for the rapid cooling in this zone of the tunnel and also for the withdrawal of the air entering at the exit end from a point adjustable longitudinally of the lehr in a hotter zone thereof, so that the point at which cooling of the glassware is initially accelerated may be adjustably controlled. As shown, I have provided a fixed conduit 84, which is preferably secured in some suitable manner to the roof of the tunnel, as by the provision thereon of flanges 85 (Fig. 10) and which is provided at various points along its length with transversely extending slots or apertures otherwise formed and arranged as shown at 86. These openings will be effective for the withdrawal of air entering at the exit end of the tunnel at 87 as indicated by the arrows in Fig. 9. The provision of a series of apertures 86 in any desired form and arrangement and at desired intervals will control the cooling of the ware according to a fair approximation adequate for all loadings of the conveyor for the rapid cooling of the ware at the cooler zone adjacent to the exit end of the tunnel.

I provide, however, for the adjustment of the point at which cooling is initially accelerated on the ware. For this purpose I have shown a longitudinally adjustable conduit member 88 which may be mounted for substantially telescopic movement within the conduit member 84 as by the provision of flanges 89 thereon as shown in Fig. 10, it being understood that the end of the fixed conduit member 84 at 90 will be so constructed as to leave little if any space for the inlet of air from the tunnel into the conduit at this point. The adjustable conduit member 88 is provided on its lower portion with a longitudinally extending rack member 91 which is adapted to mesh with the pinion 92 secured to a transverse shaft 93, the ends of which extend through the side walls of the lehr and are provided outside the tunnel at easily accessible points with one or two suitable hand wheels as illustrated at 94 for effecting longitudinal adjustment of the conduit member 88.

The position of the left hand end of the adjustable conduit member 88 as seen in Fig. 9 will thus determine the distance toward the front or hotter end of the lehr to which air entering at the exit end of the tunnel at 87 will pass before reversing its direction of flow as shown by the arrow 95 to flow through the conduits 88 and 84 to an outlet pipe 96, which will be connected with some suitable exhaust means, such as the exhaust fan shown in the Mulholland patent above referred to for cooperation with the lower cooling flue and to which the withdrawal passage 84 is connected in a manner not shown in the accompanying drawings, but similar to that illustrated in Fig. 4 for example at 17.

Thus I have provided according to this form of my invention for the adjustment of the point at which acceleration of the cooling of the glassware is initiated by the adjustment of a member longitudinally of the tunnel, the member in this case being the conduit member 88 and also provided specifically for the adjustment of the point of reversal of flow of air entering the device adjacent to the exit end of the tunnel.

Here again, as in the case of Figs. 7 and 8, the adjustment of the point of reversal of flow may be arranged to be effected in response to a particular temperature, preferably at or adjacent to such point of reversal of flow, as this point is adjusted longitudinally of the lehr, as by the provision of a suitable thermocouple such as is illustrated in Fig. 2 of the accompanying drawings. The application of such a thermocouple to the form of the invention shown in Figs. 9 and 10 is believed to be obvious, so that it has not been illustrated in detail.

While I have shown and described several embodiments of my invention, it will be understood that many changes may be made therein, including those suggested hereinabove, and certain portions of the invention have independent utility. I do not wish to be limited therefore except by the scope of the appended claims, which are to be construed as broadly as the state of the prior art permits.

What is claimed is:

1. The method of annealing and cooling glassware which comprises passing the ware through a tunnel type glass annealing lehr, establishing a flow of air in the lehr in a two-legged path from the exit end of the lehr toward the entrance end thereof and thence back toward the exit end of the lehr, at least one leg of said path being in good heat transferring relation with the ware passing through the lehr, and adjustably con-

trolling the position of the point of reversal of flow of air as aforesaid longitudinally of the lehr in response to the temperature in the tunnel adjacent to the point longitudinally of the lehr where the temperature gradient in the tunnel crosses a predetermined desired temperature, the longitudinal position of which point varies with varying rates of loading of the lehr.

2. Apparatus for annealing glassware, comprising an elongate tunnel lehr, means for moving glassware therethrough, means associated with the lehr tunnel for cooling the ware passing therethrough including means for conducting air from the exit end of the tunnel toward the entrance end thereof and thence back toward the exit end of the tunnel, the air thus traveling being for at least a part of its path in good heat transferring relation with the glassware, means for causing a flow of air through the path aforesaid, and means adjustable longitudinally of the lehr for adjustably predetermining the distance traveled by the air toward the entrance end of the tunnel before it reverses its direction of flow and thereby for adjustably predetermining the point along the tunnel at which cooling of the glassware is accelerated.

3. Apparatus for annealing glassware, comprising an elongate tunnel lehr, means for moving glassware therethrough, means associated with the lehr tunnel for cooling the ware passing therethrough including means for conducting air from the exit end of the tunnel toward the entrance end thereof and including a longitudinally adjustable passage forming means, means for conducting the air thence back toward the exit end of the tunnel, the air thus traveling being for at least a part of its path of travel in good heat transferring relation with the glassware passing through the tunnel, means for causing a flow of air through the path aforesaid, and means for adjusting the position of said passage forming means longitudinally of the lehr for adjustably predetermining the distance traveled by the air toward the entrance end of the tunnel before it reverses its direction of flow and thereby for adjustably predetermining the point along the tunnel at which the cooling of the glassware is accelerated.

4. Apparatus for annealing glassware, comprising an elongate lehr tunnel, means for moving glassware therethrough, a longitudinally extending muffle flue in good heat transferring relation to the glassware passing through the tunnel, a passage forming means disposed inside said muffle flue and arranged for adjustment longitudinally thereof for conducting air from the atmosphere at the exit end of the lehr toward the entrance end thereof and for discharging it to the inside of said flue at the end of the passage forming means nearer the entrance end of the tunnel, means for causing a flow of air from the atmosphere through said passage forming means and thence back between such means and the flue toward the exit end of the tunnel, and means for adjusting the position of the passage forming means longitudinally of the lehr and for thereby predetermining the distance which the cooling air flows toward the entrance end of the tunnel prior to its flow in the reverse direction and thereby predetermining the point along the tunnel at which cooling of the glassware is accelerated.

5. Apparatus for annealing glassware, comprising an elongate tunnel lehr, means for moving glassware therethrough, means associated with the lehr tunnel for cooling the ware passing therethrough including means for conducting air from the atmosphere at the exit end of the tunnel toward the entrance end thereof and thence back toward the exit end of the tunnel, the air thus traveling being for at least a part of its path of travel in good heat transferring relation with the glassware, means for causing a flow of air through the passage aforesaid, means adjustable longitudinally of the lehr for adjustably predetermining the distance traveled by the air toward the entrance end of the tunnel before it reverses its direction of flow and thereby for adjustably predetermining the point along the tunnel at which cooling of the glassware is accelerated, and a temperature responsive device adjustably moved with said longitudinally adjustable means and located substantially at the adjusted point of reversal of flow of the air to respond to the temperature in the tunnel at such adjusted point and thereby to serve to indicate the temperature at such point in the tunnel according to which said longitudinally adjustable means may be adjusted.

6. Apparatus for annealing glassware, comprising an elongate tunnel lehr, means for moving glassware therethrough, a longitudinally extending heating flue associated with the tunnel of the lehr and in good heat transferring relation with the glassware passing therethrough, means for supplying hot gases to said flue adjacent to the ware-entering end of the lehr, a passage forming means communicating with the atmosphere adjacent to the exit end of the lehr and adjustable in and longitudinally of said flue for conducting air from the atmosphere an adjustable distance toward the entrance end of the lehr and then for discharging it to the inside of said flue to mix with and dilute the hot gases therein, means for withdrawing hot gases and the air drawn in from the atmosphere as aforesaid from said flue adjacent to the cooler end of the tunnel, the hot gases and air passing to the point of withdrawal between the flue walls and said passage forming means, and means for adjusting the position of said passage forming means longitudinally of said flue to predetermine the point of reversal of flow of the cooling air and thereby to control the point of temperature drop in the flue caused thereby for controlling the position of the point along the lehr at which the cooling of the glassware is accelerated.

7. Apparatus for annealing glassware, comprising an elongate tunnel lehr, means for moving glassware therethrough, a longitudinally extending muffle flue associated with the tunnel and in good heat transferring relation therewith, insulation surrounding the lehr tunnel and a portion of said flue toward the hotter end of the lehr, another portion of said flue adjacent to the cooler end of the lehr being uninsulated, a passage forming means arranged in said flue for adjustment longitudinally thereof and arranged to conduct air from the atmosphere at the cooler end of the tunnel toward the hotter end thereof and then to discharge it to the interior of said flue at the end of such passage forming means toward the hotter end of the lehr, means for causing a flow of air from the atmosphere through said passage forming means to the end thereof toward the hotter end of the lehr and thence rearwardly toward the exit end of the lehr between said passage forming means and the walls of said flue, and means accessible from outside the lehr and located along a cooler por-

tion of said flue for adjusting the passage forming means longitudinally thereof, whereby the acceleration of the cooling of the glassware passing through the tunnel will be made responsive to the adjustment of said passage forming means and localized losses of heat from the hotter insulated portion of said flue occasioned by passages for gas extending through the insulation will be eliminated.

8. Apparatus for annealing glassware, comprising an elongate tunnel lehr, means for moving glassware therethrough, a longitudinally extending heating flue associated with the tunnel of said lehr and in good heat transferring relation therewith, means for supplying products of combustion to said flue adjacent to the entrance end of the lehr, a passage forming means arranged for movement in and longitudinally of said flue for conducting atmospheric air from adjacent to the exit end of the lehr toward the entrance end thereof and for there discharging such air into the interior of said flue where it may mix with the products of combustion supplied thereto as aforesaid to cool and dilute the same, means for withdrawing gaseous medium from said flue adjacent to the cooler end of the lehr, means for supporting said passage forming means for adjustive movement in and longitudinally of said flue, a rack and pinion mechanism for adjustably moving said passage forming means longitudinally of said flue to control the distance toward the forward or entrance end of the lehr to which the cooling air is conducted prior to mixing with the products of combustion in the flue to lower the temperature thereof, said rack and pinion means being located adjacent to the cooler end of the tunnel and accessible from the outside, whereby to control the position of the point along the tunnel at which cooling of the glassware is accelerated.

9. Apparatus according to claim 6 further characterized in the provision of a temperature responsive device located adjacent to the end of said passage forming means toward the hotter end of the tunnel and arranged to be adjustably moved with said passage forming means so that the temperature to which it is exposed will be characteristic of the temperature of the ware at that point in its path through the lehr at which the cooling is to be accelerated.

10. Apparatus for annealing glassware, comprising an elongate tunnel lehr, means for moving glassware therethrough, a longitudinally extending cooling flue associated with the tunnel of said lehr and extending from the exit end of said tunnel toward the entrance end thereof and open at said exit end to the atmosphere, a partition extending across said flue at a point spaced from the exit end of the tunnel, a passage forming means extending through said partition for conducting air from the portion of said flue toward the exit end of the tunnel to an outlet point at the opposite end of the passage forming means on the opposite side of said partition, means for adjusting said passage forming means longitudinally of said flue, means for causing a flow of air from the atmosphere into the end of said flue adjacent to the exit end of the tunnel thence through said passage forming means toward the end thereof nearer the hotter end of the tunnel and thence rearwardly through the portion of said flue intermediate said partition and the discharge end of said passage forming means, and a single take-off passage communicating with a hotter portion of said flue adjacent to said partition, whereby the adjustment of said passage forming means controls the point along the tunnel at which cooling of the glassware is accelerated.

11. Apparatus for annealing glassware, comprising an elongate tunnel lehr, means for moving glassware therethrough, a longitudinally extending cooling flue associated with the tunnel of said lehr and extending from the exit end of said tunnel toward the entrance end thereof, a passage forming means mounted in and adjustable longitudinally of said flue for conducting air drawn in from the outer atmosphere at the end of said flue near the exit end of the tunnel toward the end thereof nearer the hotter end of the lehr, means for causing a flow of atmospheric air into said flue at the exit end of the tunnel, through said passage forming means and thence backward toward the exit end of the tunnel intermediate said passage forming means and the walls of said flue, means for adjusting the position of said passage forming means longitudinally of said flue, and a temperature responsive device arranged to be adjustably positioned simultaneously with the adjustment of said passage forming means so as always to be located adjacent to the end of such means nearer the hotter end of the tunnel and to be responsive to the temperature in the tunnel, whereby the temperature to which said temperature responsive device is exposed may be used as an indication for adjusting said passage forming means longitudinally of the lehr to adjust the point at which the glassware is subjected to accelerated cooling longitudinally of the tunnel in accordance with the temperature thereof at such point.

12. Apparatus for annealing glassware, comprising an elongate tunnel lehr, means for moving glassware therethrough, a longitudinal heating flue associated with one wall of said tunnel and in good heat transferring relation therewith throughout its length, means to supply products of combustion to said flue adjacent to the ware-entering end of said lehr, a longitudinally extending cooling flue associated with another wall of said tunnel and open to the atmosphere at the exit end of said tunnel, said cooling flue extending part way toward the entrance end of the tunnel, a passage forming means disposed within each of said flues and arranged for independent adjustive movement longitudinally thereof, both said passage forming means communicating with the atmosphere adjacent to the exit end of said tunnel for conducting such air toward the entering end of the tunnel and discharging it into their associated flues at the forward ends of such passage forming means respectively, means for causing a flow of atmospheric air through both said passage forming means toward the entrance end of said tunnel and thence in the reverse direction through said flues intermediate said passage forming means and the flue walls respectively and for causing flow of the products of combustion through the heating flue, and means for independently adjusting said passage forming means longitudinally of their respective flues, whereby to control the position in the tunnel where the glassware passing therethrough is subjected to accelerating cooling.

13. Apparatus according to claim 12 further characterized in the provision of a temperature responsive device associated and arranged for adjustive movement with each of said passage forming means and located respectively adjacent to the ends of the associated passage forming means nearer the entrance end of the tunnel

for the indication of the temperatures at such adjusted points according to which the positions of the associated passage forming means may be adjusted.

14. Apparatus for annealing glassware, comprising an elongate tunnel, means for cooling the glassware passing through the tunnel, including a conduit extended longitudinally thereof in the cooler portion of the tunnel, means for supplying a gaseous cooling medium to said conduit adjacent to the exit end of the lehr, a plurality of nozzle openings from said conduit to the interior of said tunnel disposed along the length of said conduit, and means adjustable longitudinally of said conduit for adjustably limiting the distance the gaseous cooling medium can flow along said conduit toward the hotter end of the lehr before being discharged therefrom for predetermining the point of initiation of accelerated cooling of the ware in its passage through the tunnel.

15. Apparatus for annealing glassware, comprising a tunnel lehr, means for cooling the glass passing through the cooler portion of the tunnel of the lehr including a conduit for withdrawing gases from the tunnel and extending longitudinally thereof, said conduit being longitudinally adjustable and having an opening at its end nearer the hotter end of the lehr, means for withdrawing gases from said conduit and thereby for withdrawing gases from said tunnel therethrough, and means for longitudinally adjusting said conduit for thereby predetermining the distance to which air may flow along said tunnel from the exit end thereof in cooling the ware prior to its being withdrawn therefrom through said conduit and for thereby adjustably predetermining the point of initiation of the accelerated cooling of the ware.

DONALD G. MERRILL.