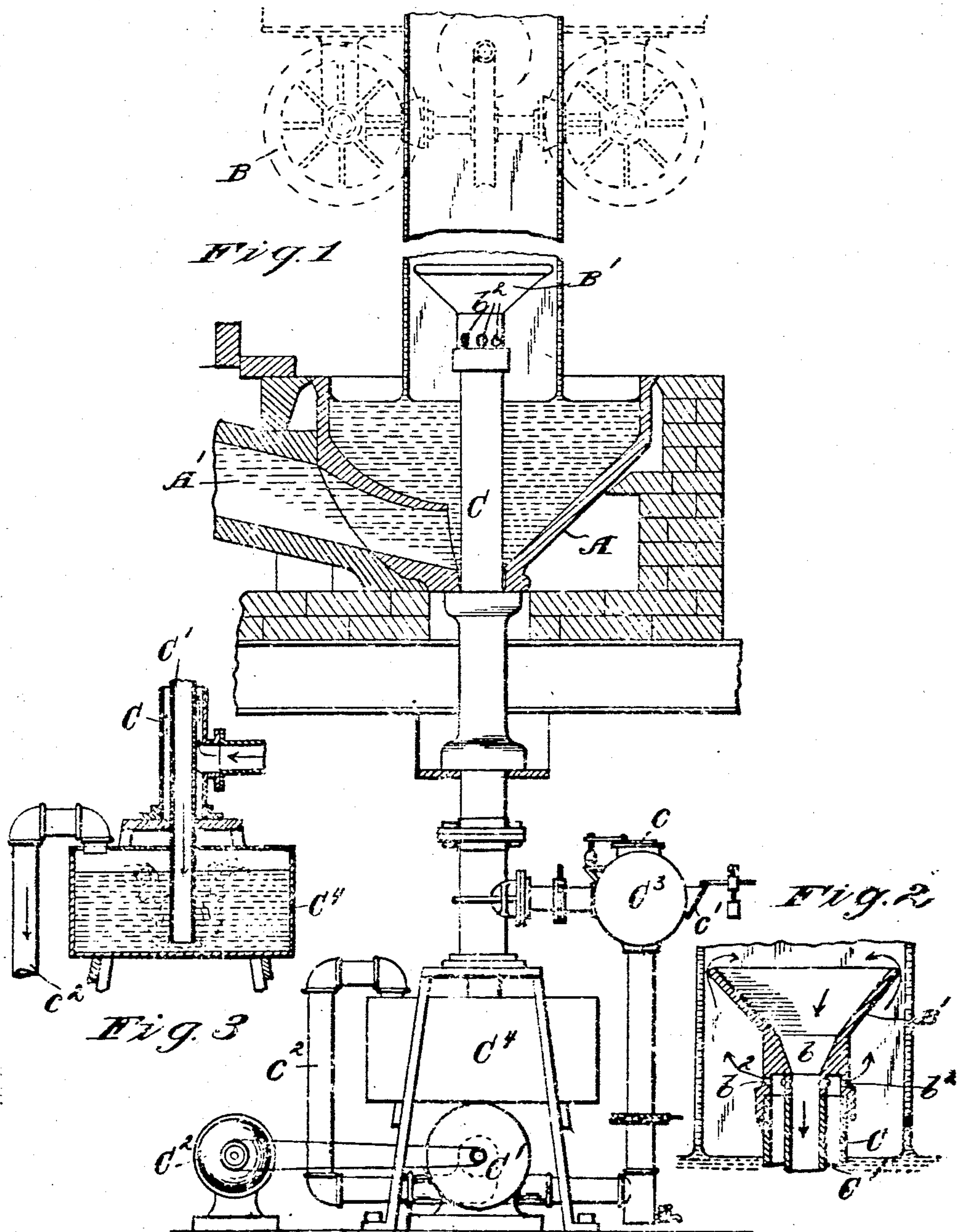


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METHOD OF AND APPARATUS FOR DRAWING GLASS.
APPLICATION FILED NOV. 9, 1908.

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METHOD OF AND APPARATUS FOR DRAWING GLASS.

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To all whom it may concern:

Be it known that I, ROBERT L. FRINK, a citizen of the United States, and a resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented a new and useful Improvement in Methods of and Apparatus for Drawing Glass, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

In the drawing of glass cylinders as practiced in the art of manufacturing window glass, it has heretofore been too little appreciated what are the relative effects of conduction, radiation and convection in determining the thickness and uniform character of the cylinder walls which ultimately, in their flattened form, provide the window glass of commerce. While the cooling of the metal both in the drawing pot and in the cylinder prior to setting may take on various important aspects, it is only with one of these that the present invention is concerned, namely, the cooling of the interior of the cylinder, while the walls of the latter are still in the plastic stage in which they persist for some distance above the level of the bath from which the cylinder rises. It is not appreciated (in fact it may be questioned whether it is understood at all), that much of the trouble encountered in the later course of manufacture of window glass may be traced back directly to this portion of the operation. The large percentage of breakage, in other words, that has heretofore attended the severing of the cylinders into lengths, the splitting of them prior to their introduction into the flattening oven, and the final cutting, has been accepted as one of the mysteries of the art rather than an object of scientific investigation and understanding. I am convinced, however, that practically all of such breakage, aside from that due to stratification, has its rise in unequal strains produced in the walls of the cylinder by the unequal cooling of the inner and outer faces thereof. I do not refer to inequality in the rate of cooling between the two faces, since owing to the inner face being inclosed by the walls it will naturally cool more slowly than the outer face, but rather to those strains which arise when either the outer or the inner face, as the case may be, is subjected to variable cooling

effects, at different points longitudinally of the cylinder.

The present invention has regard more particularly to controlling conditions of cooling within the cylinder by a proper regulation of the character of the fluid, whereby the cylinder walls are maintained in proper distended form. To the accomplishment of this object, said invention then consists of the steps and embodies the means hereinafter fully described and particularly pointed out in the claims.

The annexed drawing and the following description set forth in detail certain means and one mode of carrying out the invention, such disclosed means and mode illustrating, however, but one of various ways in which the principle of the invention may be used.

In said annexed drawing: Figure 1 is a vertical section, with parts shown in side elevation, of one approved arrangement of apparatus for carrying out my improved method of drawing glass; Fig. 2 is a similar sectional view, but on a larger scale, of the drawing head utilized in connection with such apparatus; and Fig. 3 is a similar vertical section of a tank forming another detail of the same apparatus.

Of that part of the plant designed for supplying the molten glass or metal, only that portion directly utilized in connection with the present apparatus is shown, viz., the drawing pot or receptacle A. The metal is supplied to said pot from the furnace (not shown) through a passage or conduit A' as will be readily understood. The particular form of pot, so far as the purpose of the present invention is concerned, is a matter of indifference, the illustrative construction shown being described and claimed in a co-pending application filed June 22, 1908, Serial No. 439,767. Similarly the drawing mechanism proper forms no part of the present invention, being fully described in Letters Patent No. 846,102, issued to me March 5, 1907. Such mechanism, briefly described, will be seen to comprise a set of rolls B between which the cylinder is pressed and drawn upwardly once it has been started, and an air regulating head B' that extends upwardly through an opening in the bottom of the pot to a short distance above the contemplated level of molten glass therein, namely, just below where the glass sets. The general operation of the drawing mechanism involves the supply of air

through said head, there to be discharged into the lower confined portion of the cylinder being drawn, from whence it escapes around such head, by distending the plastic cylinder walls a greater or less degree.

The support for the head B' around which the cylinder, or hollow article, is drawn, comprises two concentric pipes C C' Figs. 2 and 3, constructed of suitable material to resist the temperature to which they are exposed when surrounded by the metal in the pot B. The head, which is supported on the upper ends of the aforesaid pipes, is likewise constructed of suitable heat-resisting material, such as fire-clay or the like. The particular head here illustrated is conical, or funnel-like, in form; and has a central aperture b therein, connected, as shown, with the inner C' of the two pipes of the support. In the base of the head, there is formed an annular chamber b' surrounding such central aperture, and provided with lateral ports b², which chamber has communication with the outermost C of the two pipes. Air under pressure is designed to be supplied at the head through such outer pipe and chamber, while on the contrary suction means are designed to be connected with inner pipe, whereby a circulation of air may be maintained through the lower section of the cylinder or roller as indicated by the arrows in Fig. 2.

For supplying air to the outer pipe and withdrawing it from the inner pipe, a blower or fan c' is provided below the lower ends of such pipes, such fan being driven by a suitable motor C², whereby any desired rate of circulation may be produced. Of the apparatus interposed between this blower and the outer pipe C no detailed description will here be necessary, other than to state its object to be the regulation of the volume of air admitted to the confined portion of the cylinder by the use of suitable weighted escape valves c c' connected with a drum C³ interposed in the discharge line connecting said blower with such outer pipe. Interposed in the other line c², however, viz., the one connecting the inner pipe with the blower, is a tank C⁴ designed to contain a suitable liquid, preferably water, and of a capacity to be determined by the requirements hereinafter indicated. The connection of the inner pipe C' with such tank, and of the suction pipe c² leading therefrom to the blower, is clearly indicated in Fig. 3, from which it will be seen that the air supplied to the drawing head through the blower, is all drawn through the body of liquid contained in such tank. It is to this latter feature that particular attention is herein directed, namely, that of humidifying the air which is supplied to the drawing head, and is there utilized to maintain the plastic cylinder walls properly distended. This air,

drawn as it is in the first instance from the portion of the cylinder adjacent to such confined plastic portion, and where the operation is under way, having passed through the plastic, still more highly heated portion, will be heated to an extent such as to appreciably affect the temperature of the liquid in the tank. Indeed it is contemplated that the latter may be brought near to the boiling point. Whether such liquid be left thus to attain its own equilibrium of temperature, or such temperature be artificially controlled, it will be obvious that the air after passing therethrough, will be of a substantially uniform temperature, and what is of more importance, possess a uniform degree of saturation, approximately maximum saturation for the temperature in question. Such saturated air, as should be obvious, possesses a greater capacity for abstracting heat from the roller than would dry air of the same temperature, this being due to the greater specific heat of water. One result hence, of my improved method of drawing glass, will be to secure an increased cooling effect within the cylinder, so that the stratum in the cylinder wall cooled from the exterior and interior, respectively, will be more nearly equal. At the same time another result of equally, if not greater importance, is attained, namely, uniformity in such cooling, since the content of water vapor carried by the air may be controlled. Obviously, the more convenient mode of control is simply to secure saturation, since this is a constant under fixed conditions of temperature and pressure.

By my improved method and apparatus I am enabled, accordingly, to produce a cylinder in which not only does the internally cooled stratum remain uniform throughout the cylinder's length, but also such stratum more nearly approaches in thickness that of the exteriorly cooled stratum, an equality in such thicknesses being the ideal condition sought.

I am aware that artificial cooling of both the interior and exterior surfaces of the cylinder has been attempted by circulating a liquid, as water, through coils disposed adjacent to the rising cylinder walls. The impossibility, in practice, of obtaining uniform results by this method should be readily evident and sharply distinguishes the same from my methods of control, which involves the control of the saturation of the air and thus the absorption of heat.

It will of course be understood, that in place of the particular drawing mechanism shown, comprising the drawing rollers B and drawing head B', any of the various forms of such mechanism that have from time to time been devised may be substituted. In other words the improvements herein described are equally applicable to

the drawing of glass whether such drawing be continuous or discontinuous. Moreover, so far as certain aspects of the method are concerned, it is immaterial whether the article being drawn be in the form of a sheet or cylinder.

In conclusion, it may be remarked that by passing the air through the liquid in tank C a further incidental but quite important result is secured, in addition to what has been previously noted. I refer to the working effect on the air, whereby all dust, and like impurities, are eliminated and the difficulty of specking or otherwise damaging the surface of the glass in its plastic, impressionable, state, by such foreign matter overcome.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the means and the steps herein disclosed, provided those stated by any one of the following claims or their equivalents be employed.

I therefore particularly point out and distinctly claim as my invention:

1. The method of producing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass, and maintaining therein a body of fluid having a predetermined specific heat, substantially as described.

2. The method of producing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass, and maintaining therein a gaseous body having a predetermined specific heat, substantially as described.

3. The method of producing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass, and maintaining therein a body of air at a predetermined degree of humidity, substantially as described.

4. The method of producing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass, and maintaining therein a body of fluid having an approximately constant specific heat, substantially as described.

5. The method of producing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass, and maintaining therein a gaseous body having an approximately constant specific heat, substantially as described.

6. The method of producing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass, and maintaining therein a body of air having an approximately constant degree of humidity, substantially as described.

7. The method of producing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass, and maintaining therein a body of air approxi-

mately saturated with watery vapor, substantially as described.

8. The method of drawing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass; and introducing a fluid within said cylinder and confining the same below the point where the glass sets, the action of such fluid upon the cylinder being utilized to control its escape, and the fluid thus introduced having a predetermined specific heat, substantially as described.

9. The method of drawing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass; introducing air within said cylinder and confining the same below the point where the glass sets, the action of such air upon the cylinder being utilized to control its escape; and controlling the degree of humidity of the air thus introduced, substantially as described.

10. The method of drawing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass; introducing air within said cylinder and confining the same below the point where the glass sets, the action of such air upon the cylinder being utilized to control its escape; and maintaining the degree of humidity of the air thus introduced approximately constant, substantially as described.

11. The method of drawing hollow glass articles, which consists in drawing a cylinder from a bath of molten glass; introducing air within said cylinder and confining the same below the point where the glass sets, the action of such air upon the cylinder being utilized to control its escape; and maintaining the air thus introduced at approximately the point of saturation with watery vapor, substantially as described.

12. The method of cooling a glass article being drawn from a bath of molten glass, which consists in bringing into contact with such article, a fluid having a predetermined specific heat, substantially as described.

13. The method of cooling a glass article being drawn from a bath of molten glass, which consists in bringing into contact with such article, a fluid having an approximately constant specific heat, substantially as described.

14. The method of cooling a glass article being drawn from a bath of molten glass, which consists in bringing into contact with such article air having an increased content of watery vapor, substantially as described.

15. The method of cooling a glass article being drawn from a bath of molten glass, which consists in bringing into contact with such article air approximately saturated with watery vapor, substantially as described.

16. In apparatus for drawing glass, a drawing pot or receptacle, mechanism co-

operative with said receptacle to draw a cylinder from molten glass therein, means for supplying a fluid to the interior of such cylinder, and means for controlling the specific heat of the fluid thus supplied.

17. In apparatus for drawing glass, a drawing pot or receptacle, mechanism co-operative with said receptacle to draw a cylinder from molten glass therein, means for supplying air to the interior of such cylinder, and means for controlling the degree of humidity of the air thus supplied.

18. In apparatus for drawing glass, a drawing pot or receptacle, mechanism co-operative with said receptacle to draw a cylinder from molten glass therein, means for supplying air to the interior of such cylinder, such means including a duct connected with such cylinder, and means interposed in said duct for humidifying the air passing therethrough.

19. In apparatus for drawing glass, a drawing pot or receptacle, mechanism co-operative with said receptacle to draw a cylinder from molten glass therein, means for supplying air to the interior of such cylinder, such means including a duct connected with such cylinder, and a tank interposed in said duct, said tank containing water through which such air is passed, whereby such air is approximately saturated with watery vapor.

20. In apparatus for drawing glass, a drawing pot or receptacle, mechanism co-operative with said receptacle to draw a cylinder from molten glass therein, a head around which such cylinder is drawn, an air-supply pipe connected with said head and a tank connected with said pipe, said tank containing water through which such air is passed, whereby such air is approximately saturated with watery vapor.

21. In apparatus for drawing glass, a drawing pot or receptacle, mechanism co-operative with said receptacle to draw a cylinder from molten glass therein, a head around which such cylinder is drawn, two pipes one within the other, for supporting said head and opening, the one into the portion of said cylinder between said head and the bath, and the other into the portion of said cylinder above said head, and means adapted to withdraw air from said cylinder through such last-named pipe and return the same through the first named.

22. In apparatus for drawing glass, a

drawing pot or receptacle, mechanism co-operative with said receptacle to draw a cylinder from molten glass therein, a head around which such cylinder is drawn, two pipes one within the other, for supporting said head and opening, the one into the portion of said cylinder between said head and the bath, and the other into the portion of said cylinder above said head, means adapted to withdraw air from said cylinder through such last-named pipe and return the same through the first-named, and means interposed in one of said pipes for humidifying the air passing therethrough.

23. In apparatus for drawing glass, a drawing pot or receptacle, mechanism co-operative with said receptacle to draw a cylinder from molten glass therein, a head around which such cylinder is drawn, two pipes one within the other, for supporting said head and opening, the one into the portion of said cylinder between said head and the bath, and the other into the portion of said cylinder above said head, means adapted to withdraw air from said cylinder through such last-named pipe and return the same through the first-named, and a tank interposed in said last-named pipe, said tank containing water, through which such air is passed, whereby such air is approximately saturated with watery vapor.

24. In apparatus for drawing glass, a drawing pot or receptacle, mechanism co-operative with said receptacle to draw a cylinder from molten glass therein, a head around which such cylinder is drawn, two pipes, one within the other for supporting said head and opening, the one into the portion of said cylinder between said head and the bath, and the other into the portion of said cylinder above said head; a blower adapted to withdraw air from such last-named pipe and to return the same through the first named, a tank interposed in said last-named pipe, said tank containing water through which such air is passed, whereby such air is approximately saturated with watery vapor, and means interposed in said first named pipe for regulating the volume of air supplied therethrough to said cylinder.

Signed by me this 23rd day of October 1908.

ROBERT L. FRINK.

Attested by—

MARY GLADWELL,
JNO. F. OBERLIN.