R. L. FRINK.

METHOD OF AND APPARATUS FOR DRAWING GLASS.

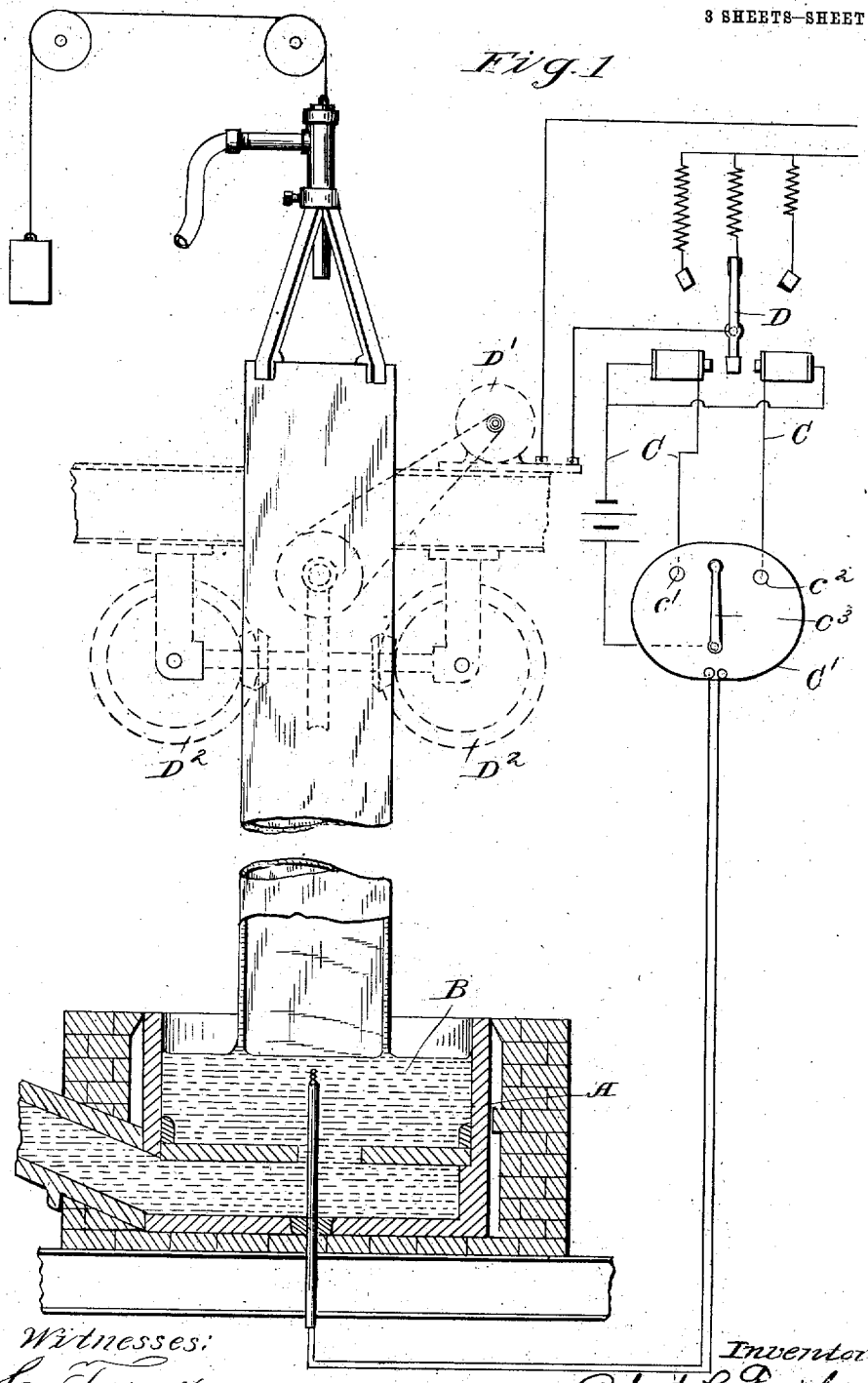
APPLICATION FILED NOV. 9, 1908.

972,613.

Patented Oct. 11, 1910.

3 SHEETS—SHEET 1.

Fig. 1



Witnesses:
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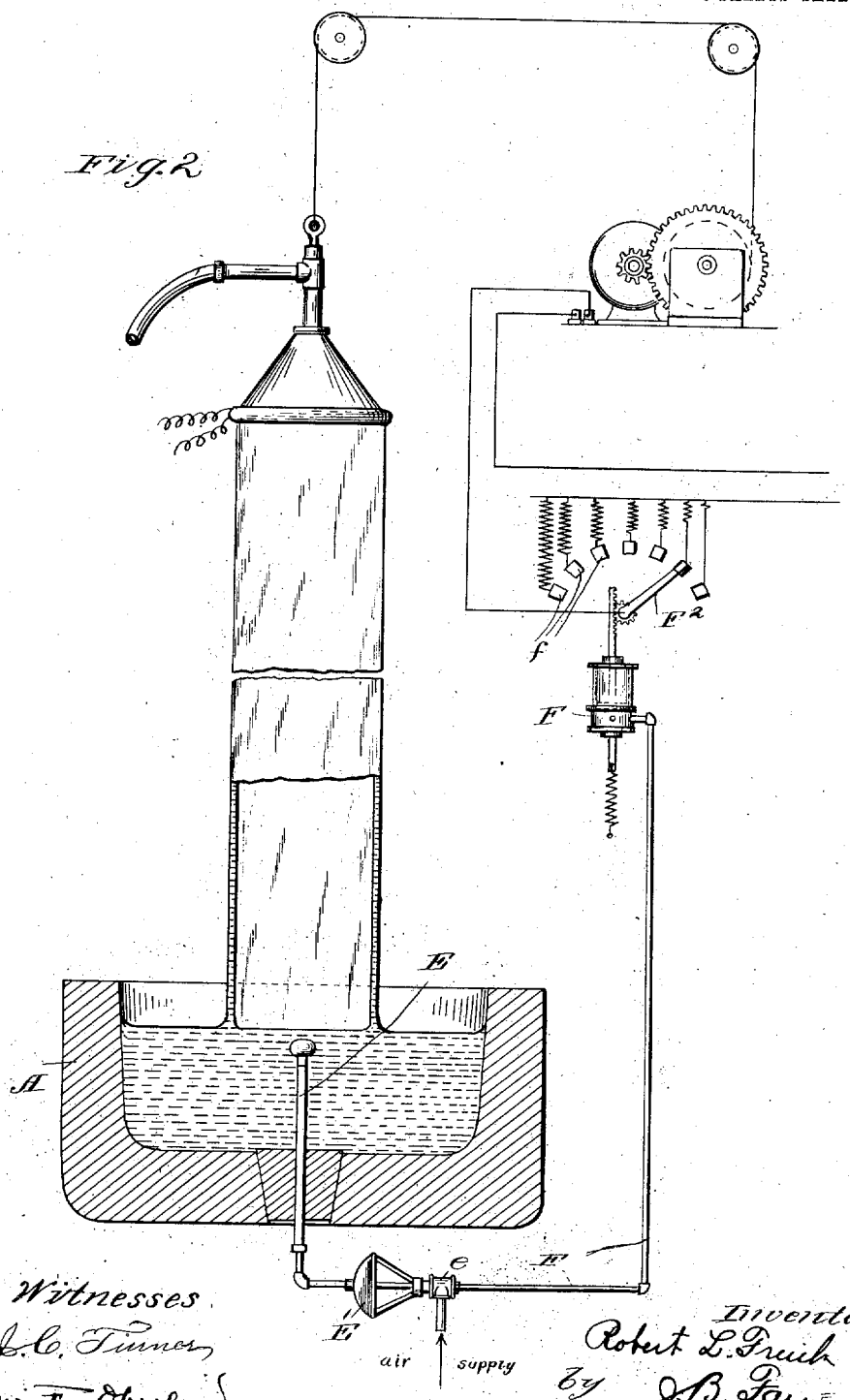
3 SHEETS—SHEET 2.

Fig. 2



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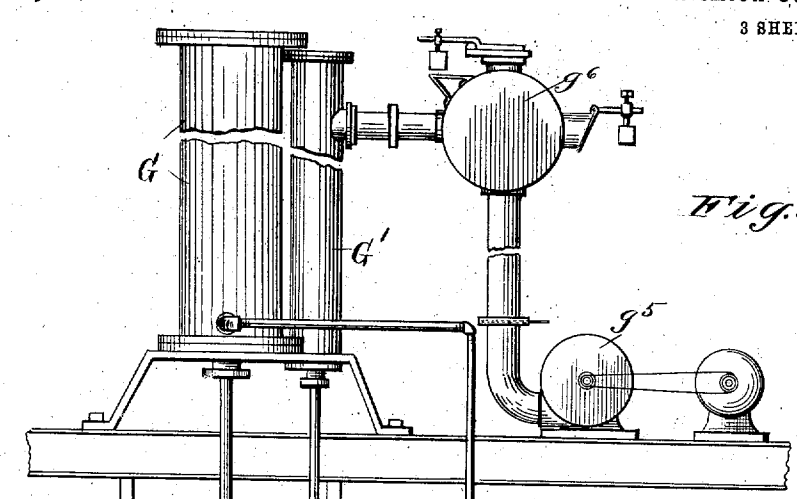


Fig. 3

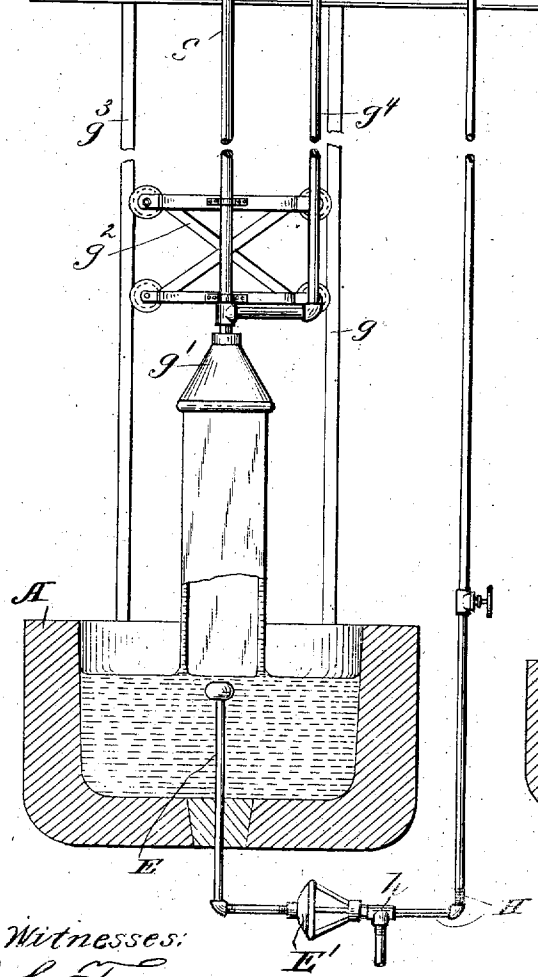
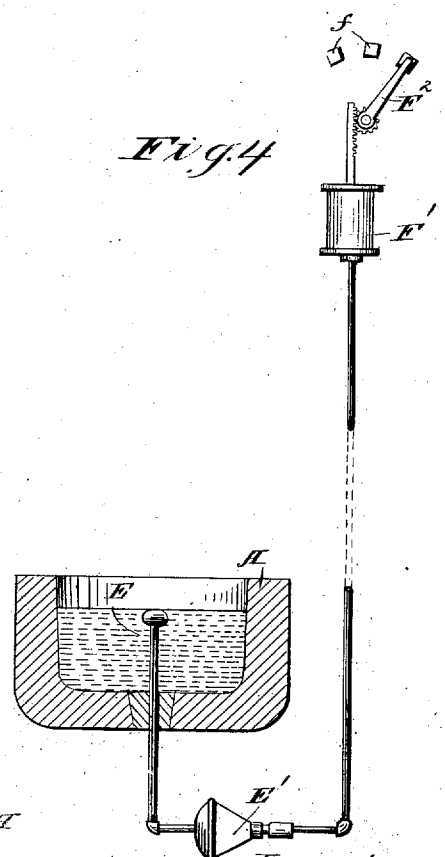


Fig. 4



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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR DRAWING GLASS.

972,613. Specification of Letters Patent. Patented Oct. 11, 1910.

Application filed November 9, 1908. Serial No. 461,838.

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 articles, such as cylinders in the manufacture of window glass, I have found it to be very important, if disaster to the product is to be avoided in the subsequent stages of manufacture, that improper strains, particularly strains longitudinally of the cylinder be carefully avoided. It will of course be understood that in cooling, both from the inside and the outside, as must necessarily be the case, there will be produced what I may call a normal strain between the interiorly and exteriorly cooled strata, and the intermediate stratum which cools by conduction through such outer strata. The strains thus induced, however, will not result seriously if they be uniform throughout the length of the cylinder, or at least do not sharply vary from one point to another. If such variation does occur, as will be the case if the exteriorly cooled stratum, for any reason suddenly becomes thicker or thinner than normal, or if the interiorly cooled stratum similarly varies, there will be produced a strain longitudinally of the cylinder, that will tend to disrupt it transversely upon the slightest provocation. Indeed I am led to believe that a large percentage of the breakage 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, may be traced to strains of this character introduced into the cylinder or roller as it is drawn.

The present invention, is concerned with certain aspects only of the problem of drawing cylinders without strains of the harmful character just described.

As has been pointed out in my Patent No. 941,312, granted November 30th, 1909, artificial variation of the temperature of the metal in the pot would seem to be one of the prime causes of the undesirable results in question, and for this reason in the present instance as in such copending application referred to, I would dispense with any such attempted regulation, since in practice the harmful results accruing therefrom, far outweigh any alleged theoretical advantages. In other words, 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. I propose accordingly to permit the bath of metal from which the roller is being drawn, whether such bath be a segregated body of molten glass, or one that is constantly replenished, to cool naturally from its high initial temperature, merely avoiding, so far as is possible, the effects of unequal radiation and convection. Obviously it will be desirable that the drawing pot or receptacle be either of insulating material or sufficiently surrounded by such material in order that the cooling of the metal may not proceed with undue rapidity. This phase of the problem, however, is not of present interest, forming no part of the invention under consideration. Assuming, then, for present purposes a body of metal to be exposed to conditions of radiation and convection as uniform as possible, it will obviously be the surface of the bath that will be primarily thus affected, with the result that a film, or skin, of congealed glass will form thereon. In the operation of drawing, it is this that is withdrawn to form the cylinder walls there being a constant renewal thereof as fast as removal takes place. The size of the cylinder, that is its diameter, will for any given thickness of cylinder wall, be dependent on the annular radiation area of the glass in the pot, for the moment that such glass is covered with the aforesaid film, which forms at approximately 1544 degrees, F., further cooling of the interior molten body can only be had by conduction through such film (neglecting the effects of conduction through the walls of the pot). The rate of loss of heat by such conduction being very much slower than by radiation, the interior of the bath will cool only relatively slowly, even where such bath consists of a segregated body of metal. The rate at which the film on the surface will hence increase in thickness, will vary only very slowly, and in the case of a pot that is con-

tinuously supplied with fresh metal, need not change at all. Irrespective, however, of whether it changes or remains constant, it will be clear, in view of what has just been stated, that to obtain a cylinder having walls of a pre-determined thickness, the rate of drawing of such cylinder will have to be correlated with the glass temperature, by which I mean the temperature of the body of glass upon which the film is forming. It is upon this principle, accordingly, that I proceed in the present improved method of drawing glass. In carrying out such method, then, I employ the steps and means hereinafter fully described and particularly pointed out in the claims.

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

In said annexed drawings: Figure 1, is partly a side elevational, partly a vertical sectional, view of one type of glass drawing mechanism, with my present improvements incorporated therein; Fig. 2 is a similar view of another type of drawing mechanism, with such improvements shown in modified form; Fig. 3 illustrates a third form, and Fig. 4 is a detail of a fourth form of the invention.

Of the two types of drawing apparatus chosen for illustrative purposes, the first is a continuous, the second a discontinuous, or intermittent, cylinder drawing mechanism, as will be evident from an inspection of the several figures previously referred to. The detailed construction of the pot, as also of the drawing mechanism proper, comprising in the one instance, a movable closed bait, to which the air is supplied, and in the other rollers between which the cylinder is drawn upwardly, and a head resting on the open end of the cylinder, need not be recited. In the first form of apparatus, however, attention is called to a thermo-electric couple B that is located within the pot A, so as to project to a point substantially central with respect to the cooling influences wherewith said pot is surrounded. This couple will obviously be affected by any changes in temperature that may occur in the bath of metal in said pot. This couple B I connect to control suitable relay circuits C, by means of terminals c' c^2 disposed so as to be variously connected upon movement in one direction or another of the pointer c^3 of the indicator C'. As shown, two such relay circuits C are employed, neither of which is closed in what may be termed the normal temperature in the bath. A temperature more than normal, however, will be effective to move the pointer to contact with terminal c', thereby closing one such circuit, while a temperature less than normal will move the pointer oppositely to contact with terminal c^2, thereby closing the other circuit. Closure of such circuits is respectively effective to operate a switch D that controls the supply of current to a motor D', such motor being connected to drive the drawing rolls D^2. As in the case of the indicator C', a convenient construction of the switch D is to have the switch arm tend to assume the intermediate position shown, at which the motor will be operated at the normal rate of speed corresponding with the glass temperature registered by the indicator when its pointer occupies the normal position described above. The temperature of the molten glass or metal in the drawing receptacle may be expected to vary less in the case of the continuous drawing apparatus, where such metal is replenished from the tank as fast as it is drawn, than where a quantity is ladled out of the tank into a receptacle apart therefrom, and then drawn. The modification in construction illustrated in the Fig. 2 may hence be regarded as an adaptation of my apparatus to the slightly different conditions presented in the latter case. It will be understood, however, that such modified apparatus could be employed with equally beneficial effect with the other form of drawing mechanism or vice versa. Such modification consists in the first instance, in a substitution for the thermo-electric couple B as the thermo-sensitive element in the apparatus, of an air thermometer E, the exterior end of which is connected with a diaphragm valve E' whereby a pilot valve e in a pressure duct F is actuated the effect of an increase in temperature in the metal being to close such pilot-valve in the arrangement illustrated. The pressure fluid thus controlled by the pilot valve is conducted to a piston and cylinder F' or equivalent device, by means of which an electric switch F^2 is operated. Such switch corresponds in general with the switch D, operation of which in the other form of apparatus was effected by means of the several relay circuits C. Since the effect of the fluid pressure can be more nicely graduated, the number of contacts f and corresponding variations in current supply for the motor F^3, may be increased so that as the segregated body of glass falls in temperature, a gradually increasing rate of speed may be imparted to the drawing mechanism.

Fig. 3 shows the adaptation of my invention to the control of the rate of draw, where hydraulic means, as cylinder G and piston g, form the motor for the drawing mechanism. This, as will be recognized, is a type of drawing mechanism occasionally used in the intermittent, or discontinuous, process. Preferably, the bait g' is directly

attached to the lower end of such piston or plunger, such piston end being secured to a carriage g^2 that travels between vertical guides g^3. In the construction in hand, air is ~~designed to be~~ supplied to the roller being drawn through bait g', by means of a pipe g connected with the latter and telescoping into a larger pipe G' disposed alongside hydraulic cylinder G. Air, in turn is supplied to the pipe G' by means of a blower g^5, between which and the pipe is interposed suitable pressure regulating apparatus g^6.

While the air supply mechanism in the foregoing construction is believed to possess features of novelty and utility, I desire particularly to call attention to the correlation of the rate of speed of the hydraulic plunger g with the temperature of the metal in pot A. This is conveniently effected in a manner analogous to that employed in the second form of apparatus discussed above, by inserting an air-thermometer E into the bath and connecting the latter with a diaphragm valve E'. The latter, however, instead of simply operating a pilot valve is here utilized to control directly, by means of a similarly located valve h, the supply of water or equivalent pressure fluid to cylinder G through duct H.

Still another mode of more directly applying the expansive force of the fluid in thermometer E is shown in Fig. 4; here the diaphragm valve E' serves in effect merely to separate such fluid from an incompressible fluid, as water, that fills the remainder of the closed duct H' and appropriately positions switch F^2 by operating the piston and cylinder device F'.

It will be understood that of course various substances may be employed as the expansive agent in the thermometer type of control device. Not only air and like gases, but liquids, and even solids, such as lead, that fuse at the temperatures to which the device is subjected, may be utilized. It should be stated, moreover, that the two general types of thermo-sensitive apparatus, viz, the air-thermometer and thermo-electric couple are illustrative only, and such other forms of pyrometer as may be found suitable may be employed in their stead.

Whichever of the several illustrative types of apparatus hereinbefore illustrated and described, may be employed, it will be clear that a strict correlation will at all times be maintained between the rate at which the glass is removed from the drawing pot, and the temperature of the body of metal from which such removal takes place. In view of the underlying principles previously enunciated, the effectiveness of this method of control, not only in attaining a maximum speed of operation, but also obtaining a product that will be free from one of the most serious imperfections arising from this stage of manufacture, should be fully evident.

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 drawing glass articles from a bath of molten glass, which consists in regulating the speed of drawing to correspond with changes in the temperature of such bath, substantially as described.

2. The method of drawing glass, which consists in automatically regulating the speed of drawing to correspond with changes in temperature of such bath, substantially as described.

3. The method of drawing glass articles from a bath of molten glass, which consists in raising the bait, and automatically regulating the speed at which said bait is raised to correspond with changes in temperature of such bath, substantially as described.

4. In apparatus for drawing glass, a drawing pot or receptacle, mechanism coöperative with said receptacle to draw an article from a bath of molten glass therein, and means for regulating the rate of operation of said mechanism, said means including a thermo-sensitive device located in said receptacle, whereby such rate of operation is correlated with the temperature of such bath.

5. In apparatus for drawing glass, a drawing pot or receptacle, mechanism coöperative with said receptacle to draw an article from a bath of molten glass therein, and means for regulating the rate of operation of said mechanism, said means including an expansive fluid thermometer located in said receptacle, whereby such rate of operation is varied to correspond with variations in the temperature of such bath.

6. In apparatus for drawing glass, a drawing pot or receptacle, mechanism coöperative with said receptacle to draw an article from a bath of molten glass therein, driving means for said mechanism, pilot means controlling the rate of operation of said mechanism, and thermo-sensitive means located in said receptacle and connected to actuate said pilot means, whereby the rate of operation of said drawing mechanism is varied to correspond with variations in the temperature of the metal in said receptacle.

7. In apparatus for drawing glass, a drawing pot or receptacle, mechanism coöperative with said receptacle to draw an article from a bath of molten glass therein, an electric motor for driving said mechanism, a switch controlling the supply of current to said

motor, pilot means for actuating said switch, and thermo-sensitive means located in said receptacle and connected to actuate said pilot means, whereby the rate of operation of said drawing mechanism is varied to correspond with variations in the temperature of the metal in said receptacle.

8. In apparatus for drawing glass, a drawing pot or receptacle, mechanism coöperative with said receptacle to draw an article from a bath of molten glass therein, an electric motor for driving said mechanism, a switch controlling the supply of current to said motor, fluid pressure means for actuating said switch, a pilot valve controlling the supply of pressure fluid to said means, and thermo-sensitive means located in said receptacle and connected to actuate said valve, whereby the rate of operation of said drawing mechanism is varied to correspond with variations in the temperature of the metal in said receptacle.

9. In apparatus for drawing glass, a drawing pot or receptacle, mechanism coöperative with said receptacle to draw an article from a bath of molten glass therein, an electric motor for driving said mechanism, a switch controlling the supply of current to said motor, fluid pressure means for actuating said switch, a pilot valve controlling the supply of pressure fluid to said means, a diaphragm valve for actuating said pilot valve, and an air-thermometer located in said receptacle and connected to actuate said diaphragm valve, whereby the rate of operation of said drawing mechanism is varied to correspond with variations in the temperature of the metal in said receptacle.

Signed by me this 27th day of October, 1908.

ROBERT L. FRINK.

Attested by—
MARY GLADWELL,
JNO. F. OBERLIN.