

F. FOURCAULT.

METHOD OF AND APPARATUS FOR DRAWING CONTINUOUS SHEETS OF GLASS.

APPLICATION FILED MAY 15 1906

Patented Nov. 30, 1909.

3 SHEETS—SHEET 1.

941,866.

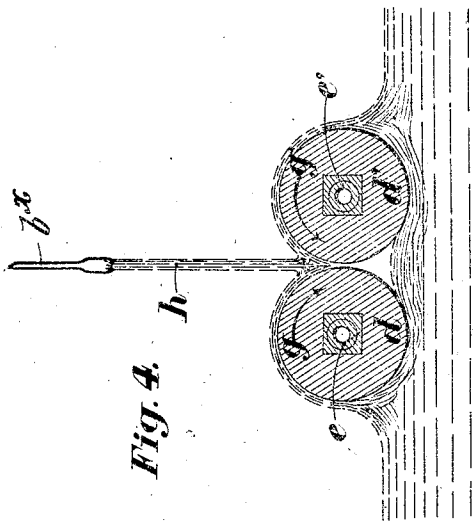


Fig. 4.

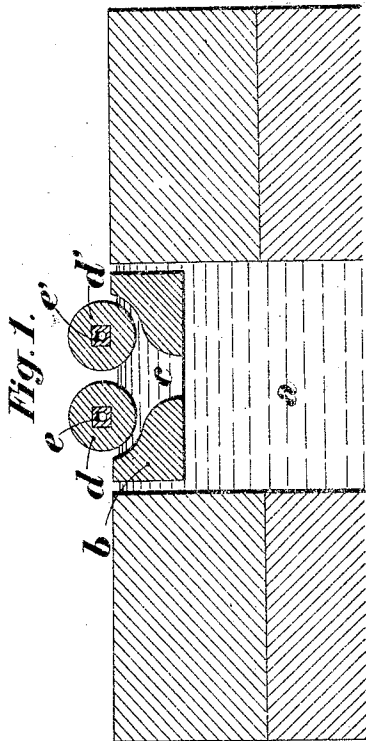


Fig. 1.

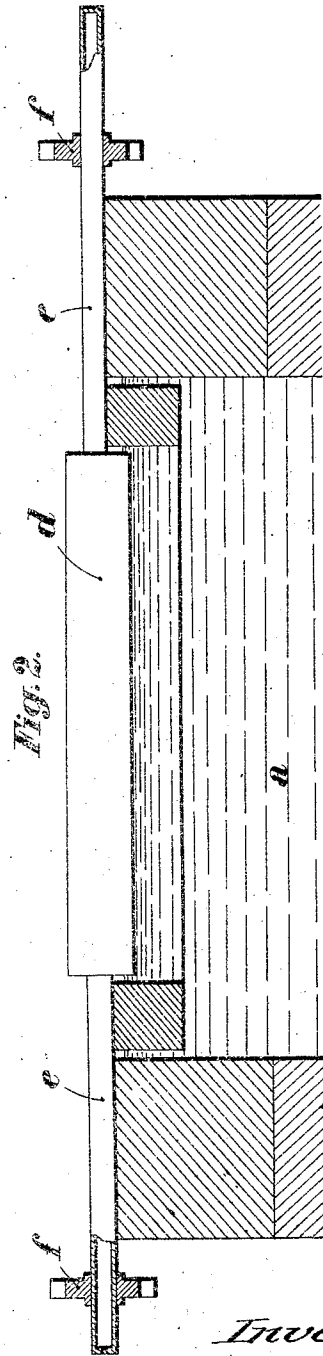


Fig. 2.

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1909

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Fig. 3.

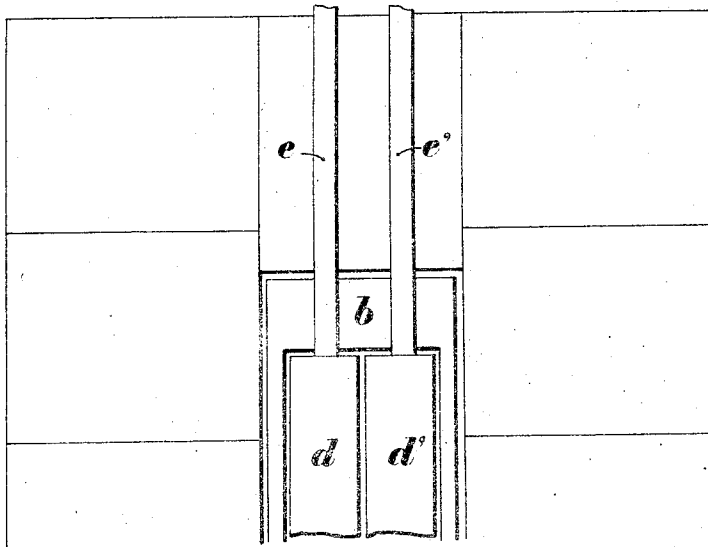
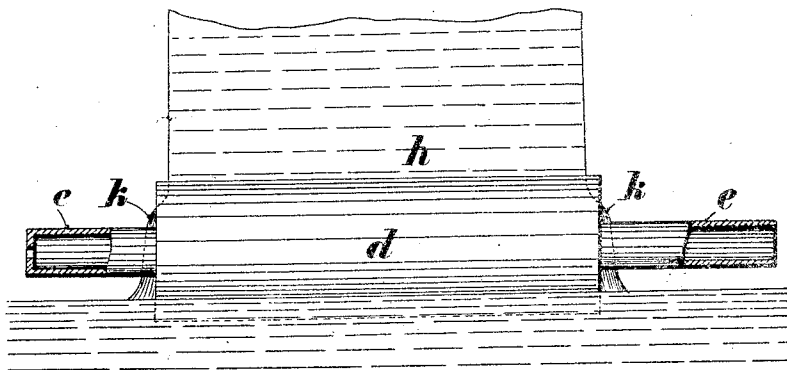


Fig. 5.



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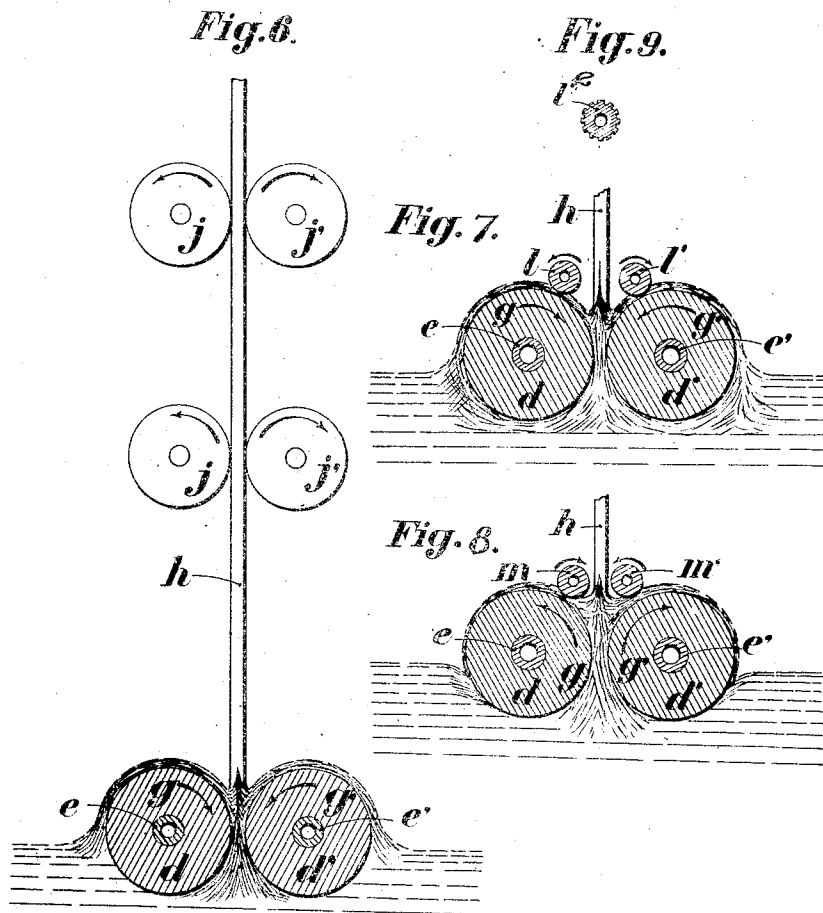
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 APPLICATION FILED MAY 16, 1905.

941,866.

Patented Nov. 30, 1909
 3 SHEETS—SHEET 3



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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR DRAWING CONTINUOUS SHEETS OF GLASS.

941,866.

Specification of Letters Patent.

Patented Nov. 30, 1909.

Application filed May 15, 1905. Serial No. 260,571.

To all whom it may concern:

Be it known that I, EMILE FOURCAULT, engineer, subject of the King of Belgium, residing at Lodelinsart, Belgium, have invented certain new and useful Improvements in Methods of and Apparatus for Drawing Continuous Sheets of Glass, of which the following is a specification.

In my Patent No. 717,378 and application No. 201,763 of April 6, 1904, relating to the manufacture of sheets of glass by drawing, I have shown a refractory float having an opening therethrough for supplying the glass and to facilitate the drawing operation. This float is more or less dipped into the molten glass for regulating the supply. By this process the sheets obtained often have wrinkles or streaks on their surfaces. This defect is the result of improper mixture of the glass when drawn and a lack of homogeneity of the molten glass.

The method and apparatus of the present invention has for its essential object to prevent the formation of wrinkles or streaks by operating to work up the glass at the basis of the sheet to render the glass more homogeneous.

The improved apparatus insures a full supply of the glass and prevents stringing of the sheet during drawing.

In the accompanying drawings: Figure 1 is a transverse section through the apparatus embodying the features of the invention. Fig. 2 is a longitudinal section of the same. Fig. 3 is a plan view. Fig. 4 is a cross sectional view of the rollers showing details of construction thereof and the operation of the same in the molten glass. Fig. 5 is a sectional elevation particularly showing one of the rollers and the hollow metallic shaft therefor. Fig. 6 is a cross sectional view of the rollers and a diagrammatic illustration of guide rollers to cooperate with the drawn sheet. Figs. 7 and 8 are detail cross sections of the rollers showing additional features cooperating therewith. Fig. 9 is a detailed cross section showing a slight modification.

The molten glass is inclosed in a tank *a*; a piece *b* of refractory material floats on the molten glass and is used not only for retaining the impurities of the surface of the molten glass, but also for preventing too great radiation of heat from its surface. The piece *b* is provided in its lower portion with a longitudinal aperture extending

therethrough and communicating with an enlargement of the same aperture at the upper portion for a purpose which will be presently set forth. In this float *b* two rollers *d d'* of refractory material are mounted, the said rollers dipping into the molten glass. These rollers are carried on hollow metallic shafts *c* and *c'* for cooling the same internally by a current of suitable liquid. On these shafts are fixed toothed wheels *f, f'*, preferably in the form of sprocket wheels, which are connected through the medium of endless chain belts, not shown, with other toothed wheels adapted to be rotated either mechanically or by hand to set up a rotation of the two shafts *c, c'* and the rollers *d, d'*. By rotating the rollers *d, d'* in either one of two directions, they will operate to draw along glass which adheres to their lower portions, and the coating will be thicker as the rollers are colder and the glass more viscous. In other words, the colder portions of the rollers will have a thicker coating of glass, or will take up more of the glass. These rollers operate practically as rotary pumps or lifting means for supplying the glass at the basis of the sheet drawn. If the cylinders *d* and *d'* are disposed at a suitable distance from each other, the coatings of glass thereon will come into contact and form a small accumulation of semi-liquid glass between the rollers. The sheet iron, or bait for feeding the glass will be brought in between the rollers at the point where the accumulation of semi-liquid glass is located, and slowly draws a continuous sheet of glass by the means described in my application No. 201,763, filed April 5, 1904, the bait being conventionally shown by Fig. 4 as *b'*.

Figs. 4 and 5 particularly illustrate how the glass passes around the rollers *d d'* when these rollers are nearly in contact and rotated in the direction of the arrows *g* and *g'*. The glass which passes around the rollers *d d'* cools when it leaves the bath of glass. In order to obtain a suitable consistency of the glass at the base of the sheet drawn, it is only necessary to vary the speed of rotation and the diameter of the rolls. The fluidity of the glass may be easily regulated by modifying the speed of rotation of the rollers, and as the rollers elevate or work up the glass at the base of the sheet, the glass is rendered very homogeneous, and streaks in the drawn sheet are thus prevented. Fur-

thermore, if the speed of rotation of the rollers d and d' is such as to feed to the basis of the sheet h an amount of glass greater than can be carried up with the sheet, the excess of glass will run off or out at h at the ends of the rollers and return to the tank a , which will result in a horizontal movement and effect a lateral drawing, which will further prevent the formation of streaks liable to be produced by a contraction of the molten sheet.

Fig. 6 illustrates the rollers as being spaced a greater distance and also extended deeper into the molten glass, and indicates that under such conditions a proper supply and a suitable consistency of the glass may be maintained between the rollers without liability of a break of the glass subjected to the drawing action. The asbestos coated rolls j, j' , as disclosed by my patent and application hereinbefore mentioned, are illustrated in coöperation with the rollers d, d' in Fig. 6.

Fig. 7 illustrates the rollers d and d' rotated in opposite directions to show that the glass may be practically drawn under such conditions.

It will be understood that the rollers thus far described and directly engaging the molten glass and also similar rollers which will subsequently be referred to may be varied as to their dimensions and material used in their construction.

In Fig. 7 metallic rolls l, l' are used with the rollers d, d' , the rolls l, l' operating to roll and cool the coating of glass on the rollers d, d' and reducing more or less the dimensions of the glass passing over the said rollers. The rolls l, l' are tubular and are cooled by a circulation of water or other suitable cooling liquid therethrough. The direction of rotation of the rollers l, l' is indicated by the arrows in Fig. 7 as being reverse to the rotation of the rollers d, d' , and if desired the rollers l, l' may be grooved as l^2 , Fig. 9, to form designs which may be impressed or printed on the drawn sheet of glass, and by this means sheets of grooved glass may be produced.

Fig. 8 shows rollers m, m' similar to the rollers l, l' located closer to the drawn sheet, and operating particularly to retain a greater quantity of glass at the base of the drawn sheet, the rollers d, d' in this instance rotating outwardly and the rollers m, m' rotating inwardly.

From the foregoing it will be understood that the method of drawing sheet glass in accordance with the present invention consists in preparing a mass of molten glass and conveying a portion of the molten mass to a sheet drawing point and continuously replenishing the supply of molten glass as the drawing operation proceeds. In addition to the operation of preparing and drawing the

glass just explained, a portion of the surface of the molten mass is continuously moved away from the two faces of the sheet as drawn and also from the two edges of the latter. This method is not dependent upon the precise mechanism shown in various forms, but may be pursued with any analogous mechanism.

The glass in accordance with the present apparatus and method is mechanically moved to a drawing point. By mechanically moving the glass it is meant to be understood that means are employed other than the containing receptacles, openings in the latter, conduits and float blocks, for moving the glass to a point of drawing independent of gravitation alone or the tendency of all liquids to seek a level in connected receptacles. Having thus described the invention, what is claimed, is:

1. In an apparatus for drawing a continuous sheet of glass, the combination of rollers for supplying glass at the basis of the sheet to be drawn, the rollers being dipped into the molten glass, a float having an opening therethrough in which the rollers are disposed, and means for operating the rollers.

2. In an apparatus for drawing sheet glass, the combination of a receptacle for molten glass, a float disposed in the receptacle and having an opening therethrough, and revolving means carried by the float and held in the opening of the latter.

3. In an apparatus for drawing sheet glass, the combination with a receptacle for molten glass, a float depressed into the receptacle and into the molten glass therein and having an opening therein, and a pair of rollers held by the float and disposed longitudinally with respect to the latter.

4. An apparatus for drawing sheet glass, comprising a receptacle for the molten glass, a bait for drawing the glass in sheet form therefrom, and revolving means extending approximately throughout the width of the sheet drawn and from between which the sheet is drawn.

5. In an apparatus for drawing sheet glass, the combination with a receptacle for the molten glass, a bait for drawing the glass in sheet form therefrom, and revolving devices approximately of the length of the width of the sheet to be drawn and from between which the sheet is drawn.

6. In an apparatus for drawing sheet glass, the combination of a receptacle for molten glass, a bait for drawing the glass in sheet form therefrom, of two revoluble bodies arranged in parallel relation and having a length approximately the same as the width of the sheet to be drawn and from between which the sheet is drawn by the bait.

7. In an apparatus for drawing sheet glass, the combination of a receptacle for molten glass, a bait for drawing the glass in

sheet form therefrom, two rollers of a length approximately that of the width of the sheet of glass to be drawn and from between which the sheet is drawn, and tubular cooling shafts for the said rollers.

8. In an apparatus for drawing sheet glass, the combination of a receptacle for molten glass, a bait for drawing the glass in sheet form therefrom, and revolving means for feeding the glass to the base of the sheet drawn and provided with supporting cooling devices.

9. In a machine for drawing sheet glass, the combination of a receptacle containing molten glass, means for drawing a sheet of glass therefrom, and means simultaneously imparting movement to and lifting the molten glass to the base of the sheet and for moving the molten mass away from the two faces of the sheet as it is drawn.

10. In a machine for drawing sheet glass, the combination of a receptacle containing molten glass, two parallel rollers revoluble in opposite directions with the lower part of their peripheries immersed in the molten glass and operating to raise the glass toward the base of the sheet drawn, and means for drawing a sheet of glass from the molten mass of glass raised toward the base of the sheet by said rollers.

11. In a machine for drawing sheet glass, the combination of a receptacle containing molten glass, two parallel rollers revoluble in opposite directions with their adjacent surfaces moving upward and the lower part of their peripheries immersed in the molten glass, whereby a portion of the mass of molten glass is conveyed to a drawing point and outwardly from the latter by said rollers, means for revolving both of the rollers at the same speed, and means for drawing a sheet of glass from the mass of glass conveyed by said rollers.

12. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means lifting a body of molten glass from below the surface of said mass and returning portions of said lifted body to the molten mass, and means drawing a sheet of glass from said lifted body of molten glass along a line between said returning portions.

13. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means continuously lifting a portion of said mass from below the surface thereof, and means drawing a sheet of glass from said lifted portion.

14. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, means raising a portion of said mass, means drawing a sheet of glass from said raised portion while the said portion is in the act of returning to the normal level of the mass in the receptacle.

15. In a machine for drawing sheet glass, the combination of a receptacle containing a mass of molten glass, a pair of refractory rollers revolving with their peripheries immersed in said molten mass, the rollers operating to convey the glass to a drawing point in relation to the molten mass in the receptacle, means directing a cooling fluid through the shafts of said rollers, and means drawing a sheet of glass from the molten mass conveyed by the rollers.

16. The method of drawing sheet glass which consists in preparing a mass of molten glass, conveying a portion of the molten mass to a sheet drawing point, and drawing a sheet of glass from the conveyed portion of the mass and imparting movement in opposite directions away from the two faces of the sheet drawn.

17. The method of drawing sheet glass which consists in continuously drawing a sheet of glass from a mass of molten glass moved to a drawing point, and continuously moving a portion of the surface of the molten mass away from the two faces of the sheet as drawn.

18. The method of drawing sheet glass, which consists in continuously drawing a sheet of glass from a mass of molten glass moved to a drawing point from a melting source, continuously replenishing the supply of molten glass as the drawing proceeds, and continuously moving a portion of the surface of the molten mass away from the two faces and the two edges of the sheet as drawn.

19. The method of drawing sheet glass, which consists in continuously drawing a sheet of glass from a mass of molten glass mechanically moved to a drawing point from a melting source, and continuously replenishing the supply of molten glass to the drawing point as the drawing proceeds.

20. In a machine for drawing sheet glass, the combination of a receptacle containing molten glass, means for mechanically moving a portion of the molten glass in the receptacle to a drawing point, and means for drawing a sheet of glass from the moved portion of the molten glass.

21. In a machine for drawing sheet glass, the combination of a receptacle containing molten glass, means simultaneously imparting movement to a portion of the molten mass to feed it to the base of the sheet drawn and also to parts of the surface portion of the molten mass away from the two faces of the sheet as it is drawn, and means for drawing a sheet of glass from the moved portion of the mass.

22. In a machine for drawing sheet glass, the combination of a receptacle containing molten glass, means for drawing a sheet of glass therefrom, and means for moving a portion of the molten mass to a drawing

1 point and continuously replenishing the molten mass to the base of the sheet drawn.

23. In a machine for drawing sheet glass, the combination of a receptacle containing
5 molten glass, means for drawing a sheet of glass therefrom, and means for simultaneously moving a portion of the molten glass in the receptacle to a drawing point and continuously replenishing the molten glass
10 at the base of the sheet drawn and to parts

of the surface portion of the molten mass away from the two faces of the sheet as it is drawn.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses. 15

EMILE FOURCAULT.

Witnesses:

ARTHUR REGNIEN,
C. BASTIER.