Oct. 20, 1936. E. R. BOYLES ET AL 2,057,763

METHOD OF PRODUCING CONCAVE CRYSTALS

Filed Dec. 19, 1934 2 Sheets-Sheet 1

FIG. 1

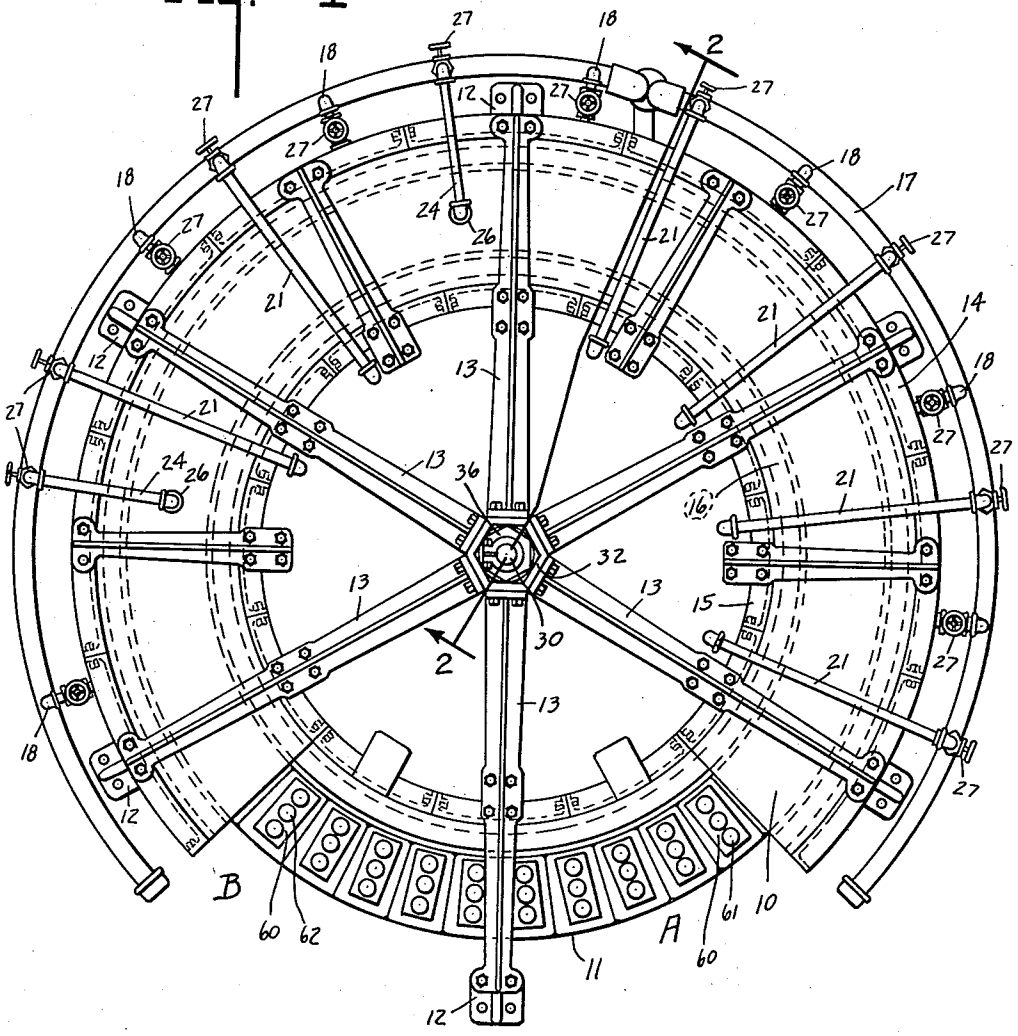
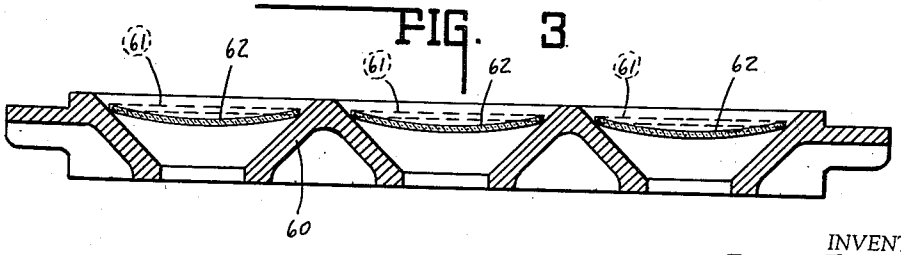


FIG. 3



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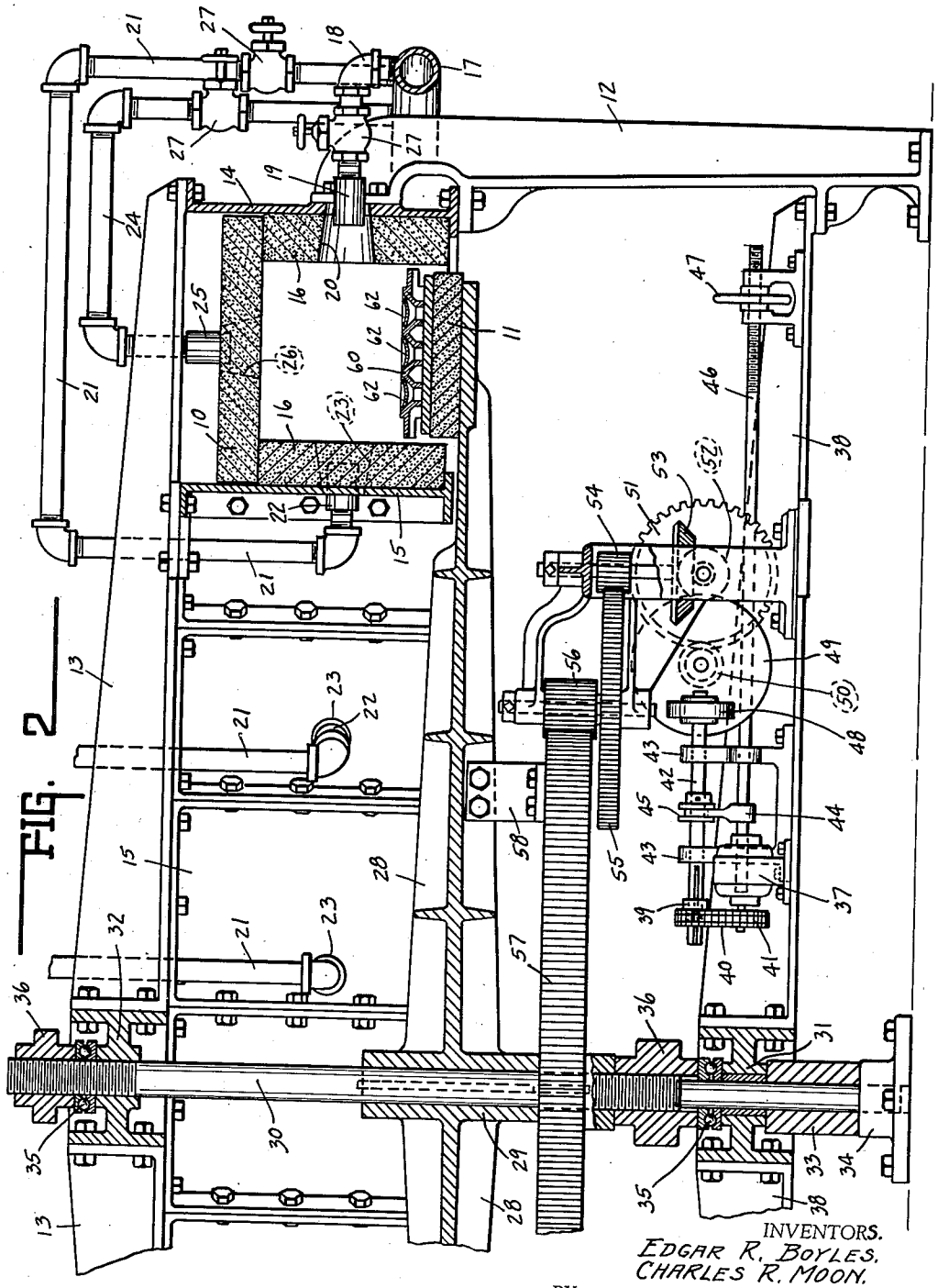


FIG. 2

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METHOD OF PRODUCING CONCAVE CRYSTALS

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Application December 19, 1934, Serial No. 758,163

2 Claims. (Cl. 49—84)

This invention relates to a method for producing concave crystals of the character commonly employed on the face of clocks, watches, and indicating instruments.

It is the general practice in the production of such crystals to cut a window glass into flat disks or blanks of substantially the desired diameter, apply heat thereto, and thereupon mold them or press them with a plunger to reform them with a concave surface of substantially the desired radius.

This method contemplates heating the disks and causing them to be reformed with the desired concavity in a continuous operation and without requirement of molds, plungers and the like. One feature of the method resides in cutting a flat blank of glass of approximately the desired diameter or area and supporting it in a mold block or by any means whereby its entire surface remains unsupported, the marginal edge only engaging with the support. The supported blanks are then heated by passing them through a suitable furnace for a predetermined length of time and predetermined temperature to so effect the glass as to permit it to sag by gravity into a concave formation. The blank is removed from the furnace or heat upon it reaching the desired curvature and passed to a lehr in the usual manner. By varying the duration of heat application, or travel through the furnace, with or without a variation in the intensity of the heat, the surface curvature may be set at the desired radius without the use of the usual mold or forming plunger and without affecting the original polish of the surface through the contact of any portion thereof with a mold or plunger surface.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

Fig. 1 is a plan view of the heating furnace and conveyor. Fig. 2 is an enlarged section taken on the line 2—2 of Fig. 1. Fig. 3 is an enlarged central vertical section through a mold block showing the blank in dotted lines and the finished crystal in full lines.

In the drawings there is shown a circularly formed furnace generally indicated at 10, through which a circular conveyor indicated at 11 is caused to continuously move. The furnace is supported upon a frame work comprising a plurality of peripherally-disposed upright standards 12. Mounted upon the standards 12 there is a spider comprising the radially-extending arms 13 having their ends secured and supported upon an outer wall 14, which in turn is mounted upon the standards 12. An inner wall 15 is secured to the arms 13 so as to be suspended therefrom. The inner lining of the furnace is formed of fire brick in the usual way, comprising the side walls 16 which are secured to and supported by the outer wall 14 and the inner wall 15, respectively. The fire brick top of the furnace spans the walls 16 and is supported thereon, leaving the bottom of the furnace open.

The furnace is heated by oil or gas in the usual manner. Surrounding the furnace, there is a circularly-formed fuel header 17 from which the branch fuel pipes 18 lead to the outer wall to discharge fuel from the nozzle 19 laterally into the furnace through an orifice 20. Similarly, a pipe 21 extends over the top of the furnace terminating in a nozzle 22 extending through an orifice 23 in the inner side wall. A pipe 24 leads to a nozzle 25 extending into an orifice 26 in the top wall. Each of said pipes is controlled by a valve 27. As will be noted in Fig. 1, the pipes to the outer and inner walls are arranged in staggered relation extending throughout the entire length of the furnace, whereas comparatively few pipes leading to the top of the furnace are provided toward the discharge end thereof. This arrangement is such that wherein there are mold blocks for supporting a number of blanks, those illustrated herein supporting three blanks, the centrally disposed blanks will be heated to substantially the same temperature as the outer blanks.

As illustrated in Fig. 2, the circular conveyor 11 is concentric with the furnace and of a width approximating that of the furnace, and extends into the open bottom thereof. It is supported upon the radially-disposed arms 28 extending from a central hub 29 mounted about the spindle 30. Said spindle is rotatably mounted within the bearings 31 and 32, the bearing 31 being supported by a spacing sleeve 33 on a central block 34, while the bearing 32 is supported by the spider arms 13. Thrust bearings 35 are provided in conjunction with the bearings 31 and 32 to support the rotating spindle, the relative position of which in respect to the bearings is adjusted by the screw threaded sleeves 36.

The turntable is continuously driven by the motor 37 mounted upon the bottom frame 38, said motor driving a sprocket wheel 39 through a chain 40 and sprocket wheel 41. The sprocket 39 is slidably keyed on a spindle 42 mounted in the bearings 43, in which it is longitudinally slidable by a yoke 44 engaging in a collar 45. The yoke 44 is mounted on an adjusting rod 46 longitudinally adjustable by a hand wheel 47. Through manipulation of the hand wheel 47, the spindle 42 may be caused to slide longitudinally to vary the position of a friction wheel 48 carried on the end thereof in engagement with a friction disk 49. Said disk 49 carries a pinion 50 meshing with a gear 51, which in turn carries a beveled pinion 52 meshing with a beveled gear 53. The gear 53 carries a pinion 54 meshing with a gear 55, which in turn carries a pinion 56 meshing with a gear 57. The gear 57 is keyed to the spindle 30

and locked to the radially-disposed arms 28 by a plate 56. Thus, through the motor 37 and associated gearing, the turntable is slowly rotated at a speed approximately one revolution to every four minutes, more or less. This speed of rotation is readily controlled by the hand wheel 47 which plays an important part in controlling or predetermining the radius of curvature of the concave surface with which the crystal is formed.

The mold block 60, as best illustrated in Fig. 3, is provided with three conical apertures having their walls tapering inwardly toward the bottom and open at the bottom as well as the top for receiving a flat blank of glass indicated by dotted lines at 61. The marginal edges of the annular blanks engage the tapered walls of the block so that they are supported near the top thereof. As the blanks are heated in passing through the furnace, they sag downwardly to the set position illustrated in full lines to form the concave crystal indicated at 62. Thus, the surface of the blank or crystal at no time engages the surface of the block, but is suspended by the marginal edge only. The radius of curvature of the concave surface formed by the sagging action is dependent upon the temperature to which it is heated in passing through the furnace and the time during which it passes therethrough. In practice, it is more convenient to maintain a substantially constant temperature in the furnace while controlling the speed by the hand wheel 47 to vary the radius of curvature or compensate for variation in temperature.

While the block is illustrated herein as having conical apertures, it can be provided with a curved concave bottom or have any other form so long as it permits the sagging action, is open to the atmosphere and does not permit any portion of the surface of the blank or crystal other than the extreme marginal edge coming in contact with the surface thereof.

It may also be noted that whereas the furnace and conveyor are herein illustrated as circular, which is the most convenient arrangement, the furnace may be extended in a straight line or otherwise through which an endless conveyor passes. It is advisable, however, that the conveyor move continuously at an even speed through the furnace rather than intermittently. An intermittent movement has the effect of disturbing the even flow or sagging movement of the glass which distorts it so that the crystal becomes lopsided.

By varying the speed of the table by the hand wheel 47, and the temperature of the furnace by the valves 27, the temperature of the molds may be controlled. This is highly important, since by running the molds at a higher temperature, they transmit more heat to the marginal portion of the glass disks. Thus, the marginal portion of the disk is softened more than the central portion so that it sags more rapidly. This results in a curvature of a shorter radius near the edge than in the center. This form of concave crystal is especially desirable for such uses as clock lenses to permit a larger clearance for the hands. Thus, for various purposes, the curvature may be controlled by manipulation of the speed of the table and the temperature of the furnace.

In operation, the furnace is heated to a predetermined temperature as nearly as possible by manipulation of the valves 27. The continuous rotating speed of the conveyor 11 is controlled by the wheel 47 to cause a predetermined amount of sag depending upon the temperature. This results in producing a concave crystal 62 from the flat blank 61 of a predetermined radius of curvature. The operator grips the block 60 with a pair of tongs, placing it on the conveyor at the loading station A, and dropping into the conical apertures of the block the blanks 61, while the conveyor is slowly moving. The blanks are carried through the circular tunnel-like furnace during which continuous travel they are heated to a point where they sag to the desired depth resulting in the predetermined radius of curvature, whereupon they pass out of the discharge or unloading end of the furnace indicated at B. At this station, the operator again grips the mold block, removing it from the conveyor and disposing of it in a suitable lehr or turning it over to deposit the formed crystal 62 in the lehr and returning the heated block to its position at the loading station A, dropping a new set of blanks into place. It is preferable to turn the finishing crystals out of the block so that the block may be replaced upon the conveyor while in its heated state.

It will be further noted that whereas the blank and crystal are herein described as circular in outline, the same apparatus and principle of operation may be employed wherein it is desired that the outline of the crystal be rectangular or of any other desired shape. In such event it is only necessary that the aperture of the mold block be so designed as to provide sufficient engagement and support for the marginal edge as may be necessary to suspend the surface for permitting its sagging action under heat to the desired concave formation.

The invention claimed is:

1. The method of producing concave crystals consisting in cutting a flat blank of glass to substantially the desired shape and dimensions of the crystal to be produced, suspending the blank at its extreme marginal edge so that the edge only contacts with a support, applying sufficient heat to the blank to soften the glass whereby it will be permitted to sag downwardly by the force of gravity to the desired concavity and still maintain said edge contact, and controlling its resistance to the force of gravity by the amount of heat applied thereto to maintain the entire undersurface unsupported during and at the end of the sagging action.

2. The method of producing concave crystals consisting in cutting a flat blank of glass to substantially the desired shape and dimensions of the crystal to be produced, suspending the blank at its extreme marginal edge so that the edge only contacts with a support, applying sufficient heat to the blank to soften the glass whereby it will be permitted to sag downwardly by the force of gravity to the desired concavity and still maintain said edge contact, and controlling its resistance to the force of gravity by the amount of heat applied to said blank and support respectively to maintain the entire undersurface unsupported during and at the end of the sagging action and to provide for a greater amount of heat being transmitted to said marginal portion through the medium of the heated support for obtaining variations in the radius of curvature about said marginal portion relative to the central portion of said blank.

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