July 6, 1965 J. C. BLAINE 3,193,119

METHOD AND APPARATUS FOR FEEDING BATCH MATERIALS TO A GLASS-MELTING FURNACE

Filed Sept. 25, 1963 2 Sheets-Sheet 1

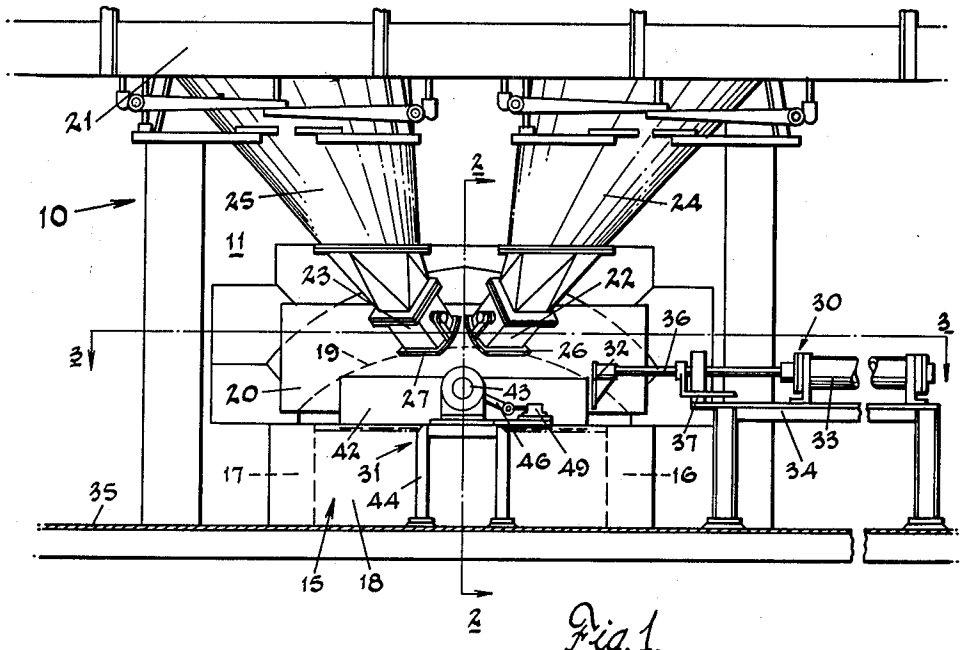


Fig. 1.

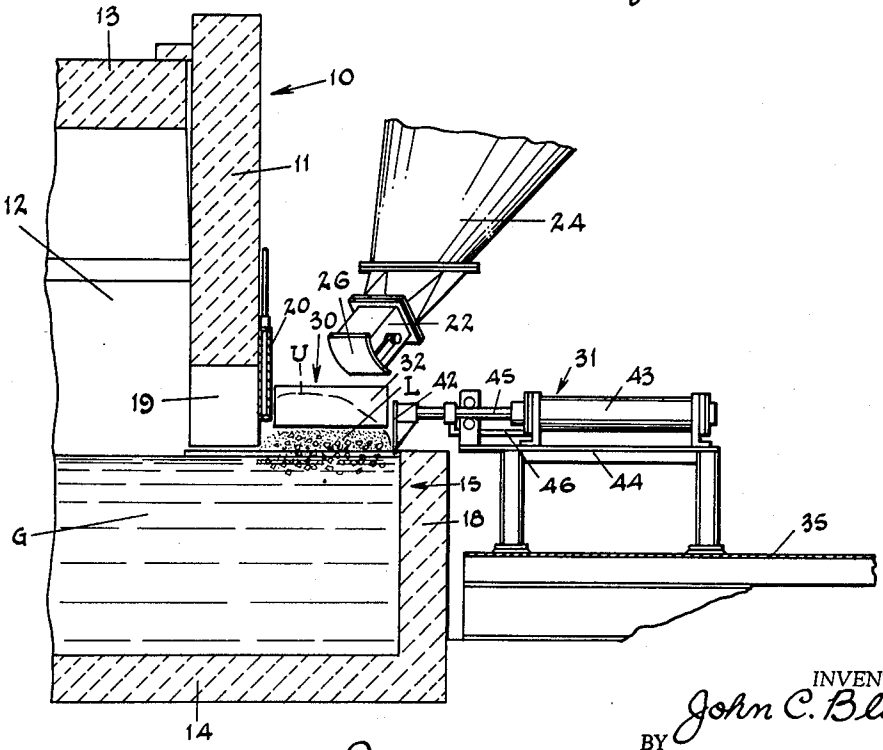


Fig. 2.

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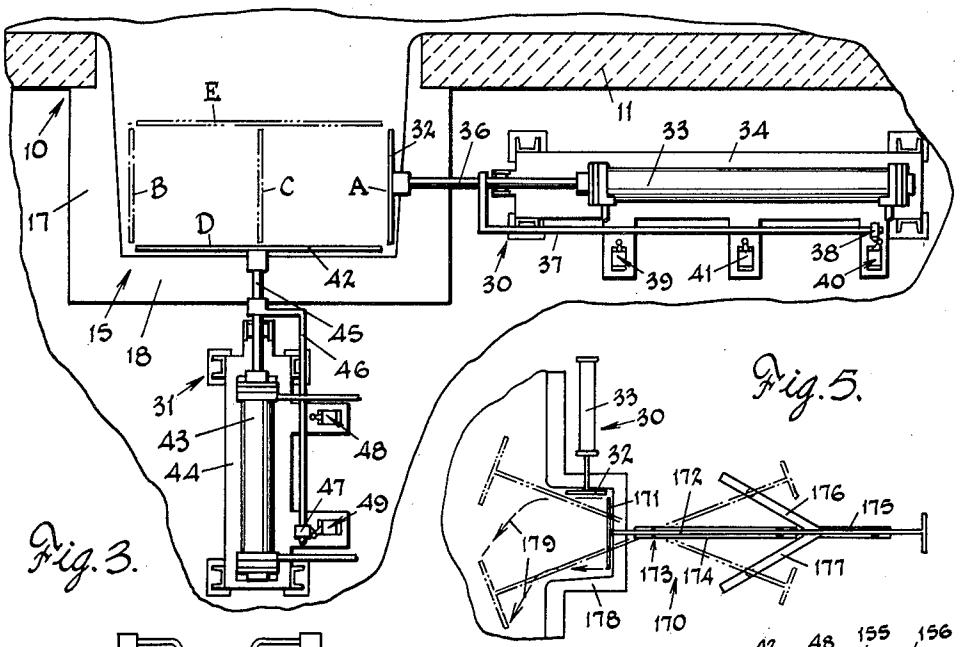


Fig. 3.

Fig. 5.

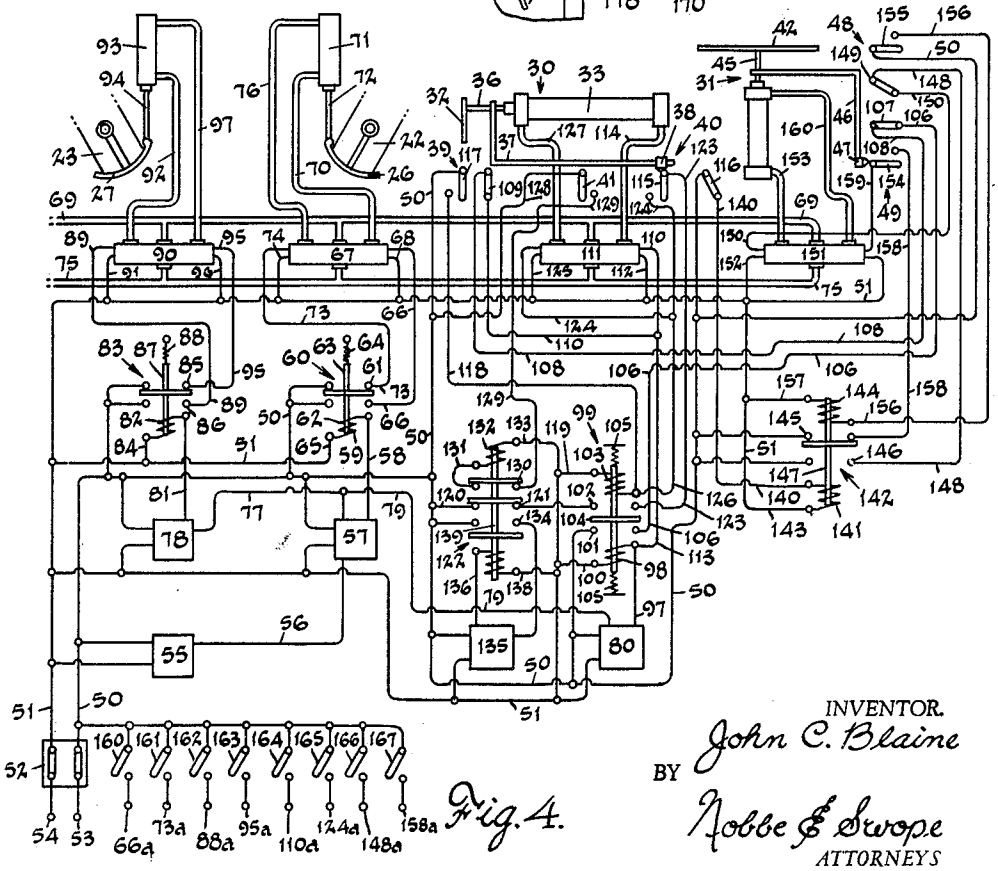


Fig. 4.

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3,193,119

METHOD AND APPARATUS FOR FEEDING BATCH MATERIALS TO A GLASS-MELTING FURNACE

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8 Claims. (Cl. 214—23)

The present invention relates to an improved method of and apparatus for feeding glass-making materials into a continuous tank-type melting furnace.

The method and apparatus of this invention is of particular utility in feeding granular or pulverulent raw batch materials and cullet or scrap glass into the charging area of a glass-melting tank furnace and for advancing these materials into the melting chamber of the furnace.

In accordance with one known method of feeding glass-making materals into melting furnaces of the type in question, a predetermined amount of cullet and raw batch materials are deposited from above upon the surface of the bath of molten glass in the charging area of the furnace, either one upon the other or simultaneously. This results in the formation of a relatively large pile or lump-like mass of general conical formation, which mass floats on the bath in substantially the middle of the charging area. Heretofore, advancing this pile or lump of loosely deposited batch material from the charging area into the melting chamber of the furnace has necessitated a rather large opening in a refractory wall separating the charging area from the melting chamber of the furnace, which opening is normally closed by a gate. When the materials are advanced into the melting chamber, the gate is moved to the open position permitting the highly heated gases maintained at a controlled positive pressure in the furnace to change with consequently undesirable variations in the furnace pressure.

It has also been found that due to the size and conical shape of the pile or lump-like mass of batch materials, the intense flames for melting the raw materials which impinge at relatively high velocity upon the lumps, are deflected upwardly toward the cap or roof arch of the furnace and may cause eventual burn-out of the refractory cap necessitating expensive furnace repair. Still another drawback of the above-described feeding procedure is that the relatively large size of the lumps requires greater time for melting the batch materials.

An important object of the invention is to provide an improved method of supplying glass batch materials to a continuous glass-melting tank furnace so as to minimize disturbance of the furnace pressure during such feeding and to also reduce the time and heat required for the melting of the batch materials.

Another object of the invention is to provide an improved method of supplying glass batch materials to the melting chamber of a tank furnace by distributing the materials laterally over the charging area to reduce the lumps to a more uniform level whereby to expose a greater surface area of the batch materials to the furnace atmosphere when advanced into the melting chamber thereby reducing the time and heat required to melt the raw materials.

Another object of the invention is to provide an improved method of supplying glass batch materials at regularly spaced intervals to the melting chamber which involves initially depositing the glass cullet and raw glass-making materials upon the molten bath in the charging area of the furnace in the form of lumps, then distributing the materials laterally over an increased area by pushing the batch materials while they are being fed to the furnace toward either or both sides, and finally pushing the materials into the melting chamber.

A further object of the invention is to provide novel apparatus for automatically carrying out the several steps of the method of the invention in timed sequence.

Other objects and advantages of the invention will become more apparent during the course of the following description when taken in connection with the accompanying drawings.

In the drawings, wherein like numerals are employed to designate like parts throughout the same:

FIG. 1 is an end elevation of a conventional tank-furnace used for the melting of glass and of glass batch feeding apparatus constructed in accordance with the invention;

FIG. 2 is a longitudinal vertical sectional view taken on line 2—2 of FIG. 1;

FIG. 3 is a plan view taken on line 3—3 of FIG. 1;

FIG. 4 is a diagrammatic view of an electrical control system; and

FIG. 5 is a fragmentary plan view of a modified form of apparatus.

Referring now to the drawings wherein, for purposes of illustration, is shown a glass-melting furnace of the continuous or tank-type generally designated by the numeral **10**, which contains a molten bath of glass flowing continuously from a charging end to an oppositely disposed outlet end of the tank. As is customary with this type of furnace, batch materials, both raw materials and cullet, are fed into a melting zone adjacent the charging end of the furnace and are reduced in the melting zone to a molten and homogeneous state and become a part of the bath G which flows into a refining zone from which the properly conditioned glass is discharged from the outlet end of the tank. The rate at which the molten glass is drawn from the refining zone governs the rate at which the glass-making materials are introduced into the tank; it being desired to maintain the bath at a somewhat constant level.

The tank-furnace **10** is defined by end walls **11**, side walls **12**, a roof arch **13** and a floor **14**. Disposed outwardly of the end wall **11** at the charging end of the furnace is a charging area or doghouse **15** which, as shown in FIG. 3, comprises a small substantially rectangular extension of the melting chamber projecting outwardly from the end wall **11** along the longitudinal axis of the furnace and defined by side walls **16** and **17**, an end wall **18** and a continuation of the furnace floor **14**. The top of the doghouse **15** is open permitting new batch material to be deposited directly on the molten bath G in the doghouse. The charging area or doghouse **15** communicates with the melting zone of the furnace through an opening or so-called "doghouse arch" **19** formed in the end wall **11**. Above the bath G in the charging area, the arch **19** is substantially closed by a movable, vertically disposed gate comprising a hollow member **20**, commonly termed and hereinafter described as a "cooler" which closes off the arch **19** to retard the escape of highly heated gases which are maintained at a positive pressure in the interior of the furnace. Naturally, the loss of heat or the entry of cooler air into the melting zone reduces the efficiency of furnace operation by decreasing the temperature and pressure in the melting zone below the optimum.

Adjacent the charging end of the tank-furnace **10** and disposed above the open area of the doghouse **15** is an elevated structure or platform **21** from which supply chutes **22** and **23** are suspended. Arranged on and extending downwardly through the platform **21** are conventionally constructed chambers **24** and **25** which supply the chutes **22** and **23** from overhead hoppers into which the cullet and the raw batch materials are initially measured and discharged. Each of the chutes **22** or **23** is equipped with a converging, funnel-shaped end that is

closed at its lower extremity by gates **26** and **27**. The gates are preferably selectively opened and closed in a sequential order, to be hereinafter more fully described, to deposit the glass-making materials in the doghouse.

In a conventional batch charging operation, the gate on one of the chutes, such as the gate **26** of chute **22**, is opened to discharge a measured amount of cullet glass onto the surface of the molten glass G in the doghouse **15**, after which the gate is again closed. Then the gate **27**, associated with the chute **23**, is opened in like manner to discharge the required amount of raw batch material into the doghouse **15**. This results in a pile or lump-like mass of the materials within the doghouse area. The quantity of materials introduced into the doghouse, and thus the size of the pile or lump deposited on the bath, is determined by the spaced intervals of time between the sequentially occurring movement of each pile or lump into the furnace melting zone which, in turn, is determined by the rate of withdrawal of molten glass from the outlet end of the furnace, it being remembered that the bath is maintained at a substantially constant level in the tank.

Usually, the production rate of a furnace is such that relatively large quantities of batch materials must be periodically charged into the melting zone of the furnace to maintain the bath at a near constant level. The size of the pile or lump-like mass of glass-making material in the doghouse determines the amount of opening required in the refractory wall to enable the mass to be introduced into the melting zone of the furnace. In other words, opening of the sliding cooler permits the escape of the pressurized heated gases from the furnace and the efficiency of the furnace may be decreased by the escape of these gases.

In addition, the other disadvantages discussed above also are inherent when large masses of the glass-making materials are introduced into the melting zone. Thus, the rate at which the materials will be melted in the melting zone is dependent upon the rate at which they become heated to the melting temperature. For the entire pile or lump to become melted, naturally the heat must penetrate the outer layers and be conducted into the inner layers of the pile. The rate at which this may be accomplished is also dependent upon the over-all size of the pile. It has been found that the shape of the pile may have an adverse effect on the furnace itself since a somewhat conical-shaped pile tends to deflect the heated gases directed thereon upwardly against the roof arch which has a detrimental effect on this arch.

To overcome these disadvantages without adversely affecting the production capacity of the furnace, the present invention contemplates a procedure of charging the batch materials into the furnace which includes distributing the batch materials substantially evenly across the surface of the bath in the doghouse thereby decreasing the over-all height of the lump-like mass of the materials and exposing more surface area to the heated gases when the materials are moved into the melting zone. In accordance with the invention, the foregoing is accomplished by a novel leveling apparatus **30** operable to engage the upper portions U of the pile or mass L and to distribute these portions across the entire width of the doghouse **15**, resulting in a substantially level layer of the glass-making materials which may be advanced by a batch moving or pushing apparatus **31** into the melting zone through a smaller opening in the end wall and which presents a greater surface area to the heated gases in the melting zone. Being substantially planar, the mass has no tendency to deflect the heated gases directed toward the mass in the melting zone upwardly against the refractory walls of the tank furnace.

As shown in FIGS. 1 and 3, the leveling apparatus **30** includes a vertically disposed, substantially rectangular pusher blade **32** disposed in the charging area and extending parallel to the longitudinal axis of the furnace between the end wall **11** thereof and the end wall **18** of the doghouse. The pusher blade **32** is coupled to an actuating means operable to move the blade back and forth transversely across the doghouse **15**. The lower edge of the pusher blade **32** is substantially parallel to the surface of the bath and spaced above the surface of the bath a preselected distance, which distance corresponds to the desired thickness of the mass of glass-making materials to be introduced into the furnace.

The actuating means in the present instance comprises a cylinder **33** supported at one side of the doghouse **15** adjacent the side wall **16** thereof by a frame **34** resting on a supporting surface **35** with the cylinder extending outwardly from the doghouse wall along an axis substantially coincident to the medial line between the cooler **20** and the end wall **18** of the doghouse. The cylinder **33** is operable to drive a piston rod **36** associated therewith and projecting from the innermost end of the cylinder endwise back and forth along an axis extending transversely to the longitudinal axis of the furnace to carry the blade **32**, secured to the outer end thereof, between limit positions adjacent each of the doghouse side walls **16** and **17**.

As will be more fully described hereinafter, the piston rod **36** is driven pneumatically by means of the cylinder **33** to move the pusher blade **32**, in timed relationship with the operation of the gates **26** and **27** controlling the discharge of materials from the chutes **22** and **23**, from one limit position across the doghouse to the other limit position in one stroke and thereafter to return the blade to the first position in an intermittent stroke divided into at least two increments of movement.

Although various control devices may be employed to achieve this sequence of movement of the pusher plate **32**, in the illustrated embodiment, operation of the cylinder **33** is governed by a control rod **37** carried by the piston rod and having an actuator block **38** adjustably mounted thereon to progressively engage a plurality of limit switches **39**, **40** and **41** mounted on the frame **34**.

In an exemplary operation, after the cullet is discharged from the chute **22** onto the bath and as the raw batch materials are discharged from chute **23** onto the cullet, the pusher blade **32** is moved from a rest position coinciding with the limit position adjacent side wall **16** as shown in full line and identified by the letter A in FIG. 3, toward the opposite limit position B adjacent the remote side wall **17**, as shown in broken line. In so moving, the blade engages the upper portion U (FIG. 2) of the accumulating batch material and pushes it toward the opposite side wall **17** thereby forming a substantially evenly distributed layer at one side of the longitudinal axis of the furnace. In sequence, after the blade **32** has reached the outermost limit position, it is drawn rearwardly to a substantially half-way position C, also shown in broken line. The blade **32** remains stationary at position C while the remainder of the raw batch materials is discharged, after which the blade resumes its rearward movement to pull such amounts of the batch as are above the lower edge of the blade toward the side wall **16**. In this manner, the blade **32** levels the piles of glass-making materials and forms a blanket-like layer of substantially uniform thickness which is then moved forwardly beneath the cooler **20** into the melting zone of the furnace by a blade **42** associated with the pushing apparatus **31**.

As shown in FIGS. 2 and 3, the pushing apparatus **31** includes a cylinder **43** mounted adjacent the end wall **18** of the doghouse with its axis parallel to the longitudinal axis of the furnace on a frame **44**. The blade **42** is secured to the free end of a piston rod **45** associated with the cylinder **43** and movable axially toward and away from the end wall **11** of the furnace. As the blade **42** is thus carried forward toward the end wall **11**, it engages the batch materials and pushes them through the doghouse arch **19** and into the furnace. For this purpose, the blade

42 extends across the doghouse 15 with its ends terminating adjacent to but being spaced slightly inwardly of the side walls 16 and 17 and is carried by the piston rod 45 between a limit position D and an outer limit position E shown in broken line in FIG. 3.

The limits between which the blade 42 is moved are determined by a control device similar to that controlling the movements of the plate 32 of the leveling apparatus. Thus, the piston rod 45 is equipped with a rod 46 having an actuator block 47 adjustably mounted thereon. At the outer limit of forward movement of the blade 42, the block 47 engages a control switch 48 and likewise at the limit of its rearward movement, the block engages a similar control switch 49; both switches being mounted on the frame 44 and controlling operation of the cylinder 43.

Referring now to FIG. 4, the sequentially occurring phases of the charging operation of batch materials will be described in connection with an electrical circuitry which for purposes of illustration is adapted to initiate, at regulated intervals of time, operation of the gates 26 and 27 to supply the cullet and raw batch materials from the respective chutes 22 and 23, movement of the leveling apparatus 30 to the outermost limit of its stroke, return movement of the leveling apparatus in two sequentially occurring partial movements to the inner limit of its stroke and then forward and rearward movement of the pushing apparatus 31.

The circuitry adapted to provide this sequence of operation of the various elements of the apparatus includes electric supply lines 50 and 51 coupled, through control switch 52, to power sources 53 and 54 and connected to an automatically repeating timer relay 55 which establishes the spaced intervals of time between the feeding of the batch materials to the doghouse area. Customarily, one of the gates, such as the gate 26 associated with chute 22, is first opened to discharge the cullet onto the surface of the molten glass in the doghouse and, for this purpose, the timer device 55 is connected by line 56 to an adjustable timing relay 57 which functions to monitor the time interval during which cullet will be discharged from the chute 22 by controlling a pneumatic actuating means operable to open and close the gate 26. To this end the timing relay 57 is connected by line 58 to a solenoid 59 of a relay switch 60, which switch includes a pair of normally closed contacts 61, a pair of normally open contacts 62, and an armature 63 which is normally biased by spring 64 to urge it into contact with the normally closed contacts 61. The circuit through the solenoid 59 is completed by line 65 to supply line 51 whereby, when relay 57 is energized, the armature 63 is moved against the spring 64 to open contacts 61 and close contacts 62 to establish a circuit from line 50 through line 66 to one side of valve 67 and back to supply line 51 through line 68. Valve 67 is thereby activated to introduce pressure fluid from supply pipe 69 through pipe 70 and into the rod end of a cylinder 71 to drive piston rod 72, attached to gate 26, upwardly to open the lower end of chute 22. When the timed activity of relay 57 is terminated, it opens the circuit to the solenoid 59 permitting the spring 64 to move the armature 63 toward its rest position to open contacts 62 and reclose contacts 61. When this occurs, a circuit is established from source line 50 through line 73 to the opposite end of valve 67 and thence through line 74 to source line 51 whereupon the valve connects pipe 70 to a return pipe 75 and connects pipe 76 to pipe 69 to admit pressure fluid into the head end of the cylinder 71 to move the gate 26 to the closed position.

Simultaneously the timing relay 57 establishes a circuit through line 77 to timing relay 78 and by line 79 to a second timing relay 80. In the first instance, the timing relay 78, connected to supply lines 50 and 51, becomes active to monitor the interval of time that raw granular batch materials will be discharged from the chute 23. To this end, the relay 78 completes a circuit from supply line 50 through line 81 to the solenoid 82 of a relay switch 83 and by line 84 to source line 51. The switch 83 has a pair of normally closed contacts 85, a pair of normally open contacts 86 and an armature 87 normally biased by a spring 88 to urge it into contact with the normally closed contacts 85. Energization of solenoid 82 moves armature 87 to open contacts 85 and close contacts 86 completing a circuit from supply line 50 through line 89 and to one side of valve 90 and back to supply line 51 through line 91. When this circuit is complete, the valve 90 connects pipe 92 to supply pipe 69 to thereby direct pressure to the rod end of cylinder 93 coupled to the gate 27 by piston rod 94. Since timing relay 78 is adjusted to determine the amount of raw batch material from the chute 23, the combined and sequentially occurring operations of the relays 57 and 78 accurately control the total amount of glass-making materials fed into the doghouse area upon completion of each of the set time intervals repeatingly controlled by the main timing relay 55.

When the timing relay 78 becomes inactive, the solenoid 82 is de-energized permitting the spring 88 to reverse the position of armature 87 to open contacts 86 and reclose contacts 85. This will establish a circuit through line 95 from source line 50 to the opposite end of valve 90 and thence by line 96 to source line 51 whereupon the valve 90 connects pipe 92 to the return pipe 75 and supply pipe 69 to pipe 97 to introduce pressure fluid into the head end of cylinder 93 thereby lowering the gate 27 to close the chute 23.

The above-mentioned timing relay 80, also connected to source lines 50 and 51, is regulated to establish a time interval during which a first portion of the raw batch materials is deposited on the layer of cullet glass. Consequently, the proportionate amount of raw batch materials to be moved toward the side wall 17 by the leveling apparatus 30 builds up on the cullet layer until the relay 80 establishes a circuit to activate said leveling apparatus. This circuit is directed through line 97 to a solenoid 98 of a spring balanced relay switch 99 and completed through line 100 connected to supply line 51. The switch 99 is equipped with normally open contacts 101 and 102, an opposing solenoid 103 and an armature and contact bar 104 urged into a normally intermediate position between the pairs of contacts 101 and 102 by springs 105. Solenoid 98, when energized, moves armature 104 to complete a circuit from line 50 by line 106 through contacts 101 and the normally closed contacts 107 of dual control switch 49, to line 108 through normally closed contacts 109 of dual control switch 39, to line 110 connected to one side of a valve 111 and thence by line 112 back to the supply line 51. Additionally by line 113, a maintaining circuit is made to the solenoid 98 of relay switch 99 to retain the contacts 101 engaged after the timing relay 80 ceases to function. Contacts 107 of control switch 49 are employed as a safety factor and are adapted to connect lines 106 and 108 only when the blade 42 of pushing apparatus 31 is in the rest position adjacent the doghouse end wall 18 thereby preventing operation of the leveling apparatus 30 in the event that the blade 42, for one reason or another, cannot or does not fully complete its return stroke to the rest position.

Actuation of the valve 111 directs pressure from supply pipe 69 through pipe 114 to the head end of cylinder 33 whereupon the piston rod 36 is caused to move the leveling blade 32 against the accumulation of raw batch materials and to thus "cut-off" or push a desired amount of said materials from the forming lump transversely toward the remote side wall 17. By means of the actuator block 38 on rod 37, and during outward movement of the piston rod 36, the contacts 115 of dual limit switch 40 will be engaged and the contacts 116 disengaged. The contacts 116, as in the case of contacts 107, function as a safety device to prevent operation of the pusher apparatus 31 until the leveling blade 32 is returned to its rest position adjacent the side wall 16 of the doghouse. During continuing forward movement of the block 38, the one-way

limit switch 41 is bypassed and the outermost limit of the stroke of the piston rod 36 is determined by the position of the dual limit switch 39. This switch, in addition to the normally closed contacts 109, is equipped with normally open contacts 117. Consequently, as the leveling blade 32 reaches its outermost limit position, the contacts 109 are opened to break the circuit of valve 111 at lines 108 and 110 and the blade is halted adjacent the side wall 17. However, upon closing of the contacts 117, a circuit is established from source line 50 through line 118 to the opposed solenoid 103 of relay switch 99 and thence by line 119 to source line 51. This circuit acts to immediately open contacts 101 thereby rendering valve 111 idle and engage contacts 102 whereupon the return stroke of the blade 32 will be initiated.

As hereinabove noted, it is desirable for the purposes of this invention to halt return movement of the blade 32 at substantially a midway point of its return stroke and to this end the limit switch 41 is employed to control the active circuit through the contacts 102. This permits the remainder of the quantity of raw batch materials to be discharged and the total lump of batch then further cut or leveled off upon continued movement of the blade 32. Thus the circuit through contacts 102 is completed from source line 50 through line 120, through presently closed contacts 121 of a relay switch 122, contacts 102 and line 123, through presently engaged contacts 115 of dual limit switch 40, through line 124 to the opposite end of valve 111 and thence by line 125 to supply line 51. Through branch line 126, a holding circuit is made to maintain the solenoid 103 of relay switch 99 energized until the blade 32 has returned to its rest position.

When the valve 111 is so operated, the pipe 114 is connected to return pipe 75 while supply pipe 69 is connected to pipe 127 connecting to the rod end of cylinder 33 thereby causing the piston rod 36 and blade 32 to be moved transversely rearward over the previously leveled quantity of batch materials. Upon temporary engagement of limit switch 41 by actuator block 38, a circuit is established from source line 50, through line 128, switch 41, line 129, through presently engaged contacts 130 of relay switch 122 and line 131 to the solenoid 132 and completed to supply line 51 via line 133. This circuit operates to disengage pairs of contacts 121 and 130 and establish a circuit from source line 50, through engaged contacts 134 of relay switch 122 to a timing relay 135. The relay 135, being in circuit with source lines 50 and 51, initiates a timed interval during which the blade 32 is stationary and then creates a circuit by line 136 to the opposed solenoid 137 of relay switch 122 and thence by line 138 to source line 51. The latter circuit causes the armature 139 to open contacts 134 and reclose pairs of contacts 121 and 130; however, since limit switch 41 is only temporarily engaged by actuator block 38, the same is reopened and the circuit to solenoid 132 is not re-established. At contacts 121, on the other hand, the above-described circuit through lines 120, 123 and 124 is re-established to again actuate the valve 111 whereby the application of pressure from pipe 69 through pipe 127 will be resumed. Continued rearward movement of the blade 32 now operates in a pulling action to further level the lump of batch materials by moving an upper portion of the same toward the side wall 16 of the doghouse. Upon reaching the rest position of the blade, the actuator block 38 engages the dual control switch 40 to open contacts 115 and to close contacts 116. In the first instance, breaking of the circuit between lines 123 and 124 renders the valve 111 inactive and discontinues the holding circuit through line 126 to solenoid 103 permitting the balancing springs 105 to move the armature 104 to a disengaged position between contacts 101 and 102.

Upon engagement of the pair of contacts 116, a circuit is established from source line 50 through line 140 to a solenoid 141 of relay switch 142 and thence by line 143 to source line 51. Relay switch 142 is equipped with opposing solenoid 144, a pair of normally closed contacts 145, a pair of normally open contacts 146 and an armature and contactor bar 147. When energized, solenoid 141 moves armature 147 to disengage contacts 145 and engage contacts 146 to establish a circuit from source line 50 through line 148, presently closed pair of contacts 149 of dual control switch 48, line 150 to one end of a valve 151 and thence to source line 51 via line 152. Valve 151 is adapted, upon activation, to connect supply pipe 69 with pipe 153 associated with the head end of cylinder 43 thereby effecting movement of the blade 42 into engagement with the leveled mass or lump of batch material to move the same forwardly into the furnace. As the blade 42 is moved forwardly by the piston rod 45, the rod 46 is carried forwardly to remove the block 47 from engagement with the dual control switch 49 thereby opening contacts 107 and closing a pair of contacts 154.

At the forward limit position E of the blade 42 shown in broken line in FIG. 3, the actuator block 47 disengages contacts 149 of dual control switch 48 and engages contacts 155 thereof. This de-energizes the solenoid 141 and establishes a circuit from source line 50, line 156 to the opposed solenoid 144 of relay switch 142 and thence by line 157 to source line 51. This circuit operates to open contacts 146 and reclose contacts 145, breaking the circuit through line 148 and establishing a circuit from line 50 by line 158, presently closed contacts 154 of dual switch 49 and line 159 to the opposite end of valve 151. The valve then connects pipe 153 to return pipe 75 and directs pressure fluid from supply pipe 69 to pipe 160 coupled to the rod end of cylinder 43 thereby effecting rearward motion of the blade 42 and whereupon contacts 155 are opened and contacts 149 reclosed.

At the rearward limit of movement of the pushing blade 42, the actuator block 47 engages dual control switch 49 to re-engage the contacts 107 and more importantly to disengage the contacts 154 whereby the circuit through lines 158 and 159 is opened to actuate valve 151 thereby closing pipe 160. This completes one cycle of the feeding and batch moving operation which, after the spaced interval of time as determined by the main timing relay 55, is repeated.

Since it is realized that the several relay switches and/or the circuits to be completed therethrough may, for one reason or another, become inactive or non-responsive to the associated actuating instrumentalities, means is herein provided for effecting a manual control over the operation of the valves 67, 90, 111 and 151. To this end, manually operated switches 160 and 161 are connected through branch lines 66*a* and 73*a* to the opposite ends of valve 67; switches 162 and 163 are connected through branch lines 88*a* and 95*a* to valve 90; switches 164 and 165 are connected through branch lines 110*a* and 124*a* to valve 111; and, switches 166 and 167 are connected through branch lines 148*a* and 158*a* to valve 151.

In briefly reviewing operation of the leveling and pushing apparatus, it is to be understood that the intervals of time which are monitored by the timing relay 55 are determined by the rate at which the charges of batch materials are to be introduced into the melting zone of the furnace 10. Likewise, the quantity of batch materials in each charge is controlled by the interval of time the gates 26 and 27 remain open. The charging rate and the amount of materials making up each charge, of course, depends to a large extent upon the rate of melting and the withdrawal of refined molten glass from the outlet end of the furnace.

In operation, upon activation of the timing relay 55, the gate 26 is operated to discharge cullet from the chute 22 into the doghouse area. In timed relation as determined by the timing relay 57, the timing relay 78 becomes active to operate gate 27 to discharge the raw batch materials from chute 23. After suitably timed periods, the relays 57 and 78 close the gates 26 and 27 and

associated chutes when the measured amount of materials has been discharged and a pile containing the required quantity of materials has been deposited on the molten bath in the doghouse. After activation of the relay **78**, the timing relay **80** produces operation of the leveling blade **32** by cylinder **33** to move transversely of the doghouse and push portions of the batch materials from the upper area of the lump and toward the remote doghouse side wall **17**. While the discharge of raw batch materials continues, the blade **32** is caused to move in the opposite direction and to stop in substantially the center of the doghouse. The blade **32** is then moved the remainder of its return stroke and pulls the uppermost materials toward the side wall **16**. This combined operation produces an evenly distributed layer of batch materials having a leveled upper surface and a width approximating the width of the open area of the doghouse. This more efficiently distributed mass is then moved into the furnace by the pushing apparatus **31**.

While the novel aspects of this invention have been described in connection with substantially straight forward movement of each lump or mass of batch materials from the charging or doghouse area of the glass-melting furnace, it is realized that leveling of the glass-making materials in accordance with the invention may be employed to equal advantage when the pushing apparatus is so moved to direct the batch materials toward one side or the other of the melting zone. In this connection, a pushing apparatus operable to move the batch materials into the melting zone in the above-described manner is disclosed in Patent No. 2,804,981, issued September 3, 1957. As disclosed in this patent, to which reference may be made for a more detailed description, means is provided for moving lumps of batch materials forwardly from the doghouse area into the melting zone and then in alternating sequences of operation directing successive lumps of the batch first toward one side of the melting zone and then toward the opposite side. A pushing apparatus **170** of the type disclosed in the patent is shown schematically in FIG. 5. The apparatus **170** includes a pusher blade **171** carried by a horizontally disposed bar **172** guided during its reciprocal movements by a track **173**. To this end, the bar **172** is swingably supported intermediate its ends on a guide roller which traverses a straight section **174** of the track extending along the longitudinal axis of the furnace. The rearmost end of the bar **172** traverses an aligned straight section **175** of the track and is alternatively guided along diverging tracks **176** and **177**. This causes the bar to pivot bodily on its support with resultant lateral swinging of the pusher blade **171** after it has moved through the area of the doghouse **178** and into the melting zone thereby to move the batch materials toward the sides of the furnace as is indicated in broken lines designated by the numeral **179** in FIG. 5.

The manner in which the leveling apparatus **30** may be used in connection with a pushing apparatus of this patented construction is believed quite apparent to those skilled in the art. Briefly stated, the transverse reciprocal movements of the leveling blade **32**, to reduce the total height of the lump of batch materials while distributing the same more equally across the doghouse area, are controlled to operate during the period of time in which the pusher blade **171** is located adjacent the end wall of the doghouse.

It is to be understood that the forms of the invention herewith shown and described are to be taken as illustrative embodiments only of the same, and that various changes in the shape, size and arrangement of parts, as well as various procedural changes may be resorted to without departing from the spirit of the invention.

I claim:

1. In a method of feeding batch materials into a glass-melting furnace having a melting chamber containing a molten bath of glass and a relatively small restricted charging area communicating with said chamber and adapted to receive glass batch materials to be melted, the steps of depositing a predetermined amount of batch materials in a pile on the molten bath within said charging area, distributing said batch materials laterally across said charging area to form a substantially level layer of the materials on said molten bath in said charging area, and thereafter moving the batch materials from said charging area into said melting area.

2. In a method of feeding batch materials into a glass-melting furnace including a melting chamber containing a molten bath of glass and a restrictive charging area in communication therewith and adapted to receive glass batch materials to be melted, the steps of introducing a predetermined amount of batch materials downwardly onto the molten bath in said charging area to form a pile of said batch materials in said charging area, moving a portion of said pile toward one side of said charging area as the materials are introduced therein, moving a subsequently introduced portion of said materials toward the opposite side of said charging area thereby to provide an evenly distributed substantially level layer of materials in said charging area, and thereafter pushing the batch materials from the charging area into the melting chamber.

3. Apparatus for feeding batch materials into a glass-melting furnace including a melting chamber containing a bath of molten glass and a relatively small restricted charging area communicating with said chamber and containing a portion of said molten bath, comprising means for depositing a pile of batch materials on the molten bath in said charging area, means for distributing said materials laterally across said charging area to form a relatively level layer of said materials on said portion of said bath, and means for pushing the layer of batch materials out of said charging area and into said melting chamber.

4. Apparatus for feeding batch materials to a glass-melting furnace as defined in claim 3, wherein said means for pushing said layer of batch materials into said melting chamber comprises a pushing blade, and an actuating mechanism for moving said blade toward and away from said melting chamber thereby to move said layer of batch materials out of said charging area and into said melting chamber.

5. Apparatus for feeding batch materials into a glass-melting furnace having a melting chamber containing a molten bath of glass and a relatively small restricted charging area communicating therewith and containing a portion of said molten bath, said apparatus comprising a leveling blade disposed in said charging area and spaced a predetermined distance above the upper surface of said portion of said bath, an actuator coupled to said blade and operable to move said blade across said charging area between a first position adjacent one side of said area to a second position adjacent an opposite side of said area, means for depositing a quantity of batch materials in a pile between said first and second positions, means activating said actuator mechanism as said materials are being deposited in said charging area to move said leveling blade between said first and second positions whereby said blade engages the materials in the upper portions of said pile and moves them toward opposite sides of said area to distribute the materials evenly across said charging area forming a substantially level layer of material on said portion of said bath, and means for moving said layer into said melting zone.

6. Apparatus for feeding batch materials into a glass-melting furnace including a melting chamber containing a bath of molten glass and a relatively small restricted charging area communicating with said melting chamber and containing a portion of said molten bath and adapted to receive batch materials therein for movement along a predetermined path out of said charging area and into said melting chamber, said apparatus comprising means for depositing a quantity of batch materials in a pile in

said charging area, a leveling blade disposed in said charging area and spaced a predetermined distance above the upper surface of said portion of said bath, actuating means coupled to said blade and operable to drive the blade back and forth across said charging area transversely of said path whereby said blade engages the batch materials in the upper portions of said pile and distributes the materials across said charging area to form a substantially level layer of the material on said portion of said bath, a pusher blade disposed in said charging area and movable along said path toward and away from said melting chamber, and actuating means for moving said pusher blade back and forth along said path in timed relationship to the movements of said leveling blade to push the layer of said batch materials into said melting chamber.

7. Apparatus for feeding batch materials into a glass-melting furnace having a melting chamber containing a molten bath of glass and a restricted charging area communicating therewith and containing a portion of said molten bath, said apparatus comprising a supply chute disposed above and opening downwardly into said charging area, a gate mounted on said chute to move selectively between open and closed positions to deposit batch materials in a pile onto said portion of said bath, a leveling blade disposed in said charging area and spaced above the upper surface of said portion of said bath, actuating means coupled to said leveling blade and operable to move said blade back and forth across said charging area when said gate is in said opened position thereby to move the blade into engagement with the upper portions of said batch materials as they are deposited in said charging area, and to move these portions across the charging area

to distribute the materials and to form a substantially level layer of batch materials on said portion of said bath, and means operating in timed sequence with the movements of said leveling blade to move said layer out of said charging area and into said melting zone.

8. Apparatus for feeding batch materials into a glass-melting furnace including a melting chamber containing a bath of molten glass and a relatively small restricted charging area communicating with said chamber and containing a portion of said molten bath, comprising means for depositing a pile of batch materials on the molten bath in said charging area, means for distributing said materials evenly across said charging area to form a relatively level layer of said materials on said portion of said bath, said distributing means including a leveling blade disposed in said charging area, means supporting said blade above said portion of said bath and spaced above the upper surface of said bath a distance corresponding to the desired thickness of said layer of batch materials, and an actuating means for moving said blade back and forth across said charging area and against the uppermost portions of said pile thereby to distribute said materials to opposite sides of the pile, and means for pushing the layer of batch materials out of said charging area and into said melting chamber.

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