

[54] **PLASTIC INJECTION MOLDING
MACHINE SAFETY MECHANISM**

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425/151

[51] Int. Cl. **B29f 1/100**

[58] Field of Search 18/30 CS, 30 CM,
18/16 C, 17 C, DIG. 45, 2 I; 164/150, 152,
153; 49/13, 68; 74/613, 615; 192/129, 134,
135, 137, 148; 425/151, 152, 169, 136

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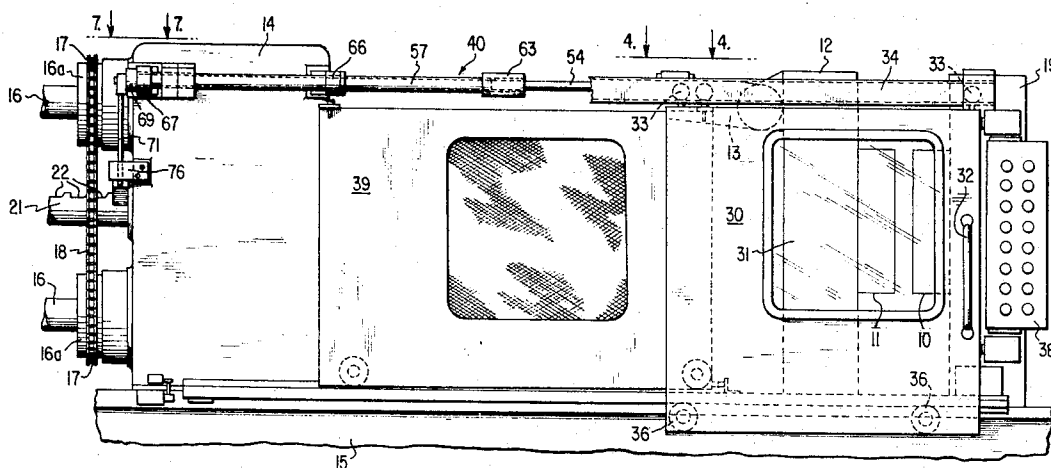
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[57] **ABSTRACT**

In order to prevent injury to the operator, the advance of the movable platen and mold is physically restrained, whenever the windowed safety gate is slightly opened, by a pawl which engages a notched guide bar connected to the movable platen. The movement of the pawl is controlled by a mechanical linkage connected to the safety gate and includes a telescopic torque shaft which is rotated upon opening or closing of the safety gate by a cam and a spherical cam follower associated, respectively, with the gate and the rotatable shaft. Circuitry is provided for detecting an inoperability of the pawl whenever the gate is opened so as to actuate an alarm system and also, if desired, shut down the hydraulic pumps.

9 Claims, 13 Drawing Figures



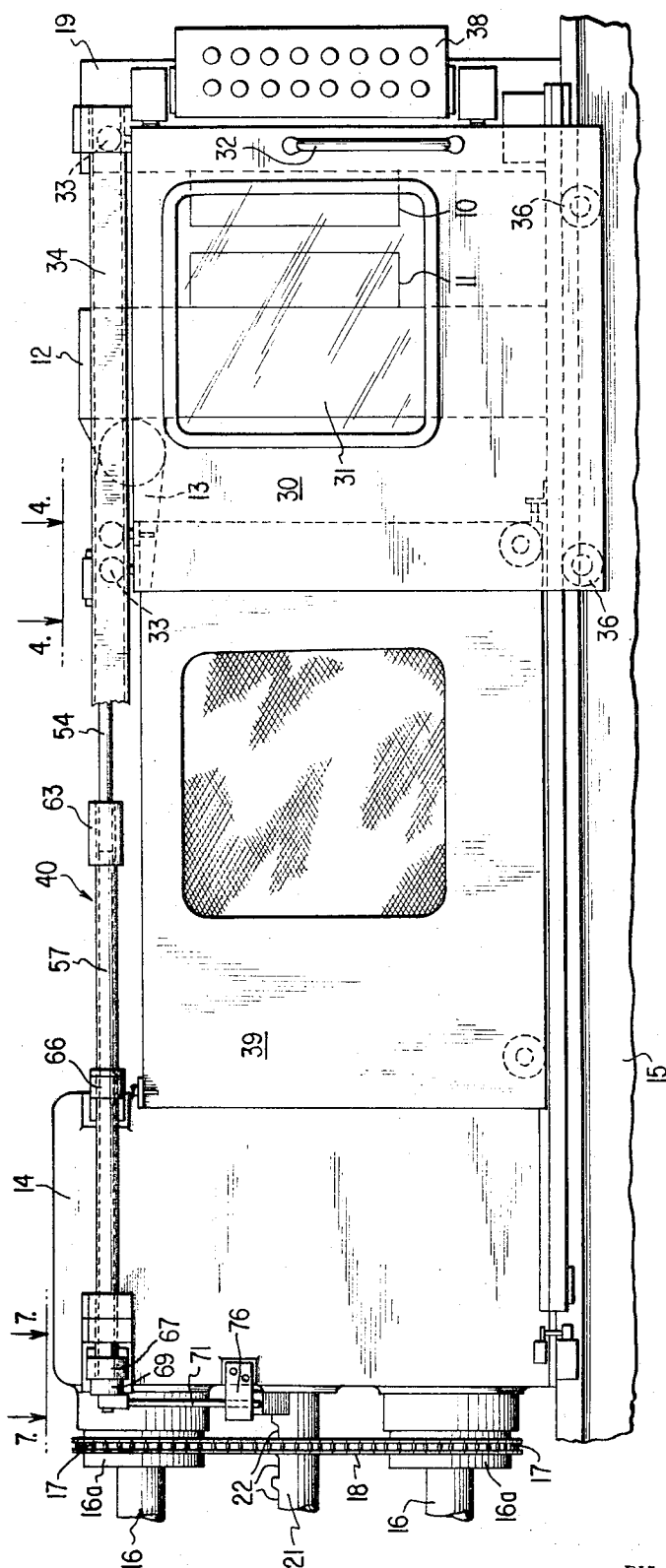


FIG. 1

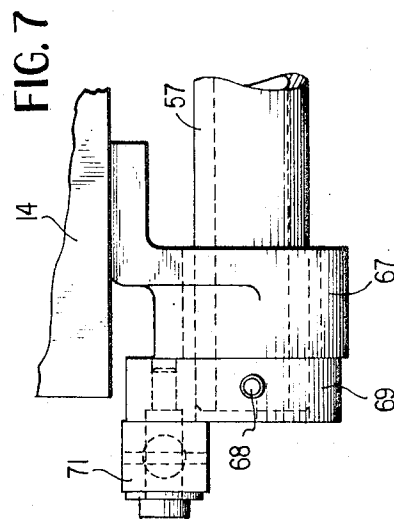


FIG. 7

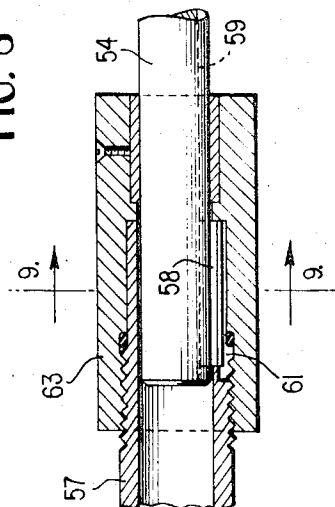


FIG. 8

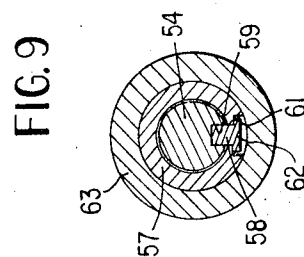


FIG. 9

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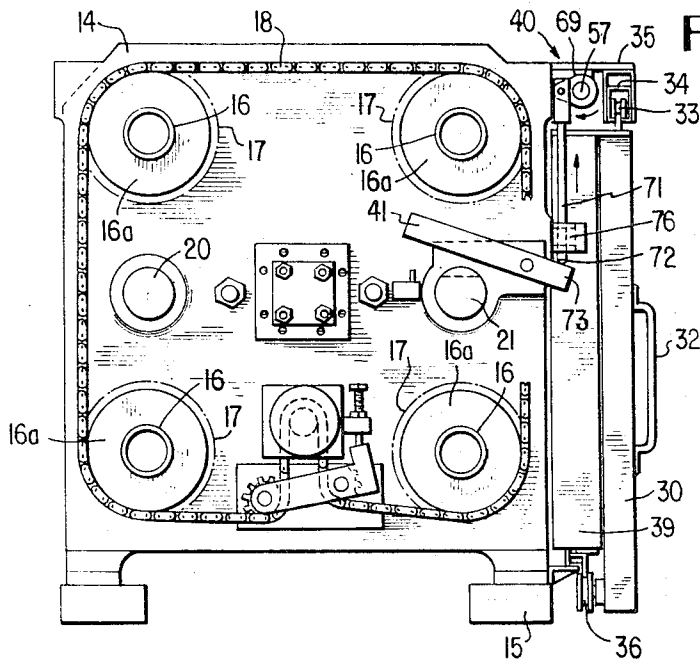


FIG. 2

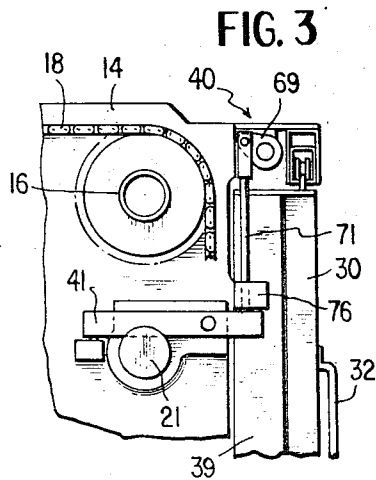


FIG. 3

FIG. 4

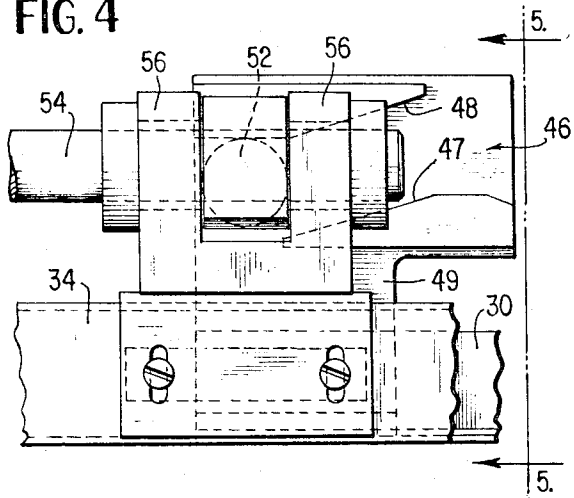
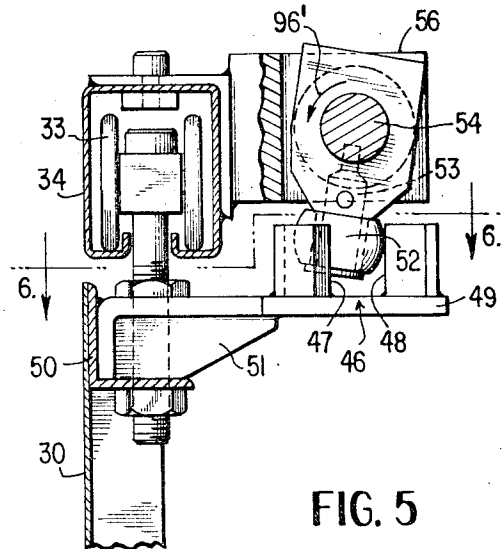


FIG. 5

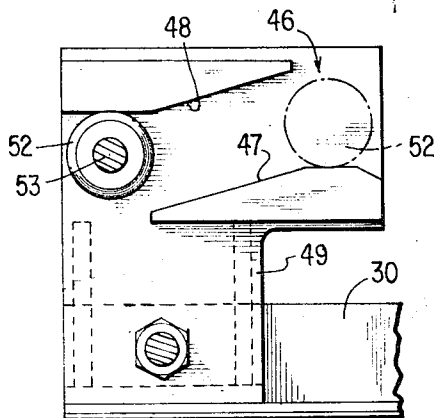


FIG. 6

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FIG. 10

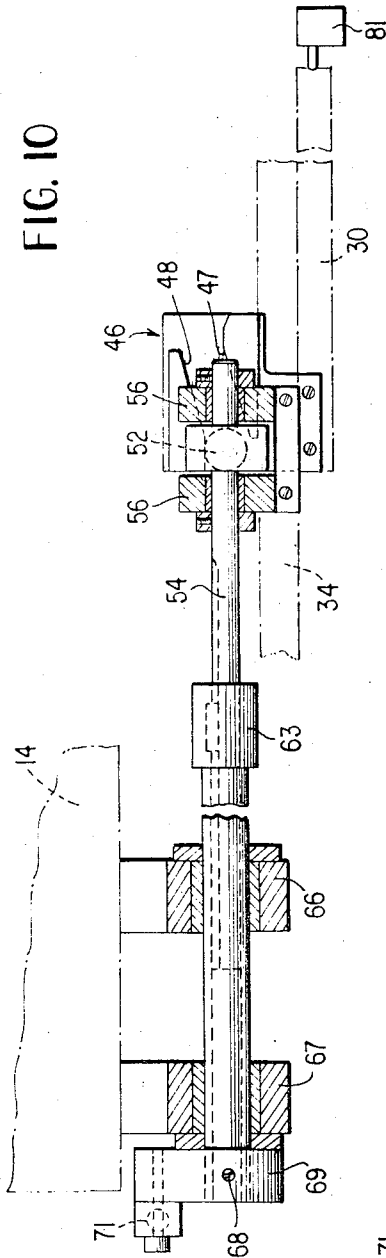
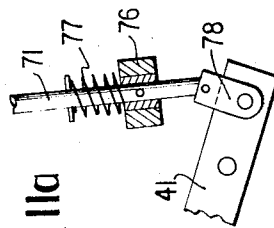
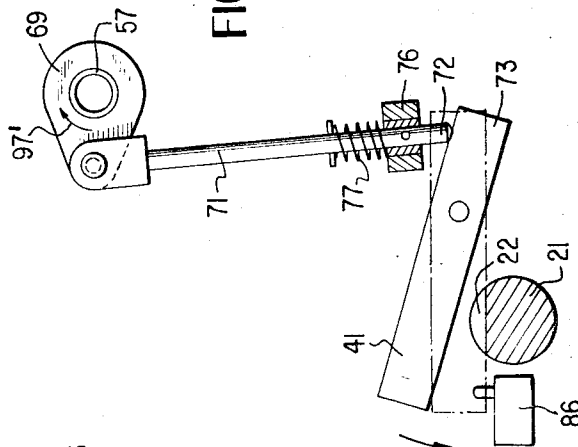


FIG. 11a

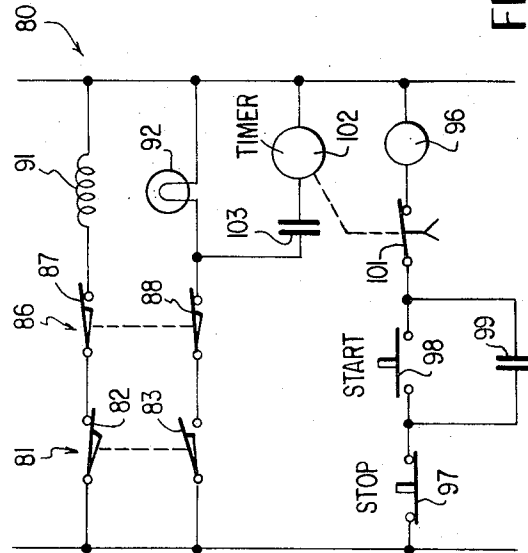
FIG. 11



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FIG. 12



PLASTIC INJECTION MOLDING MACHINE SAFETY MECHANISM

BACKGROUND OF THE INVENTION

This invention relates in general to new and useful improvements in a safety mechanism for a plastic injection molding machine having a safety gate. The purpose of the safety gate is to ensure that an operator does not extend his hand or other portion of his body into the dangerous position between the mold halves whenever the hydraulic pumps and control valves are in condition to close the molds. Since the forces involved are considerable, if an operator's hand or other parts of his body are caught between the molds the injury is necessarily severe. Various safety mechanisms have been devised in the past to ensure that the respective hydraulic control valves are deenergized whenever the safety gate is slightly opened. These normally take the form of limit switches and hydraulic safety valves which sense the exact position of the safety gate and deenergize the respective control valves whenever the gate is opened. While these mechanisms should, in theory, prevent an accident, the switches and valves could become defective or, in some instances, operators tamper with such devices rendering them inoperative in order to save time and increase the output of the machine. Thus, even the machines equipped with such safety limit switches and valves have been known to result in accidents because the switches and valves have been fixed in a position indicating that the safety gate was always closed.

A partial solution to this problem has been achieved by the mechanical safety mechanism disclosed in U. S. Pat. No. 3,386,133 issued on June 4, 1968. In that patent there is disclosed a mechanical linkage connected between the safety gate and a guide rod secured to the movable platen. Whenever the safety gate is slightly opened a pawl is inserted into the notched guide bar to restrain the movable platen against advance. Thus, even if the various limit switches and valves are rendered inoperative by the operator, there is still a physical obstruction to the advance of the movable platen and mold. While the device disclosed in the aforementioned patent has alleviated some of the previously mentioned problems, the instant invention constitutes an improvement thereover.

SUMMARY OF THE INVENTION

In accordance with the invention the plastic injection molding machine includes two mold halves movable relative to each other for opening and closing the mold cavity formed therebetween. One of the mold halves is mounted on a movable platen steadied by one or more guide bars at least one of which has notches or other stop members thereon. A safety gate is movably mounted between the mold mounting space and the operator's position for preventing entrance to the machine whenever the hydraulic systems are in an operative condition. A pawl is engageable with the guide bar for physically preventing the advance of the movable platen. A mechanical linkage is connected between the pawl and the safety gate which includes a torque shaft. Facilities are provided for rotating the torque shaft in response to movement of the gate to control the positioning of the pawl with respect to the guide bar.

In the preferred embodiment the rotatable shaft is formed in two telescopically arranged sections so as to automatically adjust the length of the shaft whenever the height of the molds is changed. Additionally, circuitry is provided for sensing a malfunctioning of the pawl whenever the safety gate is opened, so as to energize an alarm system.

Accordingly, a primary object of this invention is to provide a safety gate mechanism for a plastic injection molding machine which is simpler and more positive acting than those of the prior art.

Another object is to provide a less expensive and more easily maintained safety mechanism.

A further object is to provide a safety mechanism which automatically shortens or lengthens itself whenever the mold height is varied without the necessity of providing a supplemental drive to adjust the mechanical linkage.

It is another object of the invention to provide a mechanical linkage having a rotating torque shaft which is more rigid and rugged in construction than the prior art devices.

A still further object is to provide a safety mechanism which automatically signals a malfunctioning of the mechanical locking device to alert the operator thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial front elevational view of a plastic injection molding machine embodying the present invention and showing the safety gate in the closed position;

FIG. 2 is a partial side elevation view of the machine shown in FIG. 1, as viewed from the left, showing the locking pawl in the disengaged position;

FIG. 3 is a partial view of the machine shown in FIG. 2 illustrating the locking pawl in the engaged position;

FIG. 4 is a partial top view taken along lines 4—4 of FIG. 1 showing the camming mechanism for actuating the pawl;

FIG. 5 is a view taken along line 5—5 of FIG. 4 showing the details of the camming mechanism;

FIG. 6 is a view taken along line 6—6 of FIG. 5 showing the cam follower in solid line when the gate is in the CLOSED position, and showing the cam follower in phantom line when the safety gate is in the OPEN position;

FIG. 7 is a view taken along line 7—7 of FIG. 1 showing the details of construction of one end of the torque shaft;

FIG. 8 is a detailed cross-sectional view of the telescopic joint of the torque shaft, shown in FIG. 1;

FIG. 9 is a view taken along line 9—9 of FIG. 8 showing the key and keyway construction of the telescopic torque shaft;

FIG. 10 is a diagrammatic top view of the mechanical linkage embodying the present invention for engaging and disengaging the pawl in the notched guide bar;

FIG. 11 is a diagrammatic side elevational view of the pawl engaging mechanism, as viewed from the left in FIG. 10;

FIG. 11a shows a modification of the pawl engaging mechanism; and

FIG. 12 is a circuit diagram for detecting a malfunctioning of the safety mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 there is shown in phantom line a conventional stationary mold or die 10 and a movable mold or die 11 for producing plastic injection molded pieceparts. The movable mold 11 is mounted on a reciprocable platen 12 which is actuated by a toggle mechanism 13 (only partially shown), the details of which are well known in the art. (See for example, the New Britain Machine Company catalog, Horizontal and Vertical Reciprocating Screw Injection Molding Machines, Bulletin GB-101-1168 (1968), which is incorporated herein). The toggle mechanism 13 is secured at its other end to a transversely extending, vertically disposed clamp housing 14. The position of clamp housing 14 on the machine base 15 may be adjusted horizontally to accommodate varying mold heights by rotation of four tie bar nuts 16a-16a along threaded tie bars 16-16. Each tie bar nut 16a is provided with a sprocket 17-17 in mesh with an endless sprocket chain 18. Rotation of the chain 18 and sprockets 17-17 moves the clamp housing 14 either to the left or right (as viewed in FIG. 1) depending on the direction of rotation. The stationary mold 10 is mounted on transversely extending, vertically disposed stationary platen 19 which is rigidly connected to the base 15. A pair of guide bars 20 and 21 extend freely through the clamp housing 14 and are connected to and move with the platen 12. One of the guide bars, such as bar 21, is provided with notches, as shown at 22 in FIG. 1.

The movable mold 11 is withdrawn to the left (FIG. 1) by operation of the toggle mechanism 13 after each injection cycle to permit removal of the pieceparts. The movable mold 11 is then urged to the right in order to close the mold cavity in preparation for the next cycle of operation. In order to prevent an operator from inserting his hand or other portion of his body into the space between the mold halves 10 and 11, there is provided a safety gate 30 having a window 31 through which the operator may view the operation of the machine. As is well known, the safety gate provides a physical shield between the movable machine components and the operator. The gate includes a handle 32 by which the gate may be moved back and forth to provide access to the molds. The gate 30 is suspended on suitable rollers 33-33 which ride in complementarily shaped channel or guideway 34 (FIG. 5) secured to a portion of the machine frame as shown at 35 (FIG. 2). Rollers 36-36 provided at the bottom of gate 30 ride against the undersurface of an extension of the machine base 15 to prevent the vertical displacement of the gate. A pushbutton station 38 is mounted adjacent to the stationary platen 19 for controlling various of the operations of the machine. A secondary front safety gate is illustrated at 39, which operates in conjunction with the gate 30 but forms no part of the instant invention.

Whenever the safety gate 30 is moved from its closed position, as shown in FIG. 1, to a slightly open position it is desired to physically restrain or block the advance of the mold 11 toward the stationary mold 10. This is accomplished by a mechanical linkage generally designated 40 which is connected by a camming device at one end to the gate 30 (FIGS. 4 and 5) and connected at the other end to a pawl 41 (FIGS. 2 and 3).

As shown best in FIG. 6, a linear cam pair generally designated by the numeral 46 having two flat obliquely disposed cam surfaces 47 and 48 is secured to and extends laterally from the upper surface of the gate 30. The cam 46 is mounted on a bracket 49 which is bolted at the other end to an angle iron 50 welded to the gate 30 (FIG. 5). Bolts 51 (only one shown) also extend through the angle iron 50 to which the rollers 33-33 are secured.

The camming surfaces 47 and 48 are designed to cooperate with a cam follower having arcuate faces also referred to as a spherical cam follower 52. The cam follower 52 is connected by a pin 53 to a first section of shaft 54, forming part of the mechanical linkage 40. The shaft 54 is supported in suitable bearings 56 for rotational movement as determined by the relative position of the follower 52 and the camming surfaces 47 and 48.

As shown in FIGS. 8 and 9 the shaft 54 is telescopically connected to a second section of shaft 57 by a key 58. The key fits into a keyway 59 formed in the shaft 54 and an opening 61 which is complementary to the head 62 of the key 58. The shaft 57 is threaded into a sleeve 63 which also receives the end of the shaft 54. By reason of the keyed connection between shafts 54 and 57, the rotation applied to shaft 54 is communicated to shaft 57. Also, the telescopic connection between shafts 54 and 57 permits the combined length of the shafts to be adjusted automatically. Thus, if the height of the molds is changed, and the clamp housing 14 is advanced horizontally, either to the left or right (FIG. 1), the linkage 40 immediately compensates for the change without requiring operator attention. It is to be understood that a multiple key or spline shaft could also be used for connecting shafts 54 and 57.

The shaft 57 is supported in a bearing 66 at its mid-section, and supported at its other end in a bearing 67 secured to the clamp housing 14. The extreme end of the shaft 57 is affixed by a pin 68 to a link 69 forming an eccentric drive for a pawl actuating shaft 71 which depends therefrom. The lower end 72 of the shaft 71 engages and end 73 of the pawl 41 when urged in the downward direction (clockwise in FIGS. 2 and 3) so as to disengage the pawl 41 from the notched guide bar 21. When the eccentric drive link 69 is rotated in a clockwise direction to the position shown in FIG. 3 the shaft 71 is raised above the end 73 of the pawl 41, permitting the pawl, by gravity, to pivot in a counter-clockwise direction into engagement with the notched guide bar 21. In this position (FIG. 3) the advance of the movable mold 11 is precluded since the guide bar 21 is connected to the movable platen 12. A suitable pivotable bearing block 76 and a balance spring 77 (FIG. 11) may be provided on the shaft 71 to keep shaft 71 in a raised position against gravitational influence when the gate 30 is opened.

In FIG. 11a there is shown a modification of the pawl engaging mechanism to provide a forced motion linkage. A yoke 78 is pivotally connected between the end 72 of the shaft 71 and the end 73 of the pawl 41. The operation of the mechanism is similar to that described previously, except that in this forced motion linkage the yoke 78 prevents the opening of the gate unless the pawl 41 drops into a notch 22.

The safety of the machine can be further enhanced by the provision of an alarm circuit 80 as shown in FIG. 12. A double pole safety gate limit switch 81 having oppositely acting contacts 82 and 83 is placed in series with a double pole safety pawl limit switch 86, having like acting contacts 87 and 88. The limit switch 81 (FIG. 10) is tripped when the safety gate 30 is in the CLOSED position to the extreme right. The limit switch 86 (FIG. 11) is tripped when the pawl 41 is engaged with the notched guide bar 21. In the condition shown in FIG. 12, limit switch 81 is tripped indicating the gate 30 is CLOSED, and the limit switch 86 is released, indicating the pawl 41 is disengaged. In this state a circuit is completed to a solenoid 91 which controls the hydraulic fluid to actuate the toggle mechanism 13 and the associated movable platen 12. As soon as the safety gate 30 is slightly opened, the limit switch 81 is released thereby interrupting the circuit to the solenoid 91 to prevent movement of the platen 12. Within a fraction of a second after the gate 30 is opened, the pawl 41 should rotate to the position shown in broken lines in FIG. 11 to trip limit switch 86. This opens contact 88 to interrupt the circuit to an alarm light 92 through the contact 83, which was closed when the safety gate 30 was opened. In the event the pawl 41 should fail to engage the notched guide bar 21, and, accordingly, fail to open the contact 88, a circuit is completed to the alarm light 92 to indicate the malfunctioning to the operator. Of course, other types of alarm systems, such as an audible alarm, could be substituted for the light 92.

An additional circuit may be provided to deenergize the main pump motor starter relay 96 controlling the total hydraulic supply to the machine. The relay 96 is connected in series with manually operated START and STOP pushbuttons 97 and 98, respectively. A contact 99 is closed when relay 96 is energized to by-pass the pushbutton 98. The circuit to the relay 96 is completed through a normally closed contact 101 controlled by a time delay relay 102. The relay 102 is energized through a contact 103 which is controlled by the selection of the particular machine mode. If the machine is in the AUTOMATIC mode, the contact 103 is closed to permit a circuit completion to the relay 102 if contacts 83 and 88 are closed. In the MANUAL mode the contact 103 is always open to prevent the completion of a circuit to relay 102. Thus, in the AUTOMATIC mode if the pawl 41 fails to open contact 88, the circuit will be completed to energize relay 102 to start the time count. When the relay 102 times out, the contact 101 opens to interrupt the circuit to motor relay 96, thereby shutting down the entire machine. This forces the operator to manually restart the machine and gives further warning that the safety pawl 41 is not functioning properly.

OPERATION

The operation of the instant safety mechanism will now be described with reference to one cycle of the plastic injection molding machine. Assuming that the previous molded piecepart has been removed from the molds 10 and 11 and the safety gate 30 has been closed so as to trip the limit switch 81, the movable platen 12 and mold 11 are advanced to the right (FIG. 1) by the operation of the toggle mechanism 13. Once the next

piecepart has been molded, the mold 11 may be retracted to the left by the same toggle mechanism 13. If at any time during the molding operation the safety gate 30 is slightly opened, the spherical cam 52 is rotated by the action of the camming surfaces 47 and 48. As shown by the arrow 96' in FIG. 5, the shaft 54 rotates in a counterclockwise direction whenever the safety gate 30 is opened. As viewed in FIG. 11, this causes the shaft 57 to rotate in a clockwise direction, arrow 97', thereby raising the shaft 71 so that it disengages pawl 41 permitting the pawl to drop by gravity into one of the notches 22 in the guide bar 21. In order to free the pawl 41, it may be necessary to place the machine in MANUAL mode and open the toggle mechanism 13.

In the event the safety gate 30 is opened by the pawl 41 fails to drop into the guide bar 21 and thereby close the limit switch 86, the alarm light 92 is energized to indicate this event to the operator. Also, the motor relay 96 is deenergized to shut down the hydraulic pumps. When the gate 30 is moved into the closed position, the coupled shafts 54 and 57 rotate in the opposite direction to disengage the pawl 41 from the guide bar 21. This permits advance of movable mold 11 if all other safety devices are in the proper setting.

It is to be understood that this safety mechanism is not intended to replace the previously known and used electrical and hydraulic interlocks. Instead, it is still one further precautionary device to make an even safer plastic injection molding machine.

It should be apparent from the above description that the instant safety mechanism has numerous advantages over the prior art devices. In the first place, the use of torque shafts 54 and 57 inherently gives more rigidity and ruggedness than an elongated, slender shaft which is reciprocated on its longitudinal axis and susceptible to bending or buckling. On the other hand, the forces on the torque shaft are concentric to the longitudinal axis of the shaft and do not have a tendency to cause a bending moment and subsequent buckling.

Furthermore, the telescopic action of torque shafts 54 and 57 provides an extremely simple and efficient means for varying the length of the mechanical linkage 40 whenever there is a change in the mold height. Thus, if the clamp housing 14 is adjusted horizontally on the threaded support beams 16—16 by rotating the sprockets 17—17, the mechanical linkage 40 will readily lengthen or shorten, depending on the circumstances. Thus, there is no inducement for an operator to disassemble or render inoperative the mechanical safety mechanism because of any requirements on his time whenever there is a change in mold height. Likewise, by reason of the simplified design, there should be less maintenance and less down time required on the overall injection molding machine.

It should be understood that for the sake of convenience, the invention has been described in conjunction with an injection molding machine. This is not intended to limit the scope of the invention, it being apparent that the invention has application to numerous other types of machines having moving parts. Other types of machines on which the invention could be used include, for example, die casting machines, blow molding machines, foam molding machines, vacuum forming machines, briquetting machines, bale-forming

presses and essentially all machines having movable molds and platens which can move at high speeds and with clamp forces that are dangerous to the operating personnel.

Furthermore, it should be apparent that the relative positions of the cam and cam follower could be reversed without affecting the operation of the instant invention. Also, other mechanical connections, such as an arrangement of gears, could be substituted for the cam and cam follower which would rotate the torque shaft and permit the telescopic action between the two sections of the shaft.

As is well known, many injection molding machines have several safety gates, such a front and rear. This invention has been described with respect to the front safety gate, but has application to all the gates on the machine.

It is to be understood that only a preferred embodiment of the invention has been specifically illustrated and described, and that variations may be made thereto without departing from the invention as defined in the appended claims.

We claim:

1. In combination with a plastic injection molding machine having two molds movable relative to each other for opening and closing the mold cavity formed therebetween, one of said molds being mounted on a movable platen supported on at least one guide bar having notches therein, and a safety gate movably mounted in selective blocking relationship between the molds and the operator of the machine, the improvement comprising:

a pawl engageable with one of said notches in the guide bar for selectively preventing the advance of the movable platen;

a mechanical linkage connected between the pawl and the safety gate for engaging the pawl with the bar whenever the gate is slightly opened, said linkage including;

a torque shaft mounted for rotation between first and second angular positions;

means for rotating the torque shaft between said first and second angular positions in response to movement of the gate out of blocking relationship; and

means for engaging and disengaging said pawl when the torque shaft is respectively in said first and second angular positions comprising linkage means engaging said torque shaft at a point spaced apart from the axis thereof for transmitting rotational movement of said torque shaft to said pawl, said linkage means cooperating with said torque shaft and said pawl so that rotation of the torque shaft between said first angular position and said second angular position moves the pawl from said engaged position to said disengaged position.

2. In combination with a plastic injection molding machine having two molds movable relative to each other for opening and closing the mold cavity formed therebetween, one of said molds being mounted on a movable platen supported on at least one guide bar having notches therein, and a safety gate movably mounted between the molds and the operator of the machine, the improvement comprising:

a pawl engageable with the guide bar for preventing the advance of the movable platen;

a mechanical linkage connected between the pawl and the safety gate for engaging the pawl with the bar whenever the gate is slightly opened, said linkage including;

a torque shaft, said torque shaft includes, two telescopic sections for automatically adjusting the length thereof to compensate for a change in the height of said molds; and

means for rotating the torque shaft in response to movement of the gate to control the positioning of said pawl.

3. An apparatus as recited in claim 1, which further comprises:

circuit means responsive to a malfunctioning of said pawl for initiating an alarm and for terminating the power to said movable platen to shut down the machine.

4. An apparatus as recited in claim 1, wherein said means for rotating the torque shaft includes a forced motion linkage so that the safety gate cannot be opened if said pawl does not engage the guide bar.

5. In combination with a plastic injection molding machine having a base and carried thereon a frame, two molds movable relative to each other for opening and closing the mold cavity formed therebetween, one of said molds being mounted on a movable platen supported on at least one guide bar having a notch therein, and a safety gate movably mounted in selective blocking relationship between the molds and the operator of the machine, the improvement comprising:

a pawl engageable with the notch in the guide bar for preventing the advance of said movable platen;

a cam connected to the safety gate; and

a shaft carried for rotation by the frame between first and second angular positions, said shaft having a cam follower fixed on one end and engaging said cam and

a link means engaging the other end of said shaft at a point spaced apart from the axis thereof and said pawl, said link means cooperating with said shaft and said pawl for transmitting rotational movement of said torque shaft to said pawl so that the safety gate upon being moved out of blocking relationship rotating the cam follower and shaft from said first angular position to said second angular position to engage the pawl in the guide bar notch to prevent advance of the movable mold.

6. In combination with a plastic injection molding machine having two molds movable relative to each other for opening and closing the mold cavity formed therebetween, one of said molds being mounted on a movable platen supported on at least one guide bar having notches therein, and a safety gate movably mounted between the molds and the operator of the machine, the improvement comprising:

a pawl engageable with the guide bar for preventing the advance of said movable platen;

a cam connected to the safety gate; and

a rotatable shaft having a cam follower at one end in engagement with said cam and a link at the other end for engagement with said pawl, so that when the safety gate is opened the cam rotates the cam follower and shaft to engage the pawl in the toothed guide bar thereby preventing advance of the movable mold, said rotatable shaft includes:

a first section; and

a second section telescopically received in and keyed to the first section for permitting automatic adjustment of the length of said shaft for use with molds of different heights.

7. A plastic injection molding machine as recited in claim 5 wherein said link means is eccentrically mounted on the shaft for imparting longitudinal movement to the link to raise and lower said pawl, and which further includes, bearing support means for said link means.

8. A plastic injection molding machine as recited in claim 7 wherein said link is connected to the pawl by a yoke creating a forced motion linkage so that the safety

gate cannot be opened unless the pawl engages the guide bar having a notch therein.

9. A plastic injection molding machine as recited in claim 5 which further includes:

circuit means for rendering inoperative said movable platen which further includes:

circuit means for rendering inoperative said movable platen whenever said safety gate is opened; and

alarm means responsive to the opening of the gate for indicating a failure of said pawl to engage the notched guide bar after the gate is opened.

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