July 29, 1941. V. BERTELSEN ET AL 2,250,852

PROTECTIVE DEVICE FOR BLAST FURNACE BELL HOISTS

Filed July 30, 1940 3 Sheets-Sheet 1

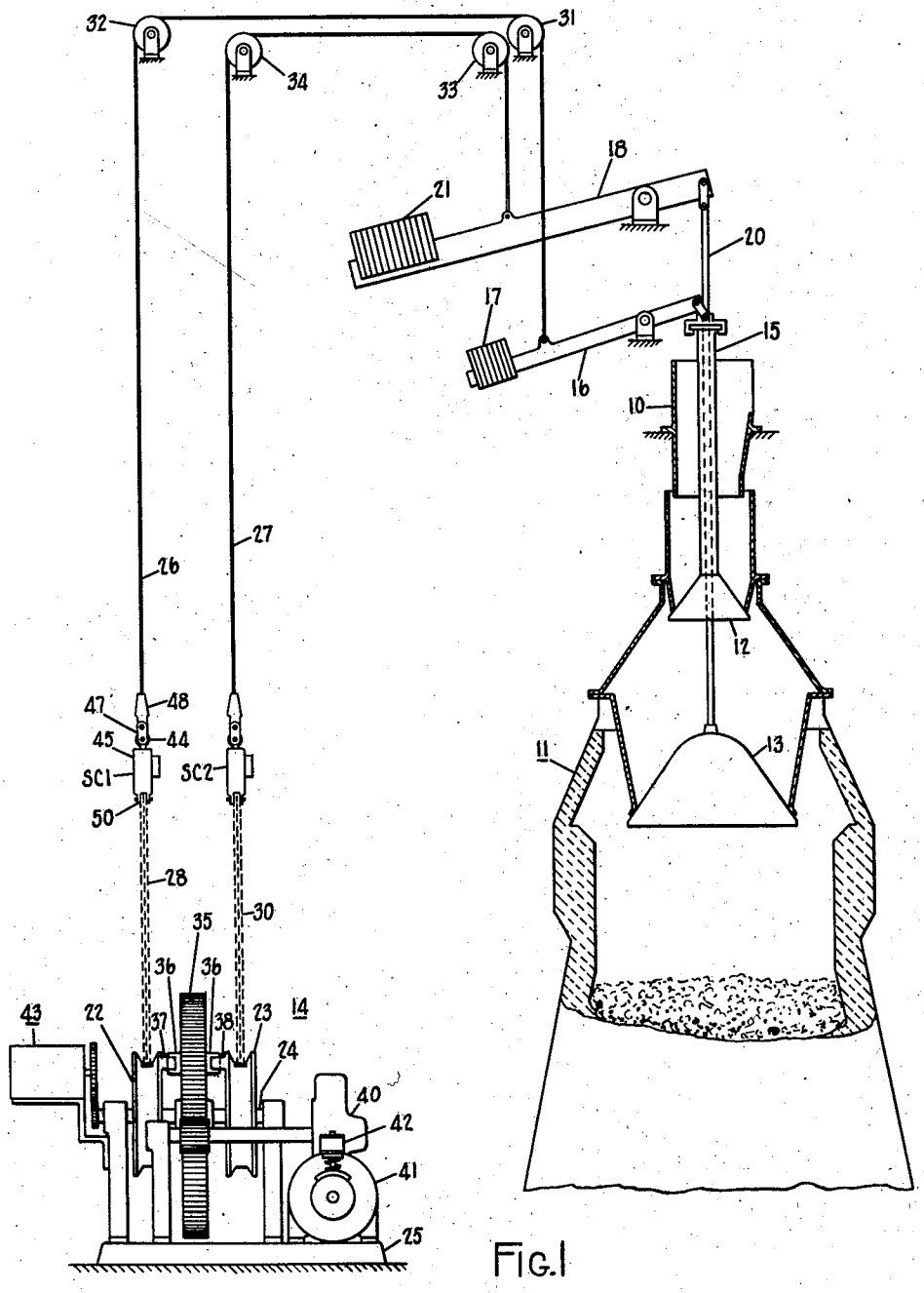


FIG. 1

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PROTECTIVE DEVICE FOR BLAST FURNACE BELL HOISTS

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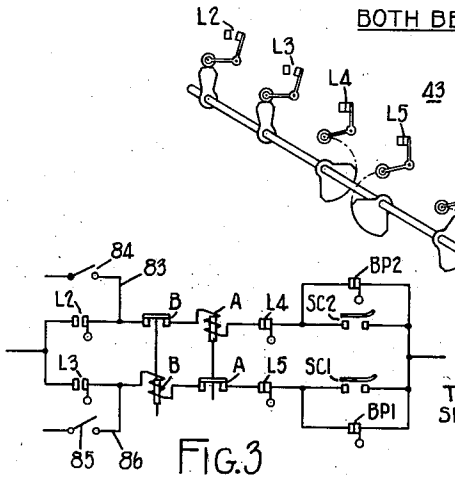


FIG.3

FIG.2

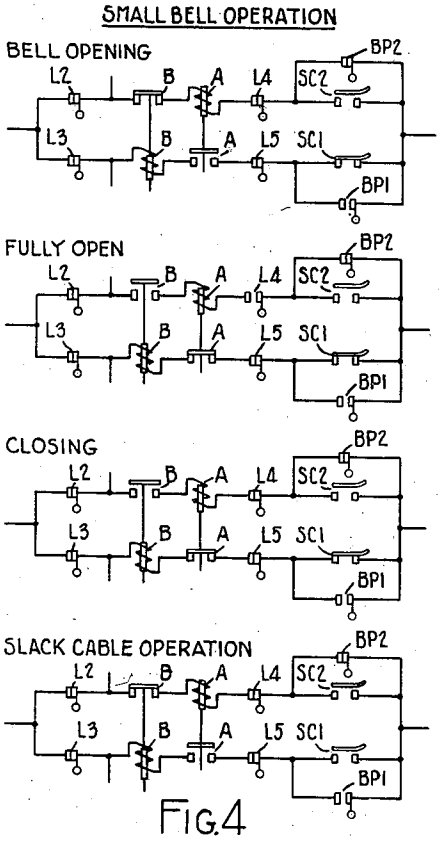


FIG.4

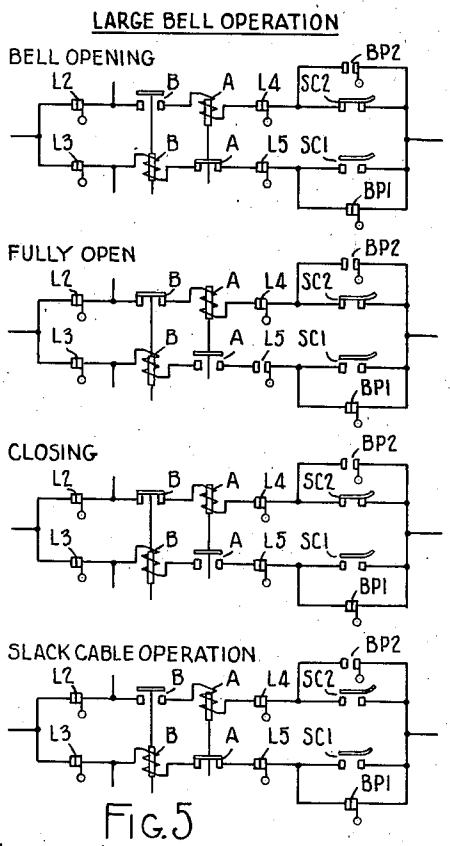


FIG.5

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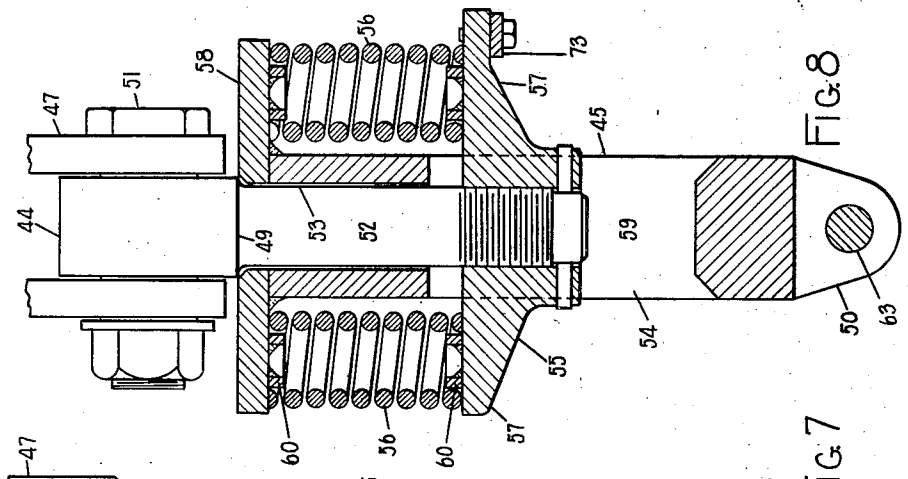


FIG. 8

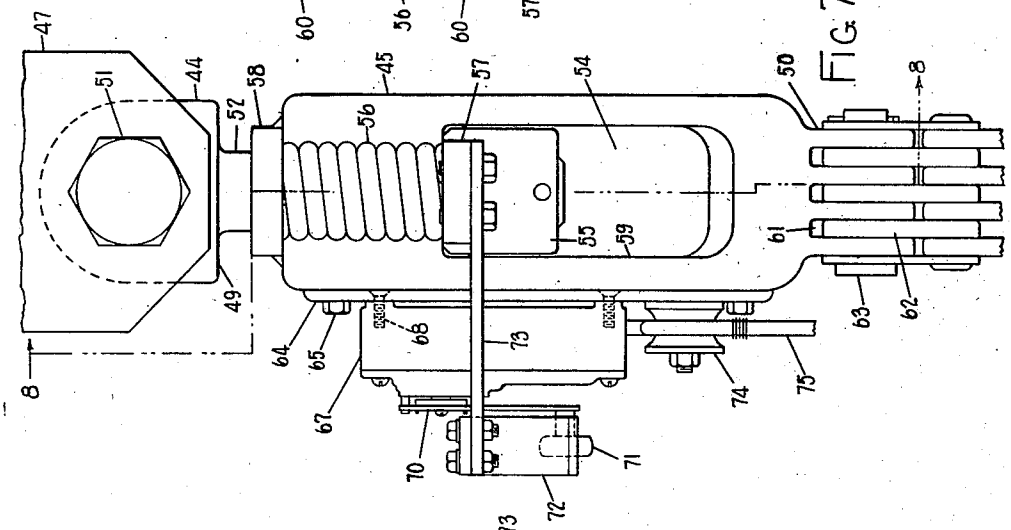


FIG. 7

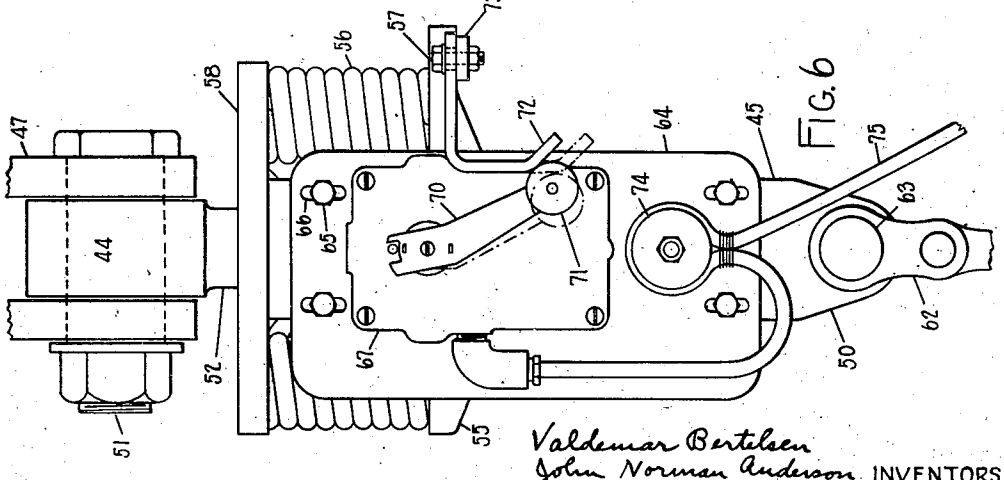


FIG. 6

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UNITED STATES PATENT OFFICE

2,250,852

PROTECTIVE DEVICE FOR BLAST FURNACE BELL HOISTS

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Application July 30, 1940, Serial No. 348,358

5 Claims. (Cl. 214—36)

The present invention relates to protective devices for blast furnace installations, especially in connection with the bell hoists of such installations.

In present day blast furnace installations, both the large bell and the small bell are biased to closed positions by counterweights. The bells are opened by means of hoisting mechanism which is connected to the bells through hoisting ropes so as to open the bells by a lifting of their respective counterweights.

In operation of the furnace, a load is dumped onto the small bell, the bell is lowered by hoisting mechanism to dump the load onto the large bell, and the small bell is then closed. This operation may be repeated several times, depending upon the installation. Thereupon the large bell is opened, the charge dumped into the furnace and the large bell closed.

The object of the invention is to insure the closure of each bell after being opened before further charging operations can take place. This provides a positive seal during regular charging sequence and insures the desired distribution of the charge where revolving tops are used. Also, if a bell were prevented from fully closing by a portion of the charge becoming caught between the bell and the hopper, the apparatus might be damaged upon the charge becoming dislodged and the counterweight slamming the bell to closed position.

One feature of the invention is to cause, in the event of the failure of a bell to fully close, the immediate reopening of the bell and reclosing thereof, repeating this operation until the bell is fully closed.

Another feature of the invention resides in the provision of a slack cable switch for each bell which operates immediately upon any tendency for slack to develop in the hoisting roping for the bell.

Another feature is the provision of a slack cable switch for bell hoist roping which is of sturdy yet simple construction, reliable in operation and economical to manufacture and install.

Other features and advantages will become apparent from the following description and appended claims.

In the drawings:

Figure 1 is a schematic representation of the bells of a blast furnace installation and the hoisting mechanism therefor;

Figure 2 is a schematic representation of the switches, including slack cable switches embodying the invention, for controlling the operation of the bells;

Figures 3, 4 and 5 are wiring diagrams illustrating different conditions of a portion of the control circuits for the operating mechanism for the bells under different conditions of operation.

Figure 6 is a front view of a slack cable switch in accordance with the invention, the biasing springs being shown compressed;

Figure 7 is a side view of the same; and

Figure 8 is a view in section taken along the line 8—8 of Figure 7, but with the springs expanded.

For a general understanding of the invention, reference may be had to Figure 1, wherein the various parts of the bell hoist are indicated by reference characters. The stock for the furnace is carried in skip buckets (not shown) to a hopper 10 at the top of the furnace 11. A load of stock, being dumped into the hopper, falls onto the small bell 12. The small bell is opened to dump the load onto the large bell 13 and the small bell is closed to receive another load. As each skip load is dumped onto the small bell, the cycle of operation is repeated, dumping the load onto the large bell. When a specified number of loads have been dumped onto the large bell, the large bell is opened, dumping the charge into the furnace, and the large bell is closed. The bells are controlled so that each one is closed before the other one is opened, thereby sealing the furnace.

The bells are operated by bell hoisting mechanism 14. Small bell 12 is connected by hollow rod 15 to one end of lever 16. At its opposite end lever 16 carries a counterweight 17 of sufficient mass to counterbalance the weight of the bell and the rod plus the weight of the load of material resting on the bell, and to provide sufficient force to maintain a sealing pressure between the bell and its seat. Large bell 13 is connected to one end of a lever 18 by a rod 20 which extends through hollow rod 15. Lever 18 is likewise provided with a counterweight 21 which counterbalances the weight of the bell and rod as well as the weight of material resting on the bell and provides sufficient sealing pressure between the bell and its seat.

In the hoisting machine for the bells, drums 22 and 23 are loosely mounted upon a shaft 24 supported by bearing pedestals mounted on base 25. The hoisting cables 26 and 27 for the bells are connected to the drums 22 and 23 by chains 28 and 30 respectively. Hoisting cable 26 for small bell 12 is connected to the weighted end

of lever 16, from which it passes over pulleys 31 and 32 and at its other end is connected to chain 28. Hoisting cable 27 for large bell 13 is connected to the weighted end of lever 18, from which it passes over pulleys 33 and 34 and at its other end is connected to chain 30. The lower ends of these chains are connected to the drums to be wound thereon.

A driving gear 35 is keyed to shaft 24. A lug 36 is provided on each side of the gear. A lug 37 is arranged on drum 22 in the path of movement of the lug on the left side of gear 35 so as to be engaged thereby when the gear is rotated to move from neutral in a counterclockwise direction as viewed from the left hand end of the bell hoisting machine. Continued movement of the gear after the engagement of the lugs causes drum 22 to rotate therewith. This winds chain 28 onto the drum, thereby opening the small bell. To close the small bell, the direction of rotation of gear 35 is reversed to allow drum 22 to return to neutral under the influence of weight 17. A similar lug 38 is arranged on drum 23 in the path of movement of the other lug 36 so as to be engaged thereby when gear 35 is rotated from neutral in the opposite direction. Continued rotative movement of the gear after lug 38 is engaged causes rotation of drum 23 to wind chain 30 thereon and thus open large bell 13. In closing bell 13, the direction of rotation of gear 35 is reversed to allow drum 23 to return to neutral under the influence of weight 21.

Driving gear 35 is driven through a train of gears 40 by motor 41 mounted on base 25. An electromechanical brake 42 is provided for bringing the rotating members rapidly to rest when the motor is deenergized. The operation of the motor and brake is controlled by switching mechanism 43 actuated in accordance with the positions of the bells and by certain switches (not shown) actuated in accordance with the positions of the skips. Switching mechanism 43 is illustrated as driven from shaft 24.

A slack cable switch is provided in a connection between the hoisting cable and chain for each bell. The slack cable switch for the small bell is designated SC1 and that for the large bell SC2. Each switch acts, in case any slack tends to develop in the cable before the bell operated thereby is fully closed, to control the operation of motor 41 to cause the bell to immediately reopen. This permits any charge stuck between the bell and the hopper to be released so that the bell may be fully seated upon its being reclosed. As soon as the bell becomes fully opened it is reclosed. The reopening and reclosing operations are repeated if the trouble is not cleared until the bell becomes fully closed. According to the preferred arrangement, each switch is connected to its hoisting rope through an eye bolt 44 slidable in the mounting block 45 and connected through links 47 to a thimble 48 secured to the end of the rope. The mounting block is connected to the chain through lugs 50 formed on the block.

The construction of the preferred form of slack cable switch is illustrated in Figures 6, 7 and 8. The links 47 are connected to eye bolt 44 by bolt 51 extending through apertures in the links and the bolt. A shoulder 49 is formed on the eye bolt. The shank 52 of the eye bolt extends downwardly through an aperture 53 formed in the mounting block 45. An opening 54 is formed in the body of the block into which aperture 53 extends. The sides 59 of this opening form the guide for a crosshead 55 secured to the threaded end of the eye bolt. Compression springs 56 extend between the wings 57 of the crosshead and a plate 58 secured to the top of the block. Spring seats 60 are formed on the plate 58 and crosshead 55 for the springs. The springs maintain the block in position with plate 58 against shoulder 49 as illustrated in Figure 8. The lug 50 on the bottom of the block is milled out to form a plurality of slots 61 to receive the links 62 of the chain. The chain is secured to the lug by a pin 63 extending through apertures in the lug and the links.

A plate 64 is mounted on the front of block 45, being adjustably secured thereto by bolts 65 extending into slots 66 in the plate. This plate carries a switch arranged inside a housing 67 secured as by screws 68 to the plate. An operating lever 70 for this switch is arranged on the outside of the housing and is secured to an operating shaft for the switch which extends through the housing cover. On the end of the lever 70 is an operating roller 71 in position to be engaged by a cam 72 secured to one of the wings of crosshead 55 through a strap 73. A porcelain spool 74 is secured to plate 64 to act as a fastener for the connecting wire 75 for the switch.

With this construction, with the springs 56 compressed as illustrated in Figures 6 and 7, crosshead 55 is held against the block at the top of opening 54 and cam 72 is in raised position to permit operating lever 70 to be swung counterclockwise as viewed in Figure 6 into position in which the switch is closed. However, as soon as any slack develops in the cable, these springs expand, forcing crosshead 55 downwardly, whereupon cam 72, acting through roller 71, forces lever 70 clockwise into position to open the switch.

The slack cable switches are illustrated schematically in Figure 2, which also is a schematic arrangement of the various control switches included in switching mechanism 43 operated by the motor 41. The control switches are operated by cams mounted on a shaft 80 driven from shaft 24 by gears 81 and 82. Switches L2, L3, L4 and L5 are limit switches. Switches BP1 and BP2 are by-pass switches for the slack cable switches. The arrangement of these switches in a portion of the control circuits for the coils of the bell hoist control switches A and B is illustrated in Figure 3.

Upon a skip dumping its load onto the small bell and starting its return to the loading pit, a circuit is completed by way of wire 83 for the coil of switch A, a switch 84 being indicated schematically in wire 83 for completing this circuit. The circuit extends through switch 84, interlock contacts on switch B, coil of switch A, limit switch L4 and by-pass switch BP2. Switch A upon operation completes the circuit for the motor 41 to effect rotation of gear 35 in the direction to open the small bell, switch A also separating its interlock contacts in the circuit for the coil of switch B. As the drum 22 starts to rotate, limit switches L2 and L3 close, limit switch L2 completing a by-pass circuit for switch 84 to maintain switch A operated. During the initial movement, tension in the hoisting roping of the small bell increases, compressing springs 56 until crosshead 55 is brought to a stop against the mounting block at the top of opening 54. This raises cam 72 sufficiently to permit the closure of slack cable switch SC1. Immediately thereafter by-pass switch BP1 opens. This is

the condition of the circuits illustrated in Figure 4 under "Bell opening."

As the small bell reaches open position, limit switch L4 opens, deenergizing the coil of switch A, which drops out to engage its interlock contacts and preferably subject to a time delay of other switching mechanism, not shown, completes a circuit for the coil of switch B as indicated in the circuits of Figure 4 under "Fully open." This circuit is through limit switch L3, the coil of switch B, interlock contacts A, limit switch L5 and slack cable switch SC1. Switch B upon operation completes a circuit for motor 41 to effect rotation thereof in the opposite direction to permit the closure of the small bell by its counterweight. Switch B also opens its interlock contacts in the circuit for the coil of switch A. As the bell starts to close, limit switch L4 closes, this being the condition of the circuits illustrated in Figure 4 under "Closing."

Just before the small bell reaches closed position, assuming no tendency for any slack to develop in the hoisting cable, by-pass switch BP1 closes to by-pass slack cable switch SC1. As soon as the small bell seats, tension decreases in the hoisting roping, permitting springs 56 to expand, thus causing the opening of slack cable switch SC1 by cam 72. Immediately thereafter limit switch L3 opens to deenergize the coil of switch B, which drops out to deenergize motor 41 and apply the brake to bring the mechanism to a stop. This brings the circuits back to the condition illustrated in Figure 3.

The opening and closing of the large bell is effected in a similar manner. After a predetermined number of loads have been dumped onto the large bell, the circuit for the coil of switch B is maintained after the opening of limit switch L3 as the small bell reaches closed position, a switch 85 being indicated schematically in a wire 86 to maintain this circuit. Thus as gear 35 continues its rotative movement through neutral, lug 38 on drum 23 is picked up, causing this drum to start to rotate. This closes limit switches L2 and L3, limit switch L3 maintaining switch B operated. During the initial movement slack cable switch SC2 closes. Immediately thereafter by-pass switch BP2 opens. This causes the condition of the circuits illustrated in Figure 5 under "Bell opening."

As the large bell reaches open position, limit switch L5 opens, deenergizing the coil of switch B, which drops out to engage its interlock contacts and upon the aforementioned time delay completes a circuit through slack cable switch SC2 for the coil of switch A as indicated in Figure 5 under "Fully open." Switch A causes operation of motor 41 in a direction to effect the closure of the large bell by its counterweight and as the large bell starts to close limit switch L5 closes, this being the condition of circuits illustrated in Figure 5 under "Closing."

Just before the large bell reaches closed position, assuming no tendency for slack to develop in the hoisting cable, by-pass switch BP2 closes to by-pass slack cable switch SC2. As soon as the bell seats, tension decreases in the hoisting roping, permitting springs 56 to expand and open slack cable switch SC2. Immediately thereafter limit switch L2 opens to deenergize the coil of switch A, which drops out to deenergize motor 41 and apply the brake to bring the mechanism to a stop, the circuits again being in the condition illustrated in Figure 3.

Should slack tend to develop in the hoisting rope of the small bell before the bell reaches fully closed position, slack cable switch SC1 opens before by-pass switch BP1 recloses, which breaks the circuit for the coil of switch B. This switch drops out and, owing to the fact that limit switch L2 is closed, the interlock contacts of switch B complete a circuit for the coil of switch A through by-pass switch BP2, causing operation of motor 41 to reopen the bell, this being the condition of the circuits illustrated in Figure 4 under "Slack cable operation." After the bell reaches open position, it is again closed and if no slack tends to develop in the hoisting rope before the bell reaches closed position, the circuits reassume the condition illustrated in Figure 3 and the motor is brought to a stop. However, if slack tends to develop again the mechanism operates in a similar manner to reestablish the circuits for the reopening of the bell, and this is repeated until the bell upon a subsequent reclosing operation fully seats itself.

Similarly, in case slack tends to develop in the hoisting rope for the large bell before by-pass switch BP2 recloses, the circuit for the coil of switch A is broken and, owing to the fact that limit switch L3 is closed, the engagement of the interlock contacts of switch A completes a circuit for the coil of switch B through by-pass switch BP1. This is the condition of the circuits illustrated in Figure 5 under "Slack cable operation." This causes the reopening of the large bell and as before the reclosing of the bell after it reaches open position. If no slack tends to develop in the reclosing operation, the circuits reassume the condition of Figure 3 as the bell seats, and the motor is brought to a stop. Otherwise the bell is automatically reopened and reclosed until the bell fully seats in the reclosing operation.

Thus it is seen that if for any reason, as for example a portion of the charge being caught between a bell and its seat during the closing operation of the bell, slack should tend to develop in the hoisting roping for either bell before the closure of the by-pass switch for the slack cable switch in that opening, the bell is automatically reopened and reclosed until the cause of this condition is removed. This insures the desired charging of the furnace, with a positive seal of the furnace during the charging operations, and protects the mechanism against damage. Also, the operation of the slack cable switch as soon as any slack tends to develop insures the reopening of the bell even if only a slight distance from fully closed position and minimizes the amount of slack before the reverse operation takes place, thus eliminating any possibility of damage to the installation in the event that the cause of the slack is removed before the slack is taken up in the reopening of the bell.

Various arrangements may be utilized for operating the bells and various types of motive means may be employed. As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a control system for a blast furnace bell hoist in which each bell is biased to closed position by a counterweight and opened against the

weight of its counterweight by motive means connected to the counterweight by roping, a slack cable switch arranged in the connection between said counterweight and said motive means for causing operation of said motive means to reopen the bell in case slack tends to develop in said roping before the bell becomes fully closed.

2. In a control system for a blast furnace bell hoist in which each bell is biased to closed position by a counterweight and opened against the weight of its counterweight by rotatable means connected to the counterweight by roping and driven by a motor, a slack cable switch arranged in the connection between said counterweight and said rotatable means for causing operation of said motor to reopen the bell in case slack tends to develop in said roping before the bell becomes fully closed, and switching means for rendering said slack cable switch ineffective once the bell becomes fully closed.

3. In a control system for a blast furnace bell hoist in which each bell is biased to closed position by a counterweight and opened against the weight of its counterweight by a drum connected to the counterweight by roping and driven by a motor, a slack cable switch arranged in the connection between said counterweight and said drum and adapted to open in case slack tends to develop in said roping, means responsive to the opening of said switch before the bell becomes fully closed for causing operation of said motor to rotate said drum to reopen said bell, and switching means for by-passing said slack cable switch when the bell becomes fully closed to prevent operation of said switch opening responsive means to effect reopening of said bell upon opening of said slack cable switch after the bell has closed.

4. In a control system for a blast furnace bell hoist in which each bell is biased to closed position by a counterweight and opened against the weight of its counterweight by a drum connected to the counterweight by roping and driven by a motor, a slack cable switch having a pair of contacts and a spring biasing said contacts to switch open position, means connecting said switch in said roping so that, in case slack tends to develop in said roping, said spring effects the opening of said switch, means responsive to the opening of said switch before the bell becomes fully closed for causing operation of said motor to rotate said drum to reopen said bell, and switching means for by-passing said slack cable switch when the bell becomes fully closed to prevent operation of said switch opening responsive means to effect reopening of said bell upon opening of said slack cable switch after the bell has closed.

5. In a control system for a blast furnace bell hoist in which each bell is biased to closed position by a counterweight and opened against the weight of its counterweight by a drum connected to the counterweight by roping and driven by a motor, a slack cable switch having a pair of contacts, an operating lever for said contacts, a cam for operating said lever, and a spring biasing said cam into position to open said switch, means connecting said switch in said roping so that, in case slack tends to develop in said roping, said spring effects the opening of said switch, and means responsive to the opening of said switch before the bell becomes fully closed for causing operation of said motor to rotate said drum to reopen said bell.

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