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P. McSHANE ET AL

BLAST FURNACE BELL HOIST

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2 Sheets-Sheet 1

Fig. 1.

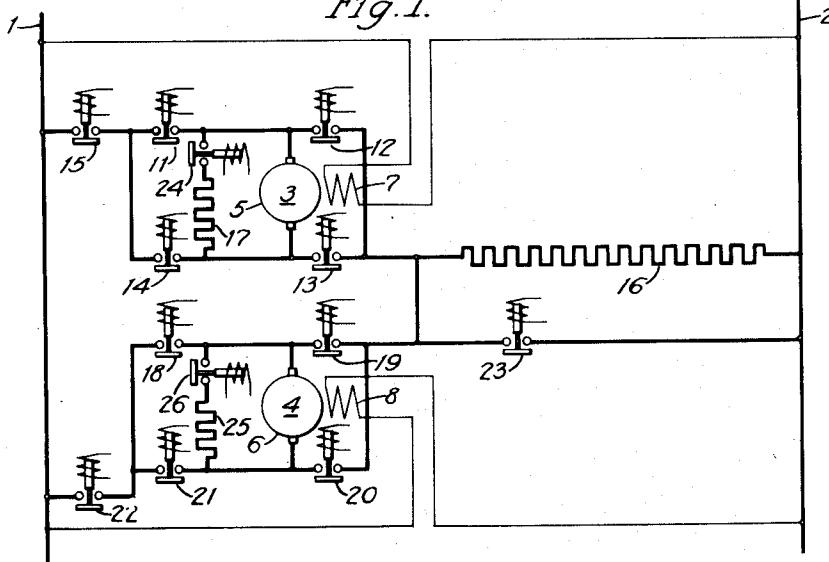
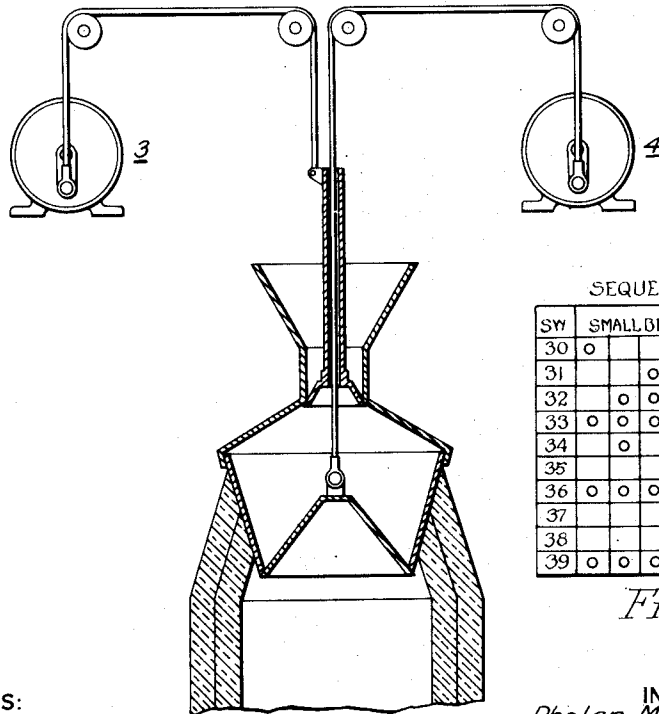


Fig. 3.



SEQUENCE CHART

SY	SMALL BELL	LARGE BELL
30	o	o
31	o	o
32	o	o
33	o	o
34	o	o
35	o	o
36	o	o
37	o	o
38	o	o
39	o	o

Fig. 4

WITNESSES:

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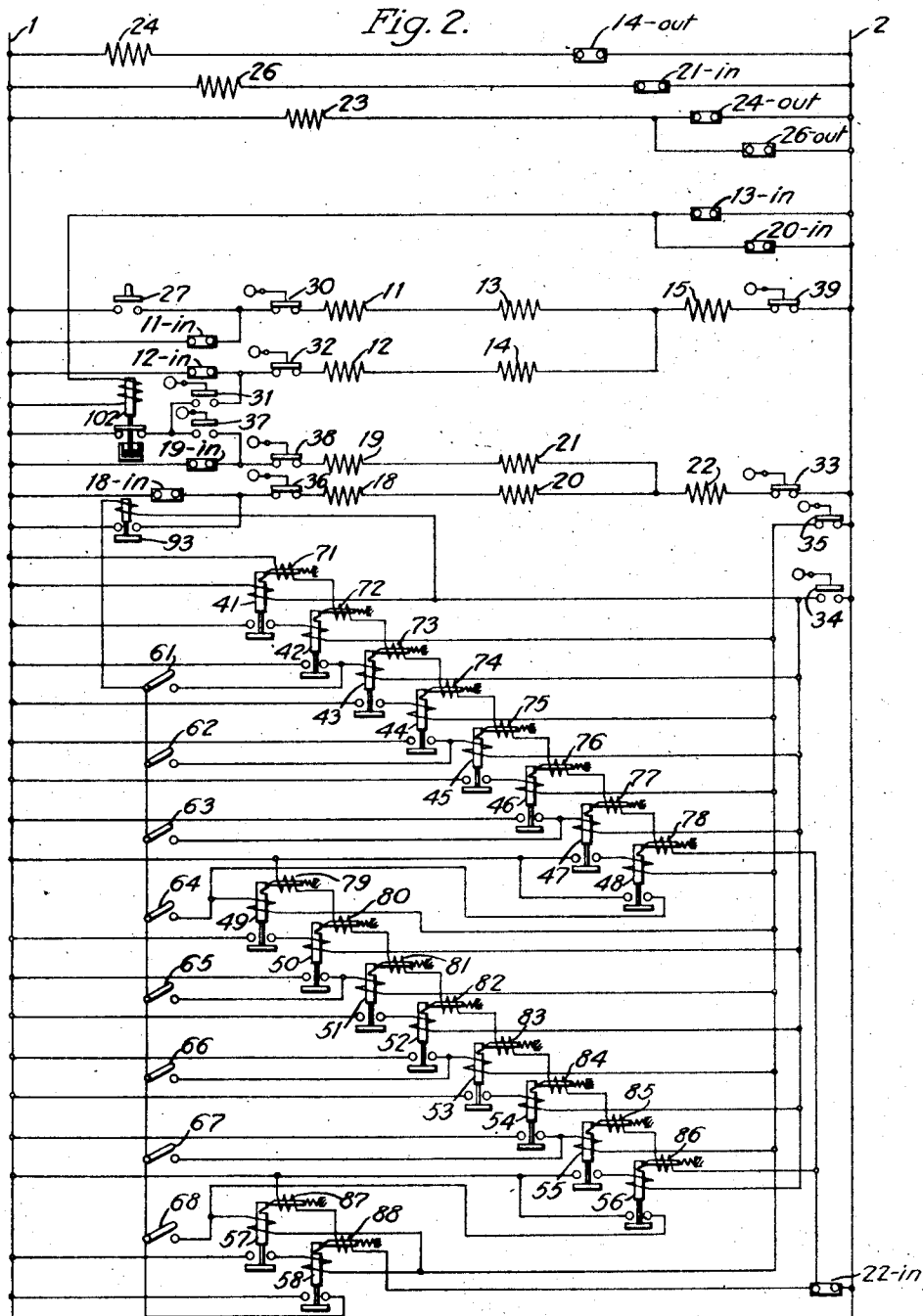
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WITNESSES:

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UNITED STATES PATENT OFFICE.

PHELAN MOSHANE, OF PITTSBURGH, AND FRANK E. LEWIS, OF EAST PITTSBURGH, PENNSYLVANIA, ASSIGNORS TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

BLAST-FURNACE BELL HOIST.

Application filed October 4, 1924. Serial No. 741,676.

Our invention relates to systems of motor control and, particularly, to such systems as embody means for controlling the mechanism for charging blast furnaces.

Our invention has, for one of its objects, to provide a simple means for selectively controlling the sequence of operation of a plurality of electric motors.

A further object of our invention is to provide a simple arrangement for effecting the operation of a plurality of electric motors through a definite cycle.

A blast furnace, as usually constructed, is provided with a charging chamber, located at its top and having openings that are controlled by valve mechanisms, respectively termed small and large bells. The small bell controls the upper opening of the charging chamber, into which coke, limestone, ore or other material may be discharged after it has been carried to this point by a skip hoist or other convenient means. The large bell controls the lower opening of the charging chamber and intermittently opens to admit to the interior of the blast furnace the material that has accumulated in the charging chamber.

In order to prevent the escape of gases while new material is being added to the contents of the furnace, but one of the bells is opened at a time. It is desirable, also, that the small bell be opened several times to admit the loads of the skip hoist into the charging chamber before the large bell is opened to permit the contents of the charging chamber to fall into the blast furnace.

It is an object of the present invention to provide a system that operates automatically to effect the operation of electric motors for controlling the small bell and the large bell of a blast furnace in any desired predetermined order throughout a definite cycle.

In accordance with our invention, we have eliminated certain mechanical devices, commonly termed sequence switches, that have heretofore been employed for predetermining and arranging the cycle of operation. The cycle is repeated automatically upon its completion, the operations of the motor for

controlling the small bell being initiated by the mechanism of the skip hoist or manually, as desired.

Our system will be best understood by reference to the accompanying drawing, in which

Figure 1 is a diagrammatic view of main circuits and apparatus embodying our invention;

Fig. 2 is a diagrammatic representation of the control circuits employed in connection with the system of Fig. 1; and

Fig. 3 is a view, partly in elevation and partly in section, of a portion of the charging mechanism of a blast furnace.

Fig. 4 is a sequence chart indicating the order of operation of various limit switches employed in the system of Fig. 2.

Referring particularly to Fig. 1, line conductors 1 and 2 may be connected to any suitable source of direct-current energy for controlling a plurality of electric motors 3 and 4 having armatures 5 and 6, respectively, and also shunt field-magnet windings 7 and 8. The small bell motor 3 is provided with reversing switches 11, 12, 13 and 14, of a familiar character, together with a line switch 15. Resistors 16 and 17 are, respectively, the usual series and dynamic braking resistors for controlling the motor. The large bell motor 4 is provided with reversing switches 18, 19, 20 and 21, together with a line switch 22, and the armature 6 is connected in such manner as to employ resistor 16 as a starting resistor when the small bell motor 3 is inoperative. A dynamic braking contactor 24 is provided for controlling resistor 17, and an accelerating contactor 23 is provided for resistor 16. Similarly, a dynamic braking resistor 25 and a contactor 26 therefor are furnished to control motor 4.

In Fig. 2, we have, for convenience, designated the operating coils of certain of the switches illustrated in Fig. 1 with the reference characters that have been assigned to these switches. A push-button 27 provides manually-operable means for initiating the operation of the system. This device may, if preferred, be operated mechanically by the skip hoist. A plurality of me-

chanically-operated limit switches 30 to 39, inclusive, are arranged to be operated in a familiar manner, for purposes to be hereinafter set forth. We have provided a plurality of sequence relays 41 to 58, inclusive, that are arranged to operate in a predetermined cycle to control the bell motors. The operation of these relays is predetermined by the closure of any one of a plurality of single-pole knife switches 61 to 68, inclusive. These relays are also arranged to be self-holding, mechanically, after the manner of a circuit breaker, and to be electrically released or tripped by means of shunt operating coils 71 to 88, inclusive. The number of sequence relays and knife switches employed, of course, depends upon the maximum number of small bell operations required prior to an operation of the large bell.

The operation of the large bell motor 4 is initiated after a predetermined number of operations of the small bell motor 3 by means of a starting relay 93.

Assuming the apparatus in its illustrated and inoperative condition, the small bell motor is started by the closure of the manually operable switch 27, thereby effecting the closure of reversing contactors 11 and 13 and line contactor 15. The small bell motor is thereby started with resistors 16 and 17 in circuit with armature 5, and the small bell is, consequently, lowered slowly. The small bell, near the end of its opening motion, opens limit switch 30 and momentarily closes limit switch 34. Switch 30 interrupts the control circuit to release the reversing and line switches to stop the motor. Limit switch 34 closes a circuit for energizing sequence relay 41, which latches itself in. At the fully open position of the small bell, limit switch 31 is closed to energize and close switches 12, 14 and 15, for initiating the reverse direction of operation of the small bell motor. The closure of these switches may be delayed for any desired time interval by means of a suitable time-element relay 102, which is controlled by an interlock "13-in" on reversing contactor 13. The small bell motor operates at high speed in the closing direction, the circuit of the dynamic braking contactor 24 being opened by an interlock "14-out" on reversing contactor 14, whereupon resistor 16 is automatically excluded from circuit, by the closure of contactor 23, to accelerate the motor 3 in a familiar manner. Near the end of its closing movement, limit switch 32 is opened by the small bell and limit switch 35 is momentarily closed. Limit switch 32 effects the interruption of the motor circuit while limit switch 35 effects the energization of sequence relay 42, which latches itself in closed position.

This cycle of operation is repeated for

each trip of the skip hoist, each operation closing the next successive sequence relay, until the desired number of trips has been made.

It was thought advisable to guard against overloading the large bell in the event of a failure in voltage. Therefore, a type of sequence relay is employed which, when momentarily energized, locks itself in position mechanically and is released by means of an auxiliary coil. The number of operations of the small bell prior to a single operation of the large bell is controlled by knife switches 61 to 68. Only one of these switches is closed to establish a predetermined sequence of operation. For example, to provide for six operations of the small bell, knife switch 66 is closed. The small bell, during its operation, alternately closes limit switches 34 and 35, successively latching in relays 41 to 52, inclusive.

It will be noted that relay 51 operates on the sixth opening motion of the small bell and 52 on the sixth closing motion. Upon the closure of relay 52, a circuit is established for the operating coil of relay 93, the closure of which establishes a circuit for the operating coils of reversing and line contactors 18, 20 and 22, respectively, of the large bell motor 4. Limit switch 33 which opens and closes with each operation of the small bell, closes when the small bell is seated and, until such time, the starting of the large bell motor is prevented.

The large bell motor circuit is interrupted upon the opening of limit switch 36, in the open position of the bell, and its closing movement is effected by momentary closure of limit switch 37, which energizes reversing switches 19 and 21. Limit switch 38 insures the stopping of the motor when the large bell is seated. An interlock, "22-in" actuated by the closure of line contactor 22, resets all the sequence relays as soon as the large bell starts to open. The small bell is then in condition to start a new cycle of operation.

Modifications of our invention will naturally occur to those skilled in the art, and we do not desire to be limited specifically to the system nor to its application exactly as described.

We claim as our invention:

1. The combination with a motor and controlling means therefor, of a plurality of successively operable relays for predetermining a corresponding number of operations of said motor in a forward and in a reverse direction, alternately, a second motor, and means controlled by the last of said relays to operate for controlling the second motor.

2. The combination with a motor and controlling means therefor, of a plurality of successively operable relays for predeter-

5 lays to operate for initiating the operation of the second motor.

10 ing a corresponding number of operations of
said motor in a forward and in a reverse di-
rection, alternately, a second motor, and
means controlled by the last of said relays
to operate for effecting a forward and a re-
15 verse operation of the second motor.

20 tions of said motor in a forward and in a reverse direction, alternately, means for controlling the operation of said relays, a second motor, and means controlled by the last of said relays to operate for controlling the
25 second motor.

20 motor in a forward and in a reverse direc-
tion, alternately, means for controlling the
operation of said relays, a second motor, and
means controlled by the last of said relays to
operate for initiating the operation of the
30 second motor.

of said motor in a forward and in a reverse direction, alternately, means for controlling the operation of said relays, a second motor and means controlled by the last of said relays to operate for effecting a forward and a reverse operation of the second motor.

30) of said motor in a forward and in a reverse direction, alternately, a second motor, and an electroresponsive means controlled by the last of said relays to operate for controlling the second motor.

(b) said motor in a forward and in a reverse direction; alternately, a second motor, and electroresponsive means controlled by the last of said relays to operate for initiating the operation of the second motor.

9. The combination with a motor and con
65 trolling means therefor, of a plurality of

troresponsive means controlled by the last of 70
said relays to operate for effecting a forward
and a reverse operation of the second motor.

successively operable relays for predetermining a corresponding number of operations of said motor in a forward and in a reverse direction, alternately, means for controlling the operation of said relays, a second motor, and electroresponsive means controlled by the last of said relays to operate for controlling the second motor.

successively operable relays for predetermining a corresponding number of operations of said motor in a forward and in a reverse direction, alternately, a second motor, means controlled by the last of said relays to operate for controlling the second motor, and electroresponsive means for restoring said relays when said second motor is started.

successively operable relays for predetermining a corresponding number of operations of said motor in a forward and in a reverse direction, alternately, a second motor, means controlled by the last of said relays to operate for initiating the operation of the second motor, and electroresponsive means for restoring said relays when said second motor is started.

controlling means therefor, of a plurality of successively operable relays for predetermining a corresponding number of operations of said motor in a forward and a reverse direction, alternately, a second motor, means controlled by the last of said relays to operate for effecting a forward and a reverse operation of the second motor, and electroresponsive means for restoring said relays when said second motor is started.

14. The combination with a motor and controlling means therefor, of a plurality of successively operable relays for predetermining a corresponding number of operations of said motor in a forward and in a reverse direction, alternately, means for controlling the operation of said relays, a second motor, means controlled by the last of said relays to operate for controlling the second motor, and electroresponsive means for restoring said relays when said second motor is started.

15. The combination with a motor and controlling means therefor, of a plurality of successively operable relays for predetermining a corresponding number of operations of

troresponsive means for restoring said re- 65
lays when said second motor is started.

21. The combination with a motor and controlling means therefor, of electroresponsive means for predetermining a corresponding number of operations of said motor in a forward and in a reverse direction, alternately, a second motor, and means controlled by said electroresponsive means for controlling the second motor.

22. The combination with a motor and 75
controlling means therefor, of electrorespon-
sive means for predetermining a correspond-
ing number of operations of said motor in
a forward and in a reverse direction, alter-
nately, a second motor, and means controlled 80
by said electroresponsive means for initiat-
ing the operation of the second motor.

23. The combination with a motor and controlling means therefor, of electroresponsive means for predetermining a corresponding number of operations of said motor in a forward and in a reverse direction, alternately, a second motor, and means controlled by said electroresponsive means for effecting a forward and a reverse operation of the second motor.

24. The combination with a motor and controlling means therefor, of a plurality of successively operable relays for predetermining a corresponding number of operations of said motor, a second motor, and means controlled by the last of said relays to operate for controlling the second motor.

25. The combination with a motor and controlling means therefor, of a plurality of successively operable relays for predetermining a corresponding number of operations of said motor, a second motor, and means controlled by the last of said relays to operate for initiating the operation of the second motor.

27. The combination with a motor and controlling means therefor, of a plurality of successively operable relays for predetermining a corresponding number of operations of said motor in a forward and in a reverse direction, alternately, selector switches for controlling the operation of said relays, a second motor, and means controlled by the last of said relays to operate for initiating the operation of the second motor.

28. The combination with a motor and controlling means therefor, of a plurality of

successively operable relays for predetermin-
ing a corresponding number of operations
of said motor in a forward and in a reverse
direction, alternately, selector switches for
5 controlling the operation of said relays, a
second motor, and means controlled by the
last of said relays to operate for effecting
a forward and a reverse operation of the
second motor.
In testimony whereof, we have hereunto 10
subscribed our names this first day of Octo-
ber, 1924.

PHELAN McSHANE.
FRANK E. LEWIS.