

June 26, 1923.

1,459,984

A. C. NELSON

FURNACE CHARGING APPARATUS

Filed Dec. 4, 1920

4 Sheets-Sheet 1

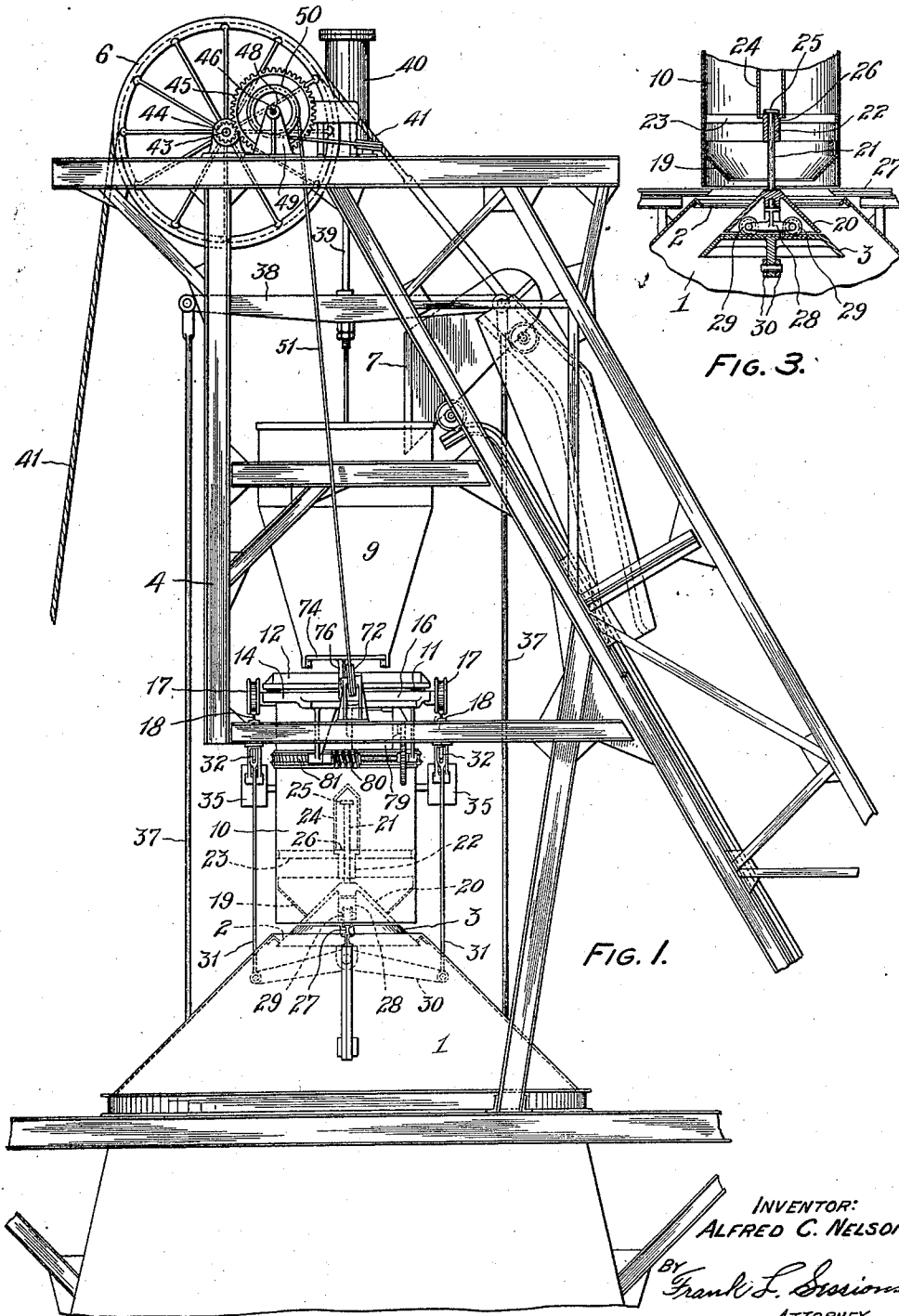


FIG. 3.

FIG. 1.

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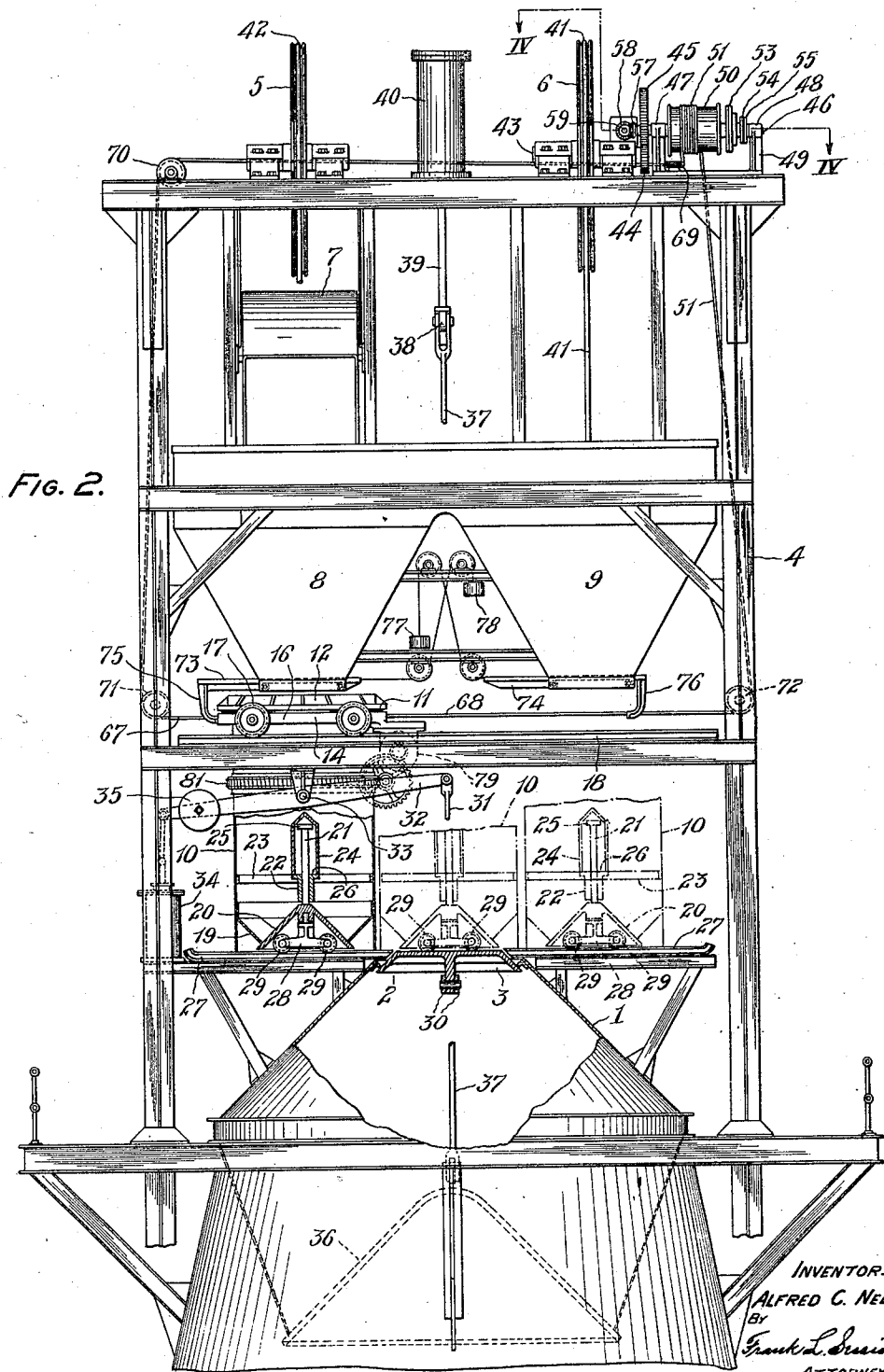
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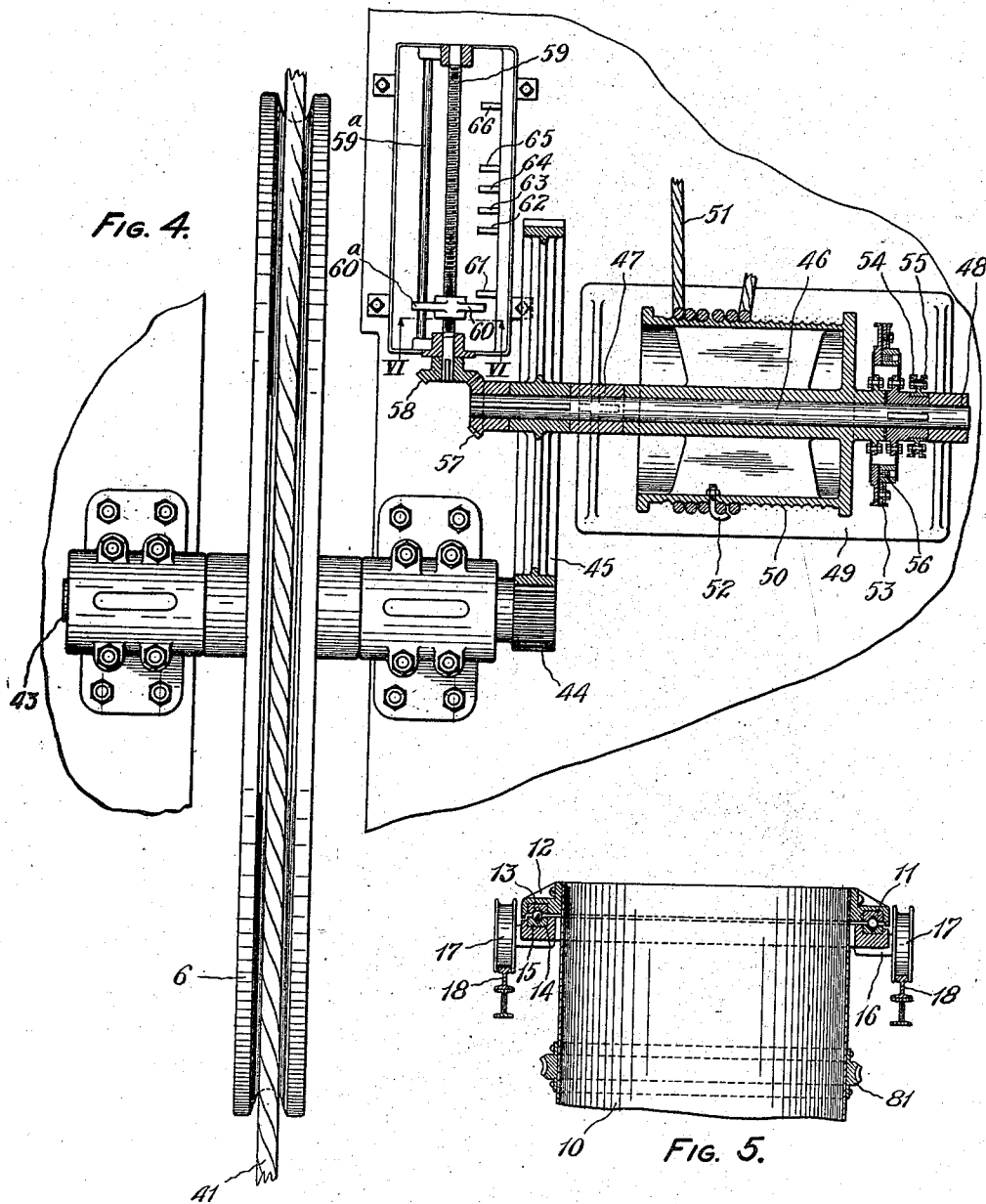


FIG. 5.

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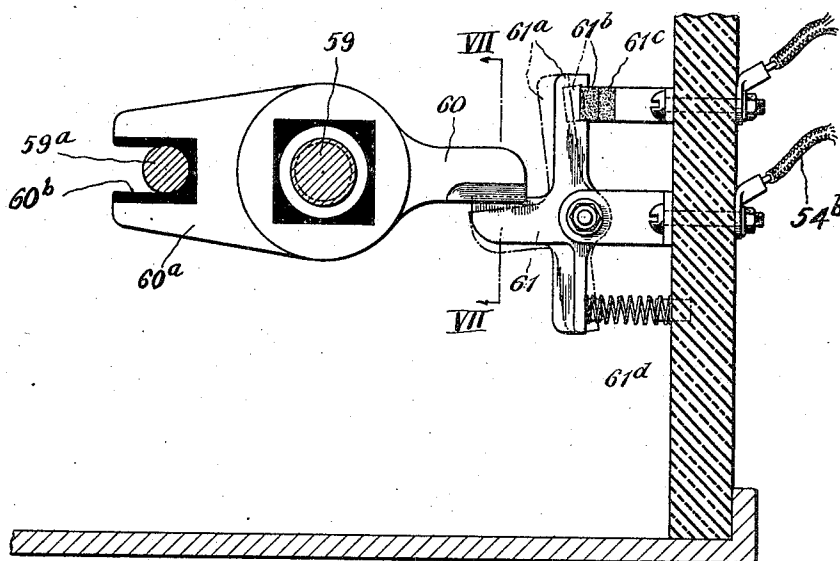


FIG. 6.

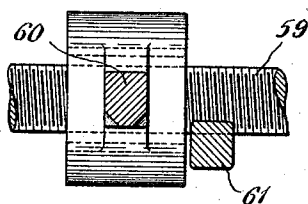


FIG. 7.

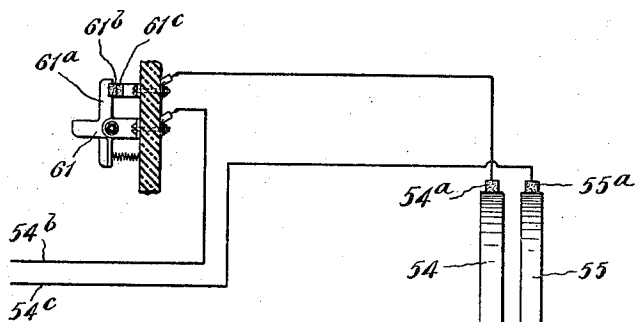


FIG. 8.

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UNITED STATES PATENT OFFICE.

ALFRED C. NELSON, OF LAKEWOOD, OHIO, ASSIGNOR TO THE WILLIAM B. POLLOCK COMPANY, OF YOUNGSTOWN, OHIO, A CORPORATION OF OHIO.

FURNACE-CHARGING APPARATUS.

Application filed December 4, 1920. Serial No. 428,247.

To all whom it may concern:

Be it known that I, ALFRED C. NELSON, a citizen of the United States, residing at Lakewood, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Furnace-Charging Apparatus, of which the following is a specification.

This invention is applicable to blast furnaces or other combustion furnaces into which material such as fuel, ore and fluxes are charged through an opening at the top of the furnace.

In the charging of furnaces of the character mentioned, it is common practice to hoist the materials to the top by means of skips, the contents of which are automatically dumped into a guiding hopper which guides the material into a receiving hopper from which it is discharged into the main hopper which is capable of holding several skip loads or a "round" of material. Finally the material is discharged from the main hopper into the furnace. The materials, such as coal, coke, ore, limestone, etc., which are thus discharged into the furnace, being granular and of different grades of coarseness, or made up of what is known in the art as "lumps and fines," arrange themselves in the furnace in positions dependent upon the positions that they occupied in the receiving hopper previous to being discharged into the main hopper.

It has been found that the most satisfactory results are obtained when most of the "lumps" lie in the center of the furnace and most of the "fines" lie next to the walls. This arrangement of the materials seems to give the best conditions for their combustion and reduction. If the draft through the furnace be obstructed on account of the uneven distribution of the coarse and fine materials (it will be understood that closely packed fine materials offer greater resistance to the passage of gas than do coarse materials), so that the draft is deflected against the walls of the furnace at one point more than another, the furnace lining is attacked at that point and is burned away sooner than at other points. This results in poor economy of operation and necessitates frequent relining of the furnace. When the draft passes uniformly straight through the furnace and is not deflected against the walls at

any one point more than another, the burning away or erosion of the walls is uniform over their entire surface, the operation of the furnace is the most efficient and repairs to the lining are a minimum.

In order to provide for the proper and even distribution of the coarse and fine materials various methods and means have been employed in charging blast furnaces. In some instances rotary receiving hoppers are employed in which the receiving hopper is rotated a portion of a revolution between skip loads so that the materials are evenly distributed in the receiving hopper before being discharged into the main hopper. In other types of charging mechanisms deflecting blades are employed for effecting the desired distribution of the materials, either in the receiving hopper or as they pass from the receiving hopper into the main hopper. The principal necessity for the employment of some sort of distributing device arises from the fact that the skips discharge their loads into the guiding hopper from one side of the top thereof always in the same direction so that a natural, one sided separation of the coarse and fine materials takes place as the skip load chutes into the guiding hopper, resulting, unless some form of distributing device is used, in a more or less regular but undesirable and unbalanced distribution of materials in the furnace.

In present constructions, where two skips are employed, side by side, for charging a furnace, separate tracks for each skip are necessary which tracks must be spaced a sufficient distance apart to provide for passing clearance between the ascending and descending skips. This necessitates the use of a guiding hopper of sufficient width or diameter to receive the contents of the skips arriving at the top on either track.

Among the objects of my invention are the provision of means for discharging the materials from the skip through the guiding hopper so that the coarse and fine materials will always assume substantially the same relative positions in the receiving hopper; the provision of a traveling car or receptacle, adapted to be traversed back and forth between the discharging positions of the two skips of a double skip charging apparatus and to receive the contents of each skip as it comes to the top and is discharged; the pro-

vision of stationary guiding hoppers above the path of the traveling car adapted to receive the contents of the skips as they are dumped and to deliver it downward directly into the center of the traveling car or receiving hopper; the provision of means for automatically traversing the traveling car between the stationary guiding hoppers and so timing the movement of the traveling car that it will receive the contents of each skip as it is discharged; the provision of means for rotating the traveling receiving hopper; the provision of means for traversing the receiving hopper over the top of the main hopper of the furnace; and the provision of means for discharging the contents of the traveling receiving hopper into the main hopper of the furnace.

These and other objects of my invention are accomplished by use of the mechanism described in this specification and shown in the accompanying drawings in which:—

Fig. 1 is an elevation of the top of a blast furnace equipped with my furnace charging mechanism;

Fig. 2 is a side elevation, partly in section, of the apparatus shown in Fig. 1;

Fig. 3 is a fragmentary vertical section through the main hopper and traveling car showing the sealing bells open for discharging the contents of the traveling car into the main hopper;

Fig. 4 is a view, partly in section on line IV—IV of Fig. 2, showing the means I prefer to employ for controlling the rotating and traversing movements of the traveling car so that it will be in position to receive the contents of the skip and will then be rotated to the desired angular position before discharging it into the main hopper.

Fig. 5 is a fragmentary vertical axial section through the top of the traveling car.

Fig. 6 is a fragmentary portion of a cross section drawn to an enlarged scale through the electric circuit controlling device, the section being taken on line VI—VI of Fig. 4.

Fig. 7 is a section on line VII—VII of Fig. 6.

Fig. 8 is a diagram of the electrical connections of one of the controlling circuits.

Referring to the drawings, 1 represents the top of a blast furnace, having the usual charging opening, 2, which is closed by the sealing bell, 3. A frame work, 4, of suitable construction is provided for supporting the charging mechanism. In the drawings there is shown a double skip charging apparatus in which the skip-hoist rope-sheaves are shown at 5 and 6. One of the skips is shown at 7 in position for discharging its contents into the stationary guiding hopper, 8. The other stationary guiding hopper which is adapted to receive and guide the contents of the other skip into the traveling receiving hopper is shown at 9.

I prefer to make the body of the traveling car, or receptacle, 10, in the form of a vertical cylinder and to support it upon an annular ball or roller bearing, 11, near its upper end so that the body of the car may rotate about its vertical axis. In Fig. 5, bearing, 11, is shown in cross section as a thrust ball bearing. An annular ring, 12, secured to the car body, 10, carries the upper ball race, 13, while a corresponding annular ring, 14, supports the lower ball race, 15. The annular ring, 14, is carried by or forms a part of the frame, 16, of a wheeled truck, the wheels, 17, of which are supported by and run upon rails, 18, which are secured to and supported by the frame work, 4. The car body, 10, has a hopper bottom, 19, having a central discharge opening having a bell closure, 20. The bell, 20, is guided in limited vertical movements by means of a rod, 21, secured to the bell and mounted for vertical sliding movement in the hub, 22, of a spoked ring, 23, which may be secured to the inner wall of the car body, 10. A protecting hood, 24, is provided for the rod, 21. A shouldered head, 25, upon the rod, 21, is adapted to rest upon the shoulder, 26, of the hub, 23, and support the bell, 20, in its open position. Rail sections (preferably monorail), 27, are supported upon the frame work, 4, below the bottom and in line with the path of movement of car, 10. The bell, 20, is supported and held closed by resting upon a swivel truck, 28, having wheels, 29, adapted to run upon the rail sections, 27, and upon the top of the bell, 3. The rail sections, 27, are, preferably, slightly inclined upwardly away from the bell, 3, so that the weight of car, 10, will be to some extent, supported by bell, 20, while receiving the load from a skip. This insures a tight closure of bell, 20, to prevent the fine materials from escaping through the bell joint at this time. As the car travels to the center of the furnace the wheels, 29, will roll upon the bell, 3, and the weight of bell, 20, together with the weight of the materials in the car supported by bell, 20, will be imposed upon bell, 3. Bell, 3, which is the closure for the top charging-opening of the furnace is at this point the sole means for holding closed bell, 20, which is the closure for the bottom-opening of car, 10. Bell, 3, is supported by an equalizing cross bar, 30, and vertical rods, 31, which are pivotally connected to separate beam levers, 32. Levers, 32, are supported upon fulcrum brackets, 33, which are secured to the frame work, 4. Fluid-actuated pistons may be provided in cylinders, 34, the piston rods of which may be suitably connected to the levers, 32, for opening and closing bell, 3. Counterweights, 35, may be placed upon the levers, 32, to balance the weight of bell, 3.

The main bell of the blast furnace hopper

is shown in dotted lines at 36. It is supported by a pair of rods, 37, which extend upward to a cross bar, 38, which in turn is supported by the piston rod, 39, of the fluid-actuated piston in the main bell operating cylinder, 40. The skip-hoist ropes, 41 and 42, pass over the sheaves 6 and 5, respectively, and extend downward to the winding drums of the skip-hoisting apparatus, which is not shown but the construction, operation and control of which are well known.

For traversing car, 10, back and forth under the stationary guiding hoppers, 8 and 9, over the bell, 3, I prefer to employ the mechanism shown at the right hand of the top of Fig. 2, and in detail in Fig. 4. Upon the shaft, 43, which carries the sheave, 6, and which is fixed for rotation with the sheave, 6, there is keyed a pinion, 44. The pinion, 44, is in driving connection with gear, 45, of the car traversing apparatus. Gear, 45, is mounted upon shaft, 46, and secured thereto for rotation therewith. The shaft, 46, is revolvably mounted in bearings, 47 and 48, in housing, 49. Upon the shaft, 46, there is mounted for free rotation thereon the rope drum, 50, to which there is secured the car traversing rope, 51, which is wound upon the drum in a suitable number of convolutions and fixed thereto at the approximate center of these convolutions by a clip, 52, in a well known manner. 53 is a magnetic friction-clutch, one member of which is secured for rotation with the shaft, 46, and the other member of which is mounted for rotation with drum, 50. 54 and 55 are electric current collecting rings which are connected to the respective terminals of an energizing coil, 56, of the magnetic-clutch, 53. Suitable brushes, 54^a, 55^a, (Fig. 8), may be provided for conducting the current from an electric circuit, 54^b, 54^c, to the collector rings, 54 and 55, in a well known manner. Geared to shaft, 46, by suitable gearing, here shown as mitre gears, 57 and 58, is the threaded shaft, 59, upon which there is mounted an electric-contact making-and-breaking device actuator or trip, 60. The trip, 60, is caused to travel along the threaded shaft, 59, by means of a suitable nut which is secured to the trip and which may be insulated therefrom. The trip, 60, may have a forked or perforated projection, 60^a, adapted to engage a rod, 59^a, in sliding relation thereto to hold the trip, 60, from rotation about the threaded shaft, 59. Trip, 60, may be insulated from rod, 59^a, by insulating material, 60^b. 61, 62, 63, 64, 65 and 66 are electric-contacts or co-acting trip members for the trip, 60.

The trip member, 61, may be connected to operate or be a part of any convenient form of circuit making and breaking device such as the switch blade, 61^a, which connects or disconnects the terminals, 61^b, and 61^c, in well known manner as shown. A spring,

61^d, may be employed to normally close the switch.

One end, 67, of rope, 51, is secured to one end of truck, 16, the other end, 68, of rope, 51, is secured to the other end of this truck. Suitable rope sheaves such as 69, 70, 71 and 72 may be provided for carrying the rope about the frame work, 4, to the truck, 16.

It will be seen that the rotation of drum, 50, will traverse the car, 10, the direction of movement of the car depending upon the direction of rotation of the drum. I prefer to provide the hoppers, 8 and 9, with horizontally sliding gates, 73 and 74, to prevent any material which may hang in the guiding hoppers from falling out of them after the traveling car has moved out from under them. Gates, 73 and 74, may be operated by means of brackets, 75 and 76, which are adapted to be engaged by the respective ends of truck, 16, and to be opened by the movement of the truck as it brings the car, 10, into position under the guiding hopper for receiving materials therefrom. Suitable rope-connected weights, 77 and 78, may be provided for closing the gates, 73 and 74, as the truck, 16, moves away from them.

The rotation of car, 10, may be controlled by suitable well known electrical or other controlling means preferably automatic, arranged so that both the traversing and rotation of the car are caused to take place in predetermined order and in repeated cycles so long as the furnace is being charged. For rotating the car, 10, I prefer to employ a motor such as shown at 79 which may be secured to the truck-frame, 16, and geared to the rotating car-body, 10, by means of the worm, 80, which is rotated by the motor shaft, and engages the toothed worm-wheel or ring, 81, which surrounds and is secured to the car-body. The motor, 79, may be of any suitable known type. Its operation is preferably effected by any suitable, well known remote-control system, the timing of its operating and idle periods being accomplished by means of the contact making-and-breaking device or trip, 60.

It will be understood that the purpose of rotating the car, 10, is so that it may discharge its contents into the main hopper at different angular positions about its axis of rotation relative to the position the car is in while it is receiving the material from the skip. The rotation of the car is therefore best performed after it has received the contents of a skip and while the car is moving to its position over the furnace charging-opening where it is to empty its contents into the main hopper. The tendency of the materials to be deposited in the furnace in any uniformly undesirable manner is overcome by thus rotating car 10. Its effect upon the distribution of the materials in the furnace is the same as would be accomplished

ed by discharging the skip-loads into a stationary circular hopper at different points around its circumference but which is, of course, impracticable.

5 To further explain the purpose and method of rotating the car, 10, assume that it is desired to discharge successive "rounds" of material at points a hundred and twenty degrees or one-third of a revolution apart
10 relative to the position of the car when receiving the contents of the skips. In such case the car, 10, may not be rotated at all while charging the first round; while charging the second round the car, after receiving
15 each skip load and before discharging it into the main hopper, may be rotated a hundred and twenty degrees, in one direction, from the position it was in while charging the first round; and while charging the third
20 round the car, after receiving each skip load and before discharging it into the main hopper, may be rotated a hundred and twenty degrees, in the opposite direction, from the position it was in while charging the first
25 round. This cycle of movements may be repeated as long the the furnace is being charged.

It is evident that by suitably arranging the controlling devices the car may be rotated any desired fraction of a revolution and that any desired number of skip loads may be successively deposited in the main hopper without rotating the car.

It is also evident that the desired angular
25 position of the car when discharging as compared to the position it was in when receiving its load can be reached by rotating the car always in the same direction without reversing it or the means which rotates it.
40 For instance, when the car has received a skip load from guiding-hopper, 8, traveled to the center of the furnace, meantime being rotated, say one third of a revolution and has discharged its contents into the main
45 hopper it may then travel on to receive a skip load from guiding-hopper, 9, return to the center of the furnace, meantime being rotated another third of a revolution, and discharge the material from hopper, 9, in
50 the same angular position it was in, relative to the position it was in when it received its load, as when it discharged the material from hopper, 8.

The complete operation of my charging
55 mechanism is as follows:

The two skips which bring materials to the top of the furnace, one of them discharging into guiding hopper, 8, and the other into guiding hopper, 9, are operated
60 by suitable hoisting apparatus, it being customary to arrange this apparatus so that the empty skips balance each other. Assuming that skip, 7, has just discharged its contents into hopper, 8, and is ready to start
65 down the track to receive another load,—as

the skip, 7, starts down the track, the other skip (not shown) which has just received its load at the bottom of the track, starts up. Sheave, 6, rotated by rope, 41, imparts its movements to shaft, 46, by means of 70 gears, 44 and 45. The electric circuit through coil, 56, of clutch, 53, is energized so long as trip, 60, is not engaged by one of the co-acting trips, 61, 62, 63, 64, 65, or 66. Clutch, 53, being in engagement, the drum, 75 50, will be rotated by shaft, 46, and car, 10, will move to the right as seen in Fig. 2, until trip, 60, engages trip, 61, and opens the circuit which energizes the magnetic clutch, 53. When this occurs, traversing movement 80 of car, 10, will stop until the trip, 60, has passed over the trip, 61, and the electric circuit through the energizing coil, 56, is again established. The car, 10, which has received a skip load from skip, 7, is first 85 stopped in its right hand movement when it is over the bell, 3. During the time that the car is stopped over bell, 3, cylinder, 34, will be operated to lower the bell, 3, which will permit bell, 20, of car, 10, to open and the 90 contents of the car to be discharged into the main hopper of the furnace. Upon the contents of the car, 10, being discharged into the furnace the bell, 3, will be closed by cylinder, 34, and counterweight, 35. The 95 bell, 20, will also be closed by the truck, 28, being lifted by the bell, 3, and the car, 10, will be ready to move into position to receive a charge from guiding hopper, 9. When the car, 10, arrives at the proper po- 100 sition under guiding hopper, 9, the skip which serves that hopper will be discharged into it and the car, 10, will start back towards the center of its traversing movement due to the reversal of the direction of 105 travel of the skip hoist ropes and the consequent reversal of the direction of rotation of drum, 50, which is rotated by its driving connection with sheave, 6. When the car, 10, upon its return movement, 110 arrives over the bell, 3, it will again be stopped by the opening of the energizing circuit of clutch, 53, by trip, 60, which at this point engages trip, 61. The contents of the car may now be discharged into the 115 main hopper after which its movement toward guiding hopper, 9, will be resumed when trip, 60, has passed beyond trip, 61, and the clutch energizing circuit has been re-established. It will be seen that as the 120 truck, 16, moved to the right from hopper, 8, gate, 73, was automatically closed by counterweight, 78, and that gate, 74, was automatically opened by the bracket, 76, being engaged by the right hand end of 125 truck, 16. When the car, 10, has received its charge through guiding hopper, 9, it will be traversed to the left, stop over the center of the furnace and be discharged into the main hopper of the furnace. Dur- 130

ing the traversing movements of car, 10, it may be rotated or not, in the manner already described.

In a similar manner trips, 62, 63, 64, 65 and 66 may be connected to open other circuits for controlling the operation of motor, 79, for rotating the car, 10, or for controlling the operation of any other motor or motors which may be employed to actuate other devices such as the valves which control the inlet and exhaust ports of cylinders, 34 and 40. Other timing trips similar to that shown at 60 may be carried and moved by the threaded rod, 59, for coacting with the stationary trips, 62, 63, 64, 65 and 66 in any desired manner and it will be understood that the stationary trips may be so spaced that the circuits they control will be opened and closed at the proper times. It will be understood that the time period during which the master switches, such as 61^a, are held open by the trips, such as 60, is determined by the widths of the contacting faces of the trips. In Fig. 7 the top face of member 61 is shown of considerable width in the direction of traverse of trip, 60, in order that the car, 10, may remain stationary while it is discharging its contents into the furnace. For the specific forms of the trips and of the controlling switches employed I make no claim as such devices are well known in the art. It will be understood that for controlling of the operation of the motor, 79, which rotates the car, 10, or any other motor or device subject to remote electric control, any convenient electro-magnetic device may be used and that its position in the electric circuit controlled by the trip, 60, will be similar to the brushes, 54^a and 55^a, shown in Fig. 8.

It will be understood that I have shown in the drawings and described herein only one embodiment of my invention and that modifications thereof may be made without departing from its scope provided such modifications embody the structure or combination of elements described in any of the following claims.

I claim:—

1. In furnace charging apparatus, a furnace having a top-opening and a closure therefor, a rotatable, traveling car adapted to be moved back and forth over said furnace, said car having a bottom-opening adapted to register with said top-opening and a closure for said bottom-opening, means for loading material into said car when it is at one side of said furnace, means for moving said car back and forth across said furnace, means for rotating said car, and means for opening and closing said closures when they are in registering position.

2. In furnace charging apparatus, a furnace having a top-opening and a closure therefor, a car support, a traveling car on

said support above said furnace, said car having a bottom-opening adapted to register with said top-opening and a closure for said bottom-opening, and means for simultaneously opening said closures when said openings are in registering position.

3. In furnace charging apparatus, a furnace having a top-opening and a closure therefor, a traveling car above said furnace having a bottom-opening adapted to register with said top-opening and a closure for said bottom-opening, and common means for opening said closures when they are in registering position.

4. In a charging device for furnaces, a rotatable, traveling car, a support for said car upon which the car may be made to travel over the top of the furnace to be charged, said car having a bottom-opening adapted to register with the charging-opening in the top of the furnace and a closure for said bottom-opening, a hopper above the path of movement of said car adapted to guide materials into said car when the car is under the hopper, means for opening said closure when said bottom-opening is over said charging-opening and means for rotating said car.

5. In furnace charging apparatus, a car support, a rotatable, traveling car on said support, said car being adapted to travel over the top of the furnace to be charged and having a discharge-opening adapted to register with the charging-opening of said furnace, a hopper above the path of said car adapted to guide materials into said car when the car is under the hopper, said hopper having a discharge opening and a closure therefor, means for opening said closure as the car moves toward its loading position under the hopper, means for closing said closure as the car moves away from said loading position, means for traversing said car on said support and means for rotating said car while it is being traversed.

6. In furnace charging apparatus, a furnace having a top-charging-opening and a closure therefor, a guiding-hopper supported above the top of said furnace at one side of said charging-opening, a rotatable traveling-car, a guiding-support for said car, said car being adapted to be moved back and forth on said support under said hopper and over said charging-opening, said car having a top-opening adapted to register with the discharge-opening of said hopper and a bottom-opening adapted to register with the charging-opening of said furnace, a closure for the bottom-opening of said car, hoisting means for bringing materials to the top of and depositing them in said hopper, means for traversing said car, means for rotating said car, and means for opening and closing said closures.

7. In furnace charging apparatus, a furnace having a top charging-opening and a closure therefor, a guiding-hopper supported above said furnace at one side of said
5 charging-opening, a rotatable traveling car, a guiding-support for said car, said car being adapted to be moved back and forth on said support under said hopper and over
10 said charging-opening, said car having a top-opening adapted to register with the discharge-opening of said hopper and a bottom-opening adapted to register with the
15 charging-opening of said furnace, a closure for the bottom-opening of said car, a hoisting skip for bringing materials to the top of said hopper and depositing them a skip-load at a time in said hopper, means for
20 traversing said car, means for rotating said car, means controlling the movements of said car and said skip to cause their respective movements to take place in predetermined order and means for opening and closing said closures.

8. In furnace charging apparatus a furnace
25 having a top charging-opening and a downwardly opening closure therefor, a traveling car having a bottom-opening and a downwardly opening closure therefor, a support for said car adapted to support and
30 guide said car in lateral movements across the top of said furnace to at one point in the movement of the car cause said bottom-opening to register with said charging-opening, supporting means for holding said
35 closure for said bottom-opening closed, said supporting means including said closure for

said charging-opening said closure for said charging-opening being the sole means for holding said closure for said bottom-opening closed when said bottom-opening registers with said charging-opening, and means
40 for opening and closing said closure for said charging-opening.

9. In furnace charging mechanism, a furnace having a top charging-opening and
45 a downwardly opening closure therefor, a traveling car having a bottom-opening and a downwardly opening closure therefor, a support for said traveling car, a track-support for said second named closure adapted
50 to hold said second named closure closed, said first named closure forming a section of said track-support, and means for opening and closing said first named closure.

10. In furnace charging apparatus, a furnace
55 having a top charging-opening and a closure therefor, closure-operating means, a car support, a traveling car above said furnace adapted to be traversed on said car support, said car having a bottom discharge-
60 opening adapted to register with said top charging-opening, a closure for said discharge-opening, means for holding said second named closure closed throughout the
65 traversing movements of said car, said closure-operating means being adapted to simultaneously operate both said closures when said openings are in registering position.

In testimony whereof I affix my signature. 70

ALFRED C. NELSON.