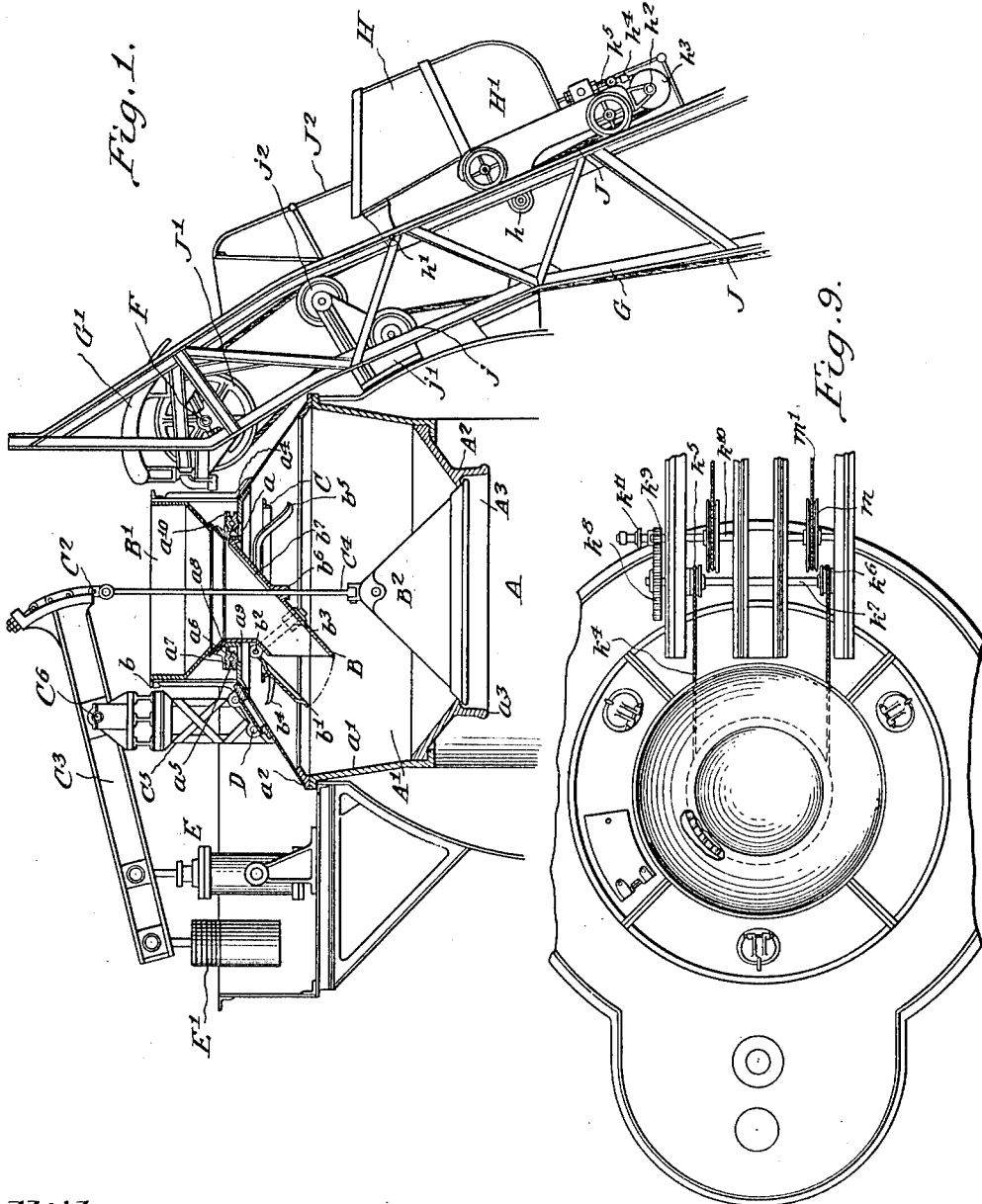


E. J. WINDSOR-RICHARDS & T. LEWIS.
CHARGING APPARATUS FOR BLAST FURNACES.
APPLICATION FILED DEC. 23, 1909.

1,061,349.

Patented May 13, 1913.

5 SHEETS—SHEET 1.



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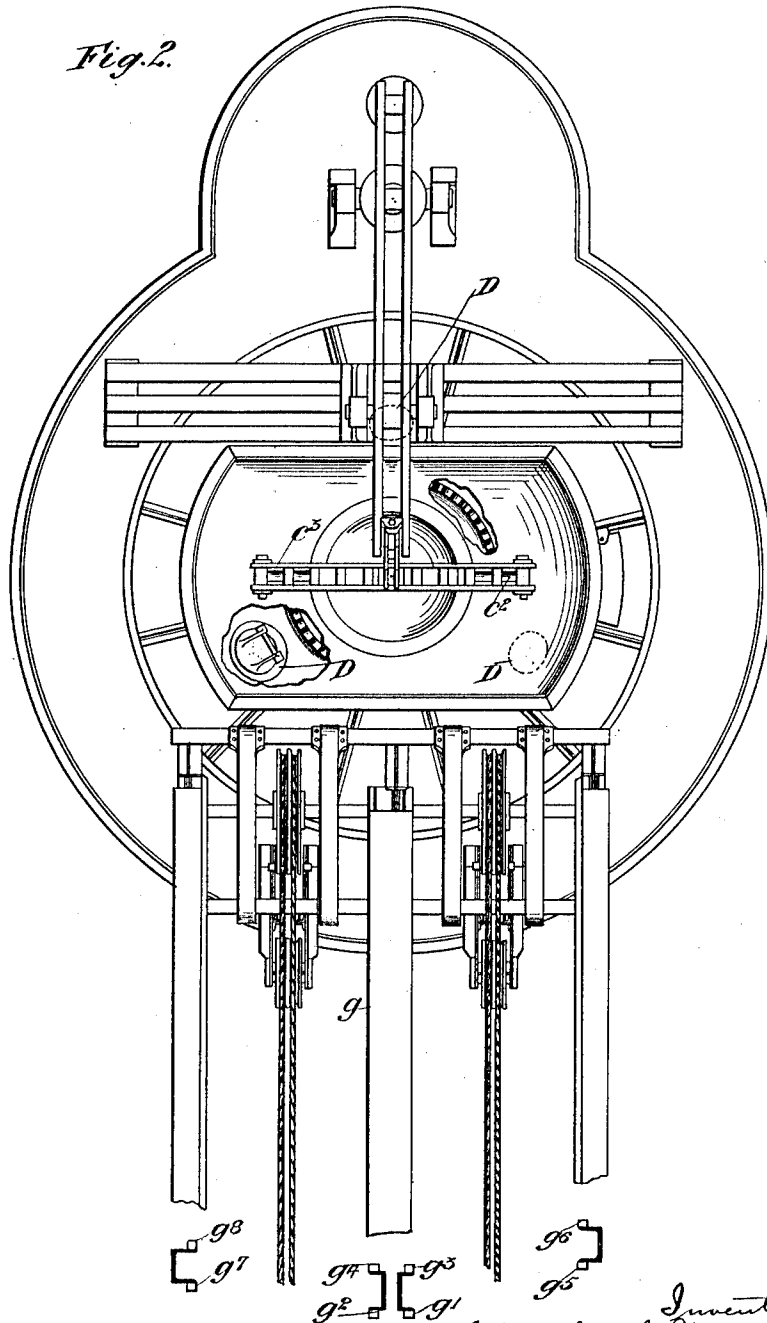
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6 SHEETS—SHEET 2.

Fig. 2.



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5 SHEETS—SHEET 3.

Fig. 4.

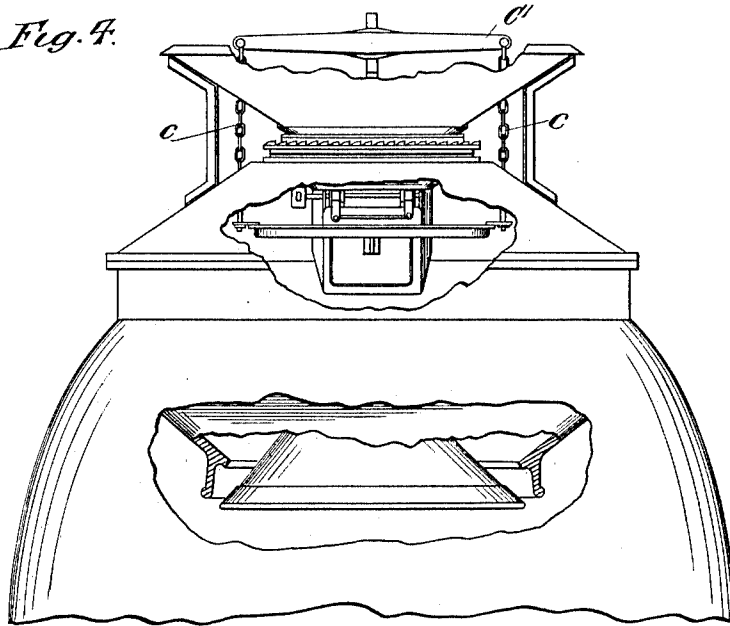
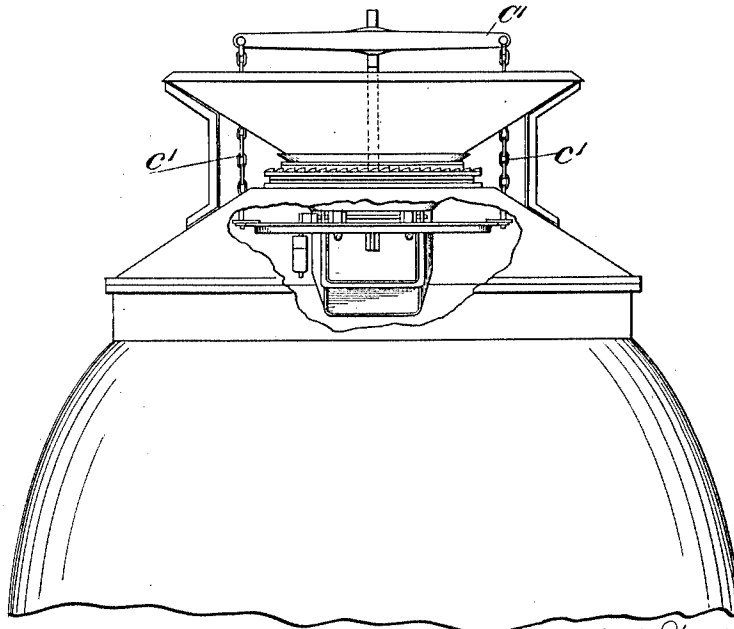


Fig. 3.



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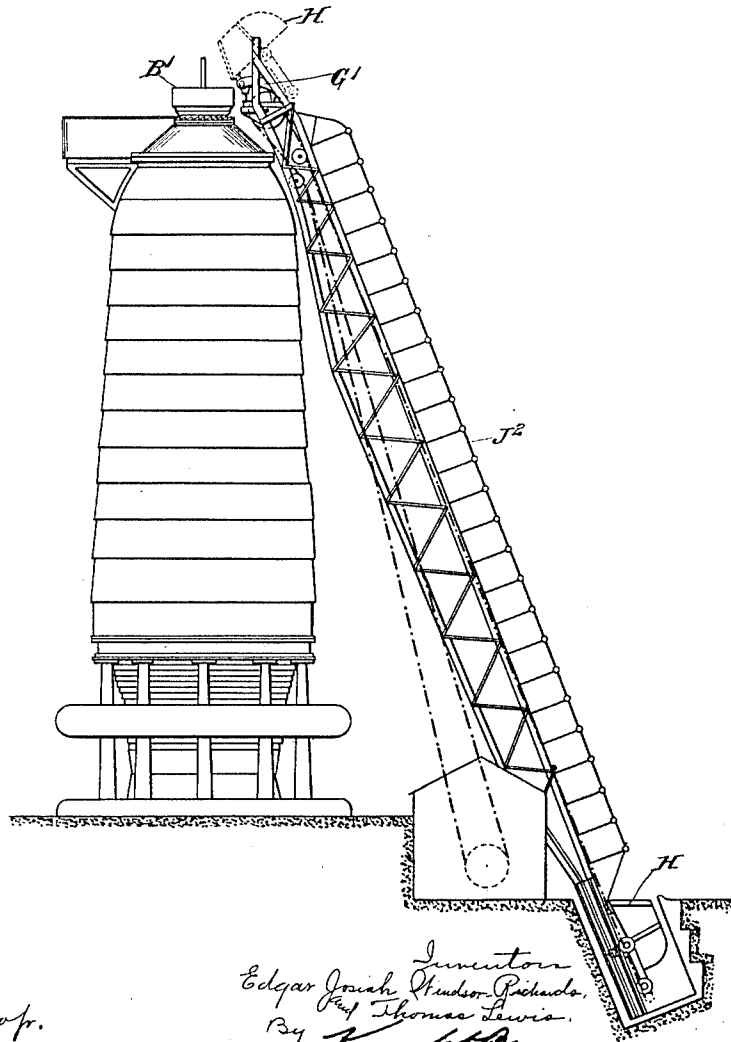
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5 SHEETS—SHEET 4.

Fig. 5.



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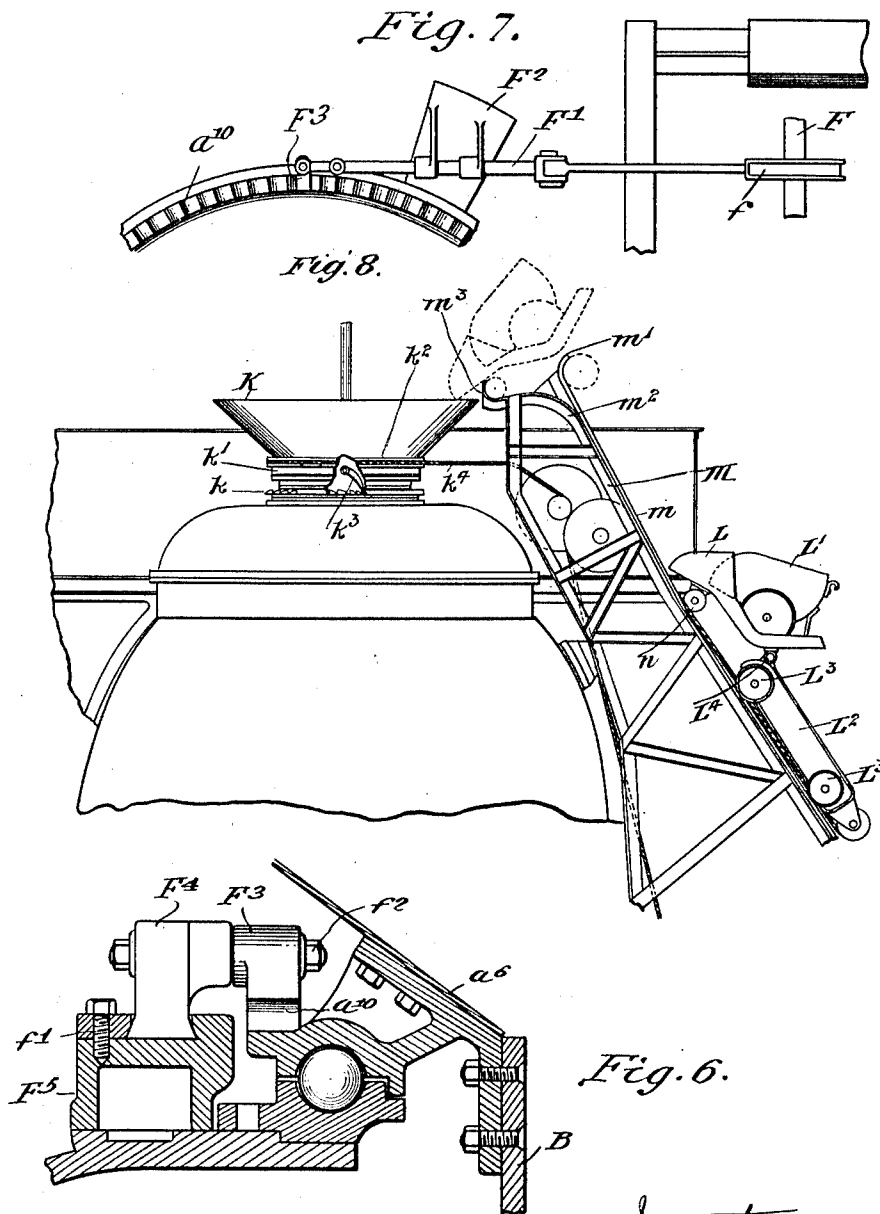
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5 SHEETS-SHEET 5.



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UNITED STATES PATENT OFFICE.

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CHARGING APPARATUS FOR BLAST-FURNACES.

1,061,349.

Specification of Letters Patent.

Patented May 13, 1913.

Application filed December 23, 1909. Serial No. 534,658.

To all whom it may concern:

Be it known that we, EDGAR JOSIAH WINDSOR-RICHARDS, general manager, "Cottage", Glengarnock, Scotland, and THOMAS LEWIS, engineer, of Garnockside Cottages, Glengarnock, Scotland, citizens of the United Kingdom of Great Britain and Ireland, have invented certain new and useful Improvements in and Relating to Charging Apparatus for Blast-Furnaces, of which the following is a specification.

This invention relates to improvements in charging apparatus for blast furnaces, and has for its object to more perfectly distribute the materials into the furnace for making pig iron; to simplify the construction of such apparatus; reduce manual labor and effect a saving of gas.

With our improvements there is no complication of parts at the head of the furnace and therefore nothing to get out of order. Further such parts as are employed to effect the charging of the blast furnace, do not project from the top of the furnace foot plate to any great extent, as hitherto. Most appliances of this kind are objectionable on account of the enormous head gear above the top of the furnace and owing to the great amount of mechanism they easily get out of order.

In our improvements, the materials such as iron ore, lime stone and coal or coke may be collected from bins by means of skips which are caused to travel up an inclined track to the mouth of a revolving chute into which the said skips tilt their material and from the said chute the material is discharged into a hopper at the mouth of the furnace having an open mouth closed by means of a rising and falling bell valve; the bell valve being lowered at the required time and allowing the material to escape from the hopper into the furnace. The chute receiving the material from the skip or skips may have either a continuous rotating motion or intermittent rotating motion so as to equally distribute the material therefrom on to the bell valve of the hopper.

Figure 1 of our improvements shows a sectional elevation of the upper portion of a blast furnace with charging and conveying apparatus applied thereto. Fig. 2 a plan thereof with the skip as shown in Fig. 1 removed. Fig. 3 an elevation of the charg-

ing apparatus as shown in Fig. 1; the said view being taken at right angles to Fig. 1, looking toward the right hand, the rocking lever for operating the bell valve as shown in Fig. 1 being eliminated as also is the inclined track and skip. In this figure a portion of the hopper is broken away to show the interior mechanism. Fig. 4 a similar view to Fig. 3; but showing the interior mechanism as shown in Fig. 3 but in a different position and also showing the belt or upper portion of the furnace broken away to show the lower portion of the hopper and bell valve. Fig. 5 shows a somewhat diagrammatical view of the skip track and power house in relation to the blast furnace and charging apparatus. Fig. 6 shows an enlarged sectional elevation of the means by which we propose to carry the rotating chute, preferably on ball bearings and also showing the arrangement for carrying the means for imparting a motion of rotation to the revolving portion of the chute. Fig. 7 a part plan view of one means we have devised for imparting motion to a pawl which operates the rotation of the rotating portion of the chute. Fig. 8 shows a modification, that is to say a different means for imparting motion to the chute and also showing the adaptation of a loose barrow or skip to the frame. Fig. 9 a plan view of Fig. 8; but with the skip and carrier eliminated therefrom.

Referring more particularly to Figs. 1 and 2, A is the interior of the upper portion of a blast furnace, having arranged in the mouth thereof a stationary hopper A¹ preferably round in shape and having at the lower depending end a dish shaped ring A² with the opening A³. The upper portion of the hopper A¹ is provided with an opening *a* through which the chute B protrudes into the hopper A¹. We prefer for the sake of general advantage in construction and also by advantages gained by such said construction to construct the hopper with the portions *a*¹ having the portion A² provided with the sleeve portion *a*²; the upper portion *a*² of the hopper A¹ being preferably provided with the ring *a*⁴ having the opening *a*. The ring *a*⁴ of the fixed hopper carries the ball ring *a*⁵, the said ring being secured to the ring *a*⁴ and bearing on the ball bearings *a*⁶ of the ring *a*⁵ is the upper cap or bracket

a^7 of a corresponding circular shape to the ring a^5 . The bracket portion a^7 is secured to the revolving chute hopper portion a^8 and also to the revolving chute portion a^9 so as to make these portions integral as shown more particularly in the enlarged detail view Fig. 6. The top of the bracket or ring and portion a^7 is provided with a ring of ratchet teeth and the arrangement is such that when the bracket portion a^7 is rotated the hopper a^8 and chute D is caused to rotate therewith; the ring a^5 and ball bearings a^6 forming the support for the said hopper a^8 and chute B. Within the rotating hopper a^8 we may provide the stationary elongated hopper B^1 which may be carried from the portion A^2 of the hopper by means of stays such as b . The mouth of the hopper B from which the material discharges into the hopper A^1 is closed at the required period by means of the door b^1 pivoted at b^3 by means of a snug or snugs formed on the chute B and being controlled in its inoperative position by means of the lever b^3 with counterweight. We prefer to provide on the outside of the said door b^1 a projection or steady b^4 and we also prefer to provide on the outside of the chute B another steady b^5 for the purpose herein-after described.

In order to dispense with any intricate mechanism or gearing for closing the door b^1 of the chute B^1 we have devised the novel means as shown in Figs. 1, 3 and 4 for effecting the closing of the doors b^1 at the correct period. This arrangement consists of a circular or angular ring C which is supported by means of the chains c , c^1 Figs. 3 and 4 from the cross beam C^1 carried from the support C^2 of the rocking lever C^3 ; the bell valve lever or rod C^4 being carried and operated from the rocking lever C^3 as are the chains c , c^1 of the ring C. Further it will be seen that the simultaneous action of the lowering of the rod C^4 by the lever C^3 causes the ring C to be lowered simultaneously with the bell valve B^2 whereby the ring C engages with the outside of the door b^1 of the chute B (or with the guide b^4) and in the downward descending motion of the ring C the door b^1 is closed and kept in that position until an upward motion is given to the rod C^4 , when the counterweight lever b^3 causes the door to be opened again as shown in Fig. 1. In Fig. 3 the door b^1 is shown open. In Fig. 4 it is shown closed. The chains c^1 pass through the slots c^2 , c^3 of the fixed hopper B^1 but the chains pass at the outside of the revolving hopper portion a^8 , to the ring C.

Referring to the dish shaped ring A^2 that is to say the sleeve portion a^3 , this arrangement prevents the bell valve from opening the mouth A^3 of the ring A^2 until the door b^1 of the chute B is closed whereby there can

be no escape of gas as hitherto; because when the bell valve B^2 has unseated the opening A^3 the door b^1 of the chute B is closed. This is due to the arrangement of the sleeves a^3 . It is obvious that the ring C being in a position for immediately operating the door b^1 , causes the door to be closed before the bell valve B^2 has been allowed to traverse sufficiently far to open or unseat the opening A^3 . We prefer to form the chute B with a bearing b^6 through which the rod C^4 protrudes and we also prefer to place at the back of the rod C^4 within the chute B a ledge or strip b^4 to prevent any of the material lodging against the rod C^4 . We also prefer to provide at the upper portion a^2 of the hopper A^1 explosion doors such as D Figs. 1 and 2 and we may prefer that these doors be retained in an open position when the bell valve is closed, for the purpose of allowing the cold air to enter through the opening of the doorways, into the interior of the hopper A^1 whereby it is kept cool. The said explosion doors may be operated from the rising and falling ring C which may have a rod for each door connected to it in such a manner that when the ring is in the position in Fig. 1 the explosion doors are caused to be poked open by the said rods of the ring C. With further reference to the ring C it should be mentioned that the guide b^5 in an opposite position to the guide b^4 of the door b^1 is for the purpose of preventing the said ring from tilting or canting as would likely be the case when the ring portion engages the door b^1 unless the guide b^5 is there to prevent it. To impart the necessary motion to the ring C and bell valve B^2 through the medium of the rocking lever C^3 we may pivot the said lever on the staging C^5 having the bearing C^6 ; the rocking lever C^3 being operated by means of the ram and cylinder E preferably an oscillating ram and cylinder and for the purpose of causing the apparatus to be returned to the position shown in Fig. 1 we may provide at the end of the rocking lever C^3 the suspended weights E^1 so that when the pressure is removed from the cylinder E, it causes the rocking lever C^3 to assume the position shown in Fig. 1.

In the arrangement shown in Figs. 1, 2, 3 and 4, the hopper a^8 is given a continuous motion of rotation and we prefer to effect this through the medium of an eccentric motion such as is shown in Fig. 7. This motion may be derived from the shaft F Fig. 1 on which is mounted the eccentric f which reciprocates the rod F^1 within the guide bracket F^2 Fig. 7; the free end of the rod F^1 having the compound link connection to the pawl F^3 in gear with the ratchet wheel a^{10} . The pawl f^3 may be pivoted loosely on an axle f^2 of the dovetail sliding block F^4 moving to and fro in the dovetailed bracket F^5 carried on the ring a^4 Figs. 1 and 6. f^1

shows the dovetailing of the bracket and block. In Fig. 6 the pawl f^3 is shown in gear with a tooth of the toothed ring a^{10} .

With regard to the conveying part of the appliance we employ an inclined track D preferably arranged of trellis work and being graduated inwardly from the upper part of the blast furnace to the hopper. We prefer that this inclined track be constructed so as to accommodate two skips running side by side and for this purpose the center portion g of the track is constructed out of channel iron as shown in sections at the right hand end of Fig. 2; the sections being placed back to back and having on their upper surface two sets of rails g^1, g^2 to accommodate the inside wheels of the bodies such as B^1 of the skips such as H, and also having two rails g^3 and g^4 at the lower side to accommodate guide pulleys h Fig. 1 provided on the body H^1 and this arrangement of rails, wheels of the body H^1 and guide wheel h prevents any tipping of the body H^1 . The inside or channels of the sections form a guide or track for the skip guide wheels h^1 ; the skip H being pivoted to the body H^1 and the arrangement is such that the skip H—owing to the body H^1 —is controlled in its position or movement by means of the guide wheel h^1 . The two outside portions of the track may consist of simple channel irons having rails g^5, g^6, g^7 and g^8 , the rails g^5 and g^7 accommodating the outside wheels of the bodies for the skips and the rails g^6, g^8 being for the outside guide wheels such as h of the body such as H^1 . A portion of the track G near to the mouth of the hopper is provided with inward curves G^1 preferably these curves being of a shape to correspond with the sections of the track that is to say of a channel section. We prefer to employ four curves such as G^1 —two for each skip H—that is to say one for each guide wheel such as h^1 . These inward curves or guides are provided with a stop end and they register with the guide portion which accommodates the pulley h^1 .

To draw the skip H and body H^1 to the required discharging position at the head of the furnace, the ropes J are drawn in the direction of the arrow Fig. 1 which ropes pass over the guide pulleys j carried by the bracket j^1 suitably secured to the side of the furnace belt; the ropes J thence passing to the haulage pulley J^1 , thence downward to the guide pulley j^2 also carried by the bracket j^1 ; thence down to the rear of the body H^1 of the skip H as shown in Fig. 1. The pulleys may be of a single or double type. As the body H^1 and skip H is drawn into position for discharging into the hopper B^1 the skip or container H is caused to follow the contour of the guide G^1 but the body H^1 follows in the direction of the inclined track, thus the contents of the skip H

are discharged into the hopper B^1 . The rear of the body H^1 is preferably provided with mechanism for taking up any slack in the ropes J. This arrangement consists of the bracket h^2 at the rear of the body H^1 carrying the wheel h^3 around which the ropes J pass. The free ends of the ropes are connected to the securing head h^4 pivotally connected to the screwed rods h^5 which are passed through the fixed snug h^6 and the arrangement is such that by unlocking the nuts of the screwed rods h the slack of the ropes J can be taken up. Owing to the manner of connecting the bodies of the skips at the rear the skips can be caused to discharge their contents into the hopper without a high leading track, as is usually employed. Each side of the track C may be provided with the hand rail J^2 .

Referring to Figs. 8 and 9, we show a modified form of the means for rotating the hopper K. In this arrangement there is no stationary hopper such as B^1 in Figs. 1 and 2; but the interior of the furnace is similar to Fig. 1 that is to say the furnace is provided with a hopper and revolving chute and in the case of the arrangement shown in Figs. 8 and 9 the hopper is given an intermittent motion that is to say after one of the skips has deposited its contents the revolving chute is caused to rotate to the extent of a portion of a circle, ready for the next charge from the skip and so as to equally distribute the charges around the bell valve as shown in Fig. 1. Also in this figure the skips L are preferably provided with the loose barrows L^1 and the arrangement is such that these loose barrows may be wheeled to the bins containing the material for making pig iron and afterward wheeled directly on to the skip bodies such as L.

Referring now to the arrangement of the intermittent rotation of the hopper K, we may provide the arrangement of ball bearings with upper and lower caps as in Fig. 1 and with the arrangement of the toothed ring similar to that as shown at k , Fig. 8. The chute K is integral with the chute within the interior of the hopper and provided on the lower portion of the chute K is a loose collar or ring k^1 preferably having a pulley part k^2 . Pivoted to the said collar is the pawl k^3 and around the pulley part k^2 is the driving rope k^4 , as shown more particularly in the plan Fig. 9. The toothed pawl k^3 is normally in gear with the toothed ring k ; but it only imparts a motion of rotation in one direction viz. clockwise. The ring k^1 is free to be rotated counter-clockwise that is to say that it does not impart a motion of rotation to the chute K when thus rotated. To effect the rotation of the chute K simultaneously with the advancing and receding of the skip bodies L and bar-

rows L^1 , we mount at the head of the inclined track M a hoisting pulley such as m for each skip and barrow; the rope m^1 around the said pulley being connected to any suitable driving power (say) lower down the track, one end of the said rope being connected to the rear of the skip body L^2 and the other around the drum of the power winding mechanism. The rope k^4 around the pulley k^7 has each end coiled around the drum k^5 , k^6 mounted on the shaft k^7 arranged between the sides of the inclined track; the ends of the said rope being coiled on the said drum in such a manner that as one winds up the rope the other pays out. Keyed on to the shaft is the toothed wheel k^8 in gear with the toothed pinion k^9 mounted on the pulley shaft k^{10} and the arrangement is such that as the pulleys m are rotated, a motion of rotation is correspondingly given to the shaft k^7 through the medium of the gear pinion and wheel k^9 , k^8 is wound on the drum k^5 and by reason of the pawl k^3 of the sleeve k^1 gearing with the toothed ring k , the chute, collar and toothed ring are made integral and rotate together. By the lowering action of the one skip the drum k^6 now winds up the rope k^4 and the other drum k^5 pays out the rope and the sleeve k^1 and pawl k^3 assume the normal position, that is to say the collar k^1 rotates without rotating the hopper K . We may provide on any convenient position on the top of the furnace casing a back pawl (not shown) to prevent the rotation of the toothed ring when the pawl k^3 is sliding over the teeth.

The track M is of similar construction to that of the other track shown in Figs. 1 and 2; but in this case it is somewhat simplified because a set of runners for the lower wheel of the body as shown in Fig. 1, is dispensed with in the body L^2 Fig. 9. In this case we provide the body L^2 with the two wheels L^3 and with a similar rope tightening arrangement as shown in Fig. 1. The skip L is pivoted to the skip body L^2 at L^4 and the forward end of the body L is provided with the guide wheel n which runs on rails of the track m as do the wheels L^3 of the body L^2 . The upper portion of the track is inclined inward, that is to say toward the center of the furnace and the rails m of the track are extended as shown in Fig. 8 and preferably curve outwardly as shown at m^1 so as to provide a stop for the wheels L^3 of the skip body L^2 . The track at the upper end is also provided with the curved guides such as m^2 which register with the higher level portion of the track M and are provided at their free ends with the upwardly curving stops m^2 and the arrangement is such that as the skips and bodies are hauled up, the skip is caused to assume the position shown in

dotted lines in Fig. 8 that is to say the wheels m follow the contour of the curved guides m^2 until the barrow L^1 is in a position for discharging its contents into the hopper K . The skips such as L may be merely open frames with side portions as shown and they may be caused to nip the barrows so as to firmly hold them thereon. There may be a hinged back support on the skip L for the barrows. The skips may be caused to discharge two or more barrows into the chute K without it being rotated that is to say in the one place; or the chute may be rotated without the skips discharging in a certain place say for example if it is desired to place a charge into the furnace beyond the usual discharging point. This we may effect by the small clutch k^{11} that is to say the pinion k^9 may be drawn out of gear with the toothed wheel k^8 then of course the chute is not rotated. The furnace top may be provided with the explosion doors as in the case of Fig. 1 and the arrangement of the operating cylinder and rocking lever may also be similar. Referring to the ring C and the chain connections with cross beams for operating same we may if desired actuate this annular ring by means of rods with direct piston communication; but this is a matter of detail so far as the novel features of the ring are concerned.

Although we have shown a track with an arrangement of skips for charging material into the hoppers of the furnaces, we may dispense with such said track and skips and employ ordinary conveying traps for conveying the material to the mouth of the furnace and in this case charge into the furnace from the barrows after the manner as is done in hand feeding.

In our improved arrangement of track and skip the power house may be situated on the same base level of or below the furnace that is to say on the ground line as shown in Fig. 5 and the skips can not tilt backward because their gravity is always toward the center of the furnace. In arrangements hitherto the power houses are generally arranged at a certain height above the ground level and are in themselves a costly construction requiring as they do to be carefully and firmly built up.

We may prefer that the hoppers which rotate be so arranged that they slightly gain in each revolution and so that the point of discharging on to the bell valve and consequently to the furnace is varied. Further, a perfect mixing of the ore, limestone and coke is effected because they are not discharged in the same position within the furnace at every revolution of the chute. We may also prefer that the gearing of the chute be inclosed within half cases, to prevent dust or dirt having access to the gearing. We also may prefer that the casement top

of the furnace be mounted on small roller wheels say two sets at opposite sides; the rollers engaging with and resting on the top of the furnace plate or the top flange of the hopper and the arrangement is such that by removing the studs that hold the casement top in position, it can be moved to one or the other side so as to effect any repairs in the hopper or to replace the old bell valve by a new one; the rod of the bell valve and other parts requiring to be disconnected, being dismantled previous to the said operation. In the arrangement shown in Figs. 8 and 9 we may employ skips without loose barrows, similar to that shown in Fig. 1.

In combination with either of the improved charging apparatus described and shown, we may employ an electrical indicator to record the number of skips of material that are charged into the furnace that is to say that every time the bell valve hereinbefore referred to is lowered—so as to allow the material to drop into the furnace—the operating parts are caused to close an electrical circuit whereby the indicator records each charge into the furnace. Also in combination with the said furnace we may employ another indicator with a series of glow lamps arranged in circular fashion and to correspond with the position of the chute relatively with the inside of the hopper, that is to say assuming that the hopper has seven discharging points in the case of the arrangement shown in Figs. 8 and 9 within the hopper—on to the cone—there are seven corresponding glow lamps in the indicator. On a suitable stationary part of the casement top of the furnace we provide studs each in communication with the electrical indicator, and on the revolving chute we place a sliding contact which engages with the studs hereinbefore referred to—as the chute is rotated—thereby closing the circuit and indicating by the positioned glow lamp the position of the chute within the hopper.

We are aware that it has been previously proposed to revolve a chute within a hop-

per; also to close the door of a chute by means of gearing within the hopper, and to rotate the chute by means of overhead gearing; and we lay no claim to the broad principle of the employment of a chute door; nor do we lay any claim to the broad principle of revolving the chute or hopper.

Claims.

1. In a charging apparatus for blast furnaces, the combination of a hopper adapted to deliver to the furnace, a bell-valve for closing the mouth of said hopper, a rotating chute adapted to feed said hopper, a door for closing said chute, a counter-balance adapted to open said door and a ring in position to engage a portion of the door to close it in opposition to its counter-balance.

2. A charging apparatus for blast furnaces comprising a hopper, a rotary chute in said hopper, means for imparting intermittent rotary movement to said chute, a door for closing said chute, a ring for closing said door at suitable intervals and a counter-balance on said door normally tending to open it.

3. In a charging apparatus for furnaces, the combination of a hopper, a chute, means for imparting intermittent rotation to said chute, means for opening and closing the chute in consequence of its rotation, and an indicating means adapted to record the number of charges of material delivered by said chute.

4. In a charging apparatus for furnaces, the combination of a hopper, a chute, means for imparting intermittent rotation to said chute, means for opening and closing the chute in consequence of its rotation, and an indicating means adapted to record the number of charges of material delivered by said chute, said indicating means being adapted to show the position of the chute within the hopper.

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