No. 816,222. PATENTED MAR. 27, 1906.

J. W. DOUGHERTY.

BLAST FURNACE CHARGING APPARATUS.

APPLICATION FILED MAR. 17, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

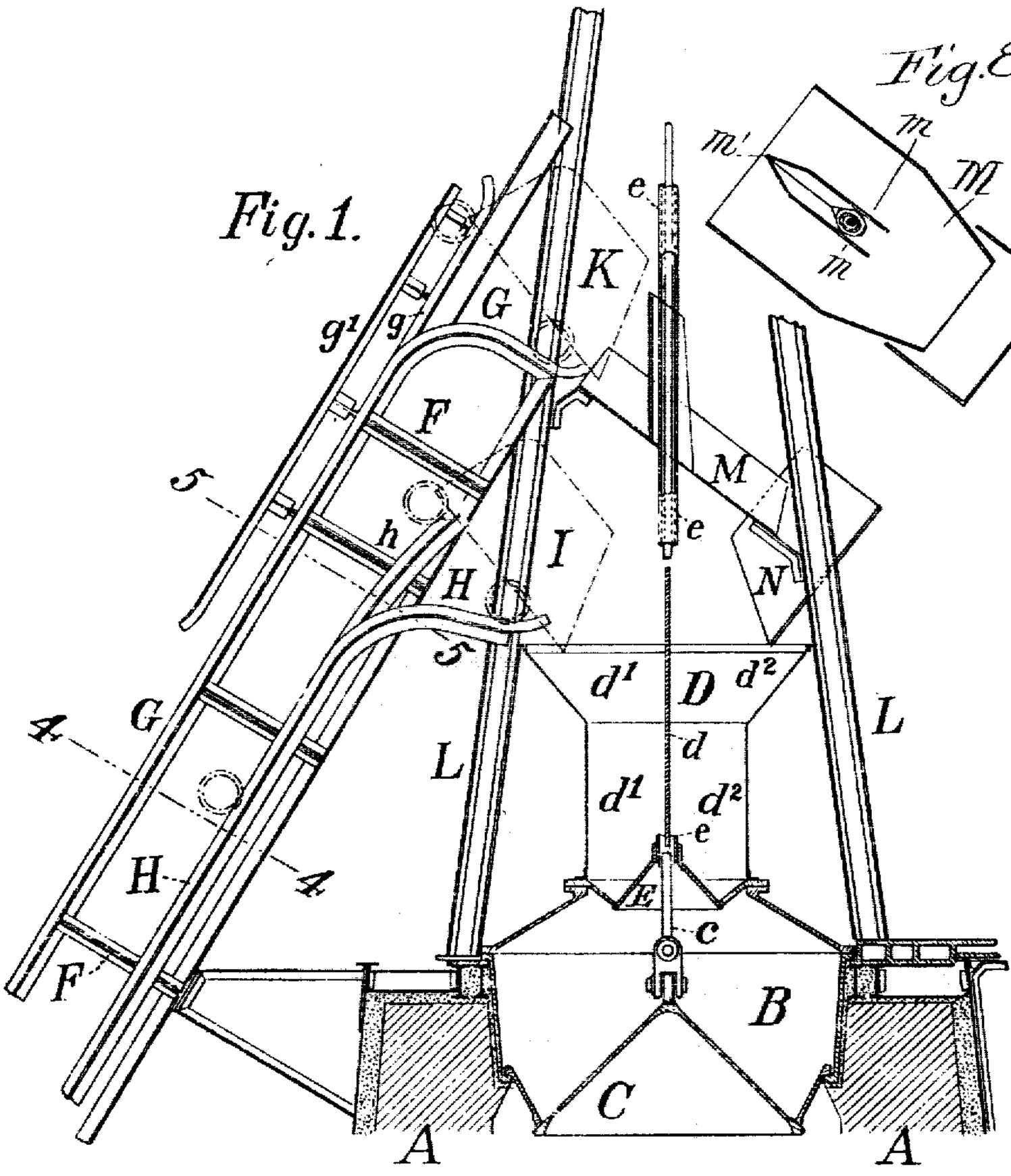

Fig. 8.

Fig. 2

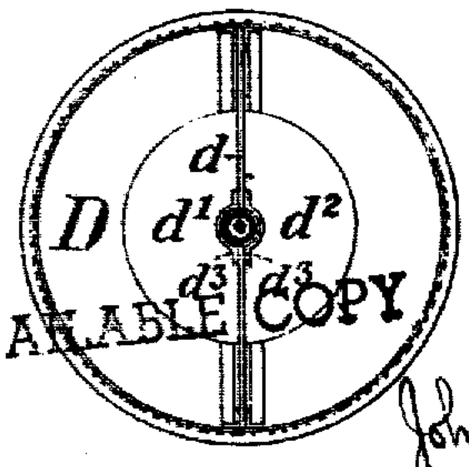

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Fig. 3.

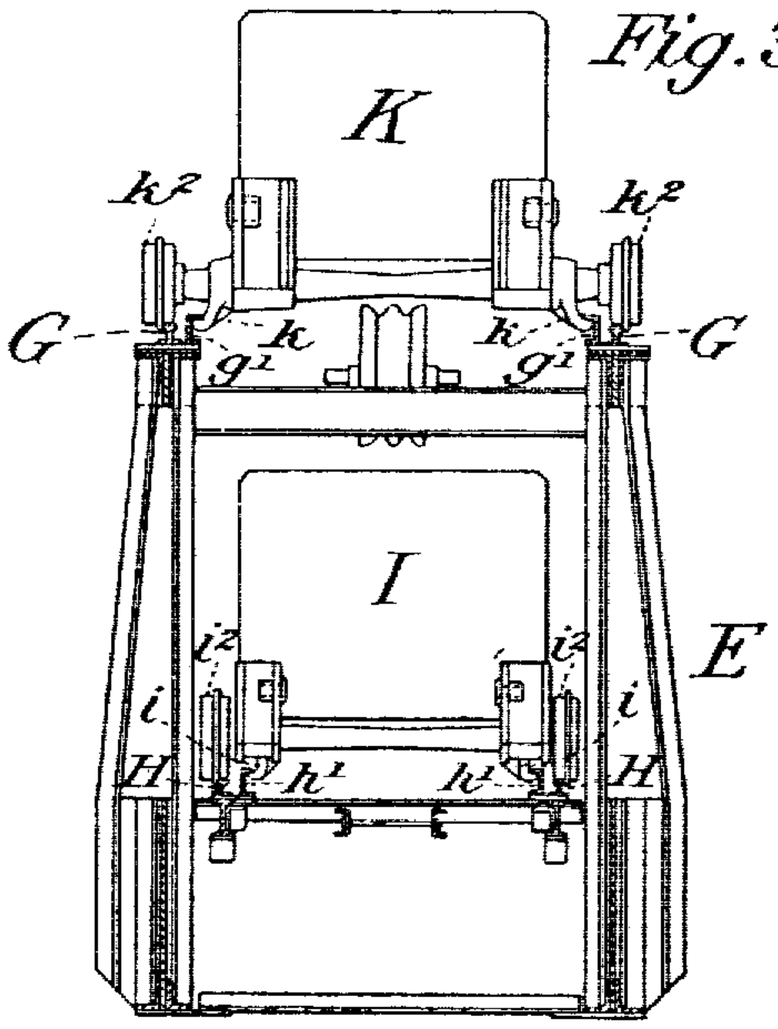

Fig. 4.

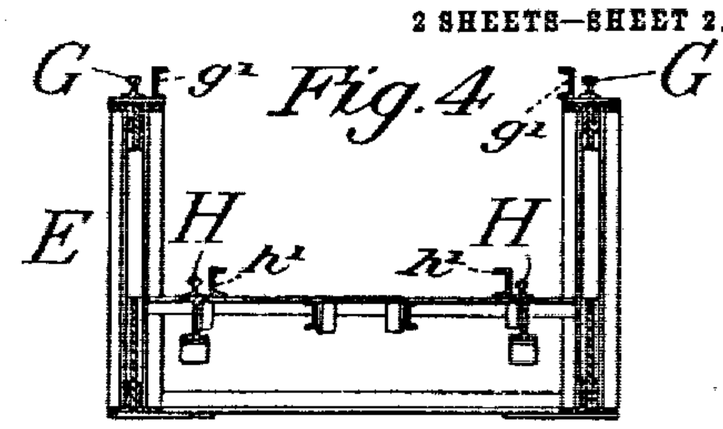

Fig. 5.

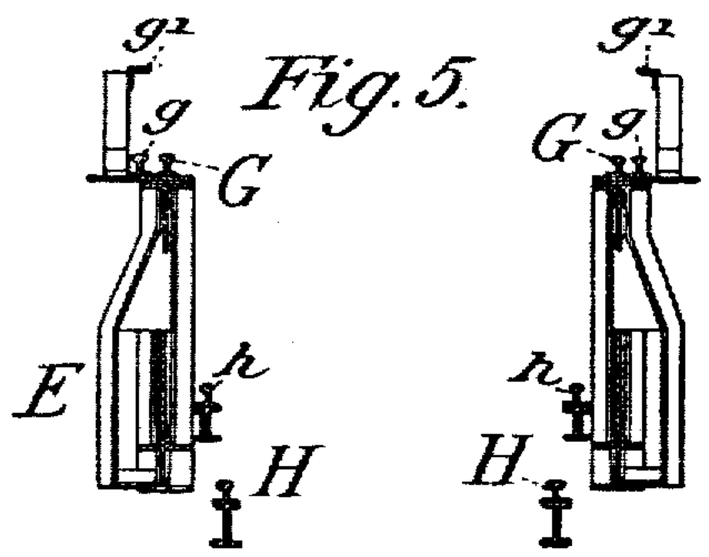

Fig. 9.

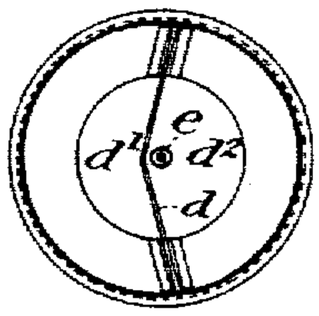

Fig. 10.

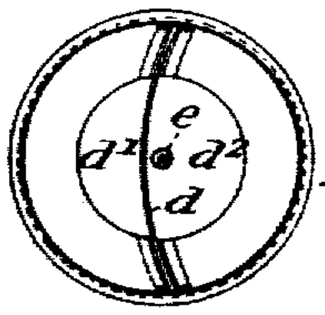

Fig. 11.

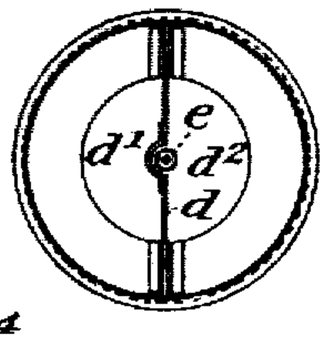

Fig. 6.

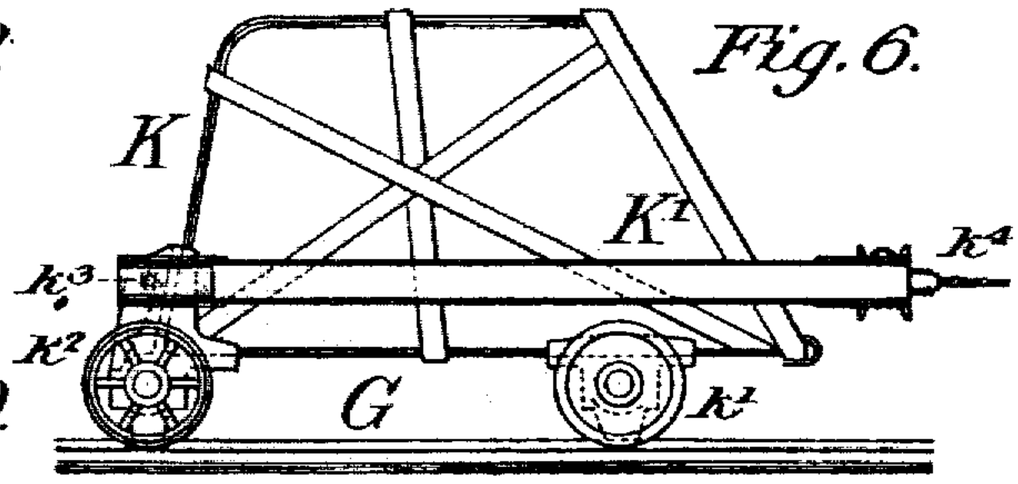

Fig. 7.

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UNITED STATES PATENT OFFICE.

JOHN WEBSTER DOUGHERTY, OF STEELTON, PENNSYLVANIA.

BLAST-FURNACE-CHARGING APPARATUS.

No. 816,222. Specification of Letters Patent. Patented March 27, 1906.

Application filed March 17, 1905. Serial No. 250,575.

To all whom it may concern:

Be it known that I, JOHN WEBSTER DOUGHERTY, a citizen of the United States, residing at Steelton, county of Dauphin, State of Pennsylvania, have invented certain new and useful Improvements in Blast-Furnace-Charging Apparatus, of which the following is a specification.

My invention relates to certain improvements in blast-furnace-charging apparatus employing cars, skips, or buckets for conveyance of the stock hoisted to the top of the furnace and there automatically discharged of their contents, and has for its object the provision of devices to insure improved deposition of the stock discharged from such skips.

In the drawings, in which similar letters indicate corresponding parts, Figure 1 is a vertical sectional view of the upper part of a blast-furnace with my improvements, the bell-hangers being broken out to show partition *d*. Fig. 2 is a plan of the supplemental hopper. Fig. 3 is an enlarged sectional view of the bridge-truss structure at the center. Fig. 4 and Fig. 5 are reduced sectional views of the bridge-truss, taken on the lines 4 4 and 5 5, respectively, in Fig. 1. Fig. 6 is a side elevation of the upper skip, showing the bale attached to the same. Fig. 7 is a side elevation of the lower skip, showing the pusher attached to the same. Fig. 8 is a plan of chute M and section of chute N, taken on plane of bottom of chute M. Fig. 9 is a plan of supplemental hopper with diaphragm modified by a vertical bend. Fig. 10 is a plan of supplemental hopper with diaphragm modified by curve. Fig. 11 is a plan of supplemental hopper with diaphragm modified by having flat parts connected by open corrugation.

In the above drawings, A is a blast-furnace, provided at its top with main hopper B, with charging-bell C, supplemental hopper D, and its bell E, said bells being gas-tight, as usual, and operated in the usual manner for charging stock into the blast-furnace.

F is the upper end of the truss of a bridge-truss structure, one end of which rests on suitable foundations on the ground, the other end resting on the wall of the furnace, said bridge-truss structure being provided with tracks G and H, traversed by skips I and K, which carry the stock from the ground to the desired elevation, being actuated by means of cables. Said cables are carried on a system of sheaves, which are supported by a framework L on the top of the furnace proper. Said framework also supports mechanism for operating the bells C and E; but as my invention does not relate to such mechanism or to the particular means of effecting the upward movement of the skips I have not shown same in said drawings.

By reference to Patent No. 730,799, patented June 9, 1903, may be seen full details of a hoisting arrangement, skips, &c., suitable for the application of my improvement.

As shown in Fig. 1, the bridge-truss F carries two sets of tracks—viz., an upper set G, carried on top of the truss, and a lower set H, carried inside of the truss, and therefore preferably of a narrower gage. At the loading-pocket, (not shown,) near the foot of the truss, where the skips receive the stock, the tracks are in one and the same plane; but as the center of the truss is approached the planes of the respective tracks separate, until at the center of the truss said tracks are farthest apart, whereby the ascending skip passes the descending skip without interference, as shown in Fig. 3. From the center of the truss toward the top of the furnace the planes of the respective tracks converge somewhat and then continue parallel, as in Fig. 4, to the places where the tracks are differently disposed for the purpose of effecting the dumping of the skips.

As shown in Fig. 3, the wheels on the rear axles of the skips are each made with two treads, placed on each side of the flange i^2, the inner treads of said rear wheels serving in all cases to carry the rear ends of the skips in their general movements of upward and downward travel on the rails G G and H H, the same as the front ends of the skips are carried on said rails by the single-tread wheels, with the flanges outside of the rails. The tracks G and H are curved downwardly, near their upper ends, almost at right angles to their normal direction, the truss members on which they are supported being also curved downwardly and secured to the framework L. At points just before these curved portions begin there are auxiliary tracks *g* and *h*, respectively, fixed to suitable supporting structures and placed in each instance outside of the main tracks G and H and extend in nearly the same plane, although end of track *h* is given a slight downward bend or curve. When the skips I and

K on their alternate upward trips bring their rear wheels over the ends of the auxiliary tracks *g* and *h*, the outer treads of said wheels take bearing thereon, providing support for the rear axles of the skips after said wheels have passed beyond the downward bends of the tracks G and H. The front wheels of the skips following the downward bends of the tracks G and H, while the rear wheels continue on their higher planes, the skips I and K are tipped to the position indicated by the dotted lines in Fig. 1 by the completion of their travel, whereby the stock carried up in the skips is discharged and fed into the furnace through the supplemental hopper D.

Parallel to each of the two sets of tracks G and H for their entire length are channel-bars *g'* and *h'*, suitably placed and supported to receive hooked projections *i* and *k* from the axle-bearings of each skip. The object of said channel-bars and hook projections is to form guards which will prevent the possibility of skip leaving the tracks. Pivoted to the rear of skip I is a pusher I', consisting of a frame held to said skip by bar i^3 and having its rear end, to which the hauling-cable is attached, supported on an axle i^4, provided with wheels i^5, constructed to travel on the track H.

The body of the skip K is of practically the same dimensions as that of the skip I, although the axle for the wheels *k'* and k^2 are of a length to adapt them to gage of tracks G, and the hooked projections *k* are also modified, as shown, to meet the channel-bars *g'*. A three-sided frame or bale K' is pivoted to the rear of this skip by means of a bar k^3, the said frame normally extending around the car and attached at the front to the hauling-cable.

In the construction and operation of the foregoing apparatus I follow as closely as practicable the details of Patent No. 730,799, as my invention relates more particularly to the control of the stock after it has left the skips as it descends into the hoppers and to means for insuring a better control of the deposition of stock entering the furnace than has heretofore been practicable in operating blast-furnaces of the modern closed-top type, where the stock goes first into the upper or supplemental hopper from cars, skips, or buckets in which the stock is hoisted and there delivered, as shown and described in Patent No. 730,799, patented June 9, 1903.

In operating such blast-furnaces it is sometimes found that one side of the furnace is working faster than the other side, or, in other words, that one side of the furnace is free and fairly open to passage of the hot gases, while the other side is bound or partially clogged, which condition I have found to be due to the tendency of the coarser and most lumpy part of the stock to enter one side of the furnace, while the other side of the furnace receives the finer and least lumpy part of the stock. This is brought about in this way. The upper hopper being empty, the first skip-load of stock discharged into it will often heap itself against one side of hopper, presenting a sloping surface on which the next skip-load of stock falls, causing the lumps and coarser parts to bound and roll away until stopped by the other side of the hopper, while the finer parts remain where they fell, building up the slope, conducing to the rolling of a still greater proportion of the lumps in the next skip-load, and so on until the upper hopper is dumped, when the above is repeated. The frequent repetitions of the above results in one side of the furnace becoming filled with stock much more permeable than the stock on the other side of the furnace, causing that side of the furnace to take the greater proportion of the blast and to smelt faster, while the condition of the other side of the furnace rapidly becomes worse, reducing the output and necessitating much expense to correct. To overcome the tendency above mentioned and to confine the stock as much as possible to the part of the upper hopper where it falls, I provide in the supplemental hopper D where the stock is received before it is charged into the furnace a centrally-placed vertical partition or diaphragm *d*, by which the supplemental hopper is divided into two separate compartments—viz., compartment *d'* on the side nearest the bridge structure and compartment d^2 on the other side. (See Figs. 1 and 2.) By means of this partition or diaphragm *d* the stock charged into either of said compartments will be retained there, thus preventing the lumps from rolling over to the opposite side of the hopper and becoming separated from the finer parts of the stock which were with the lumps when the skips were discharged.

The diaphragm *d* is secured in the supplemental hopper D, as shown in Fig. 2, and is fixed to the sides thereof by lugs, brackets, or flanges commonly employed in plate-iron construction, the diaphragm being composed principally of two metal plates, the outer edge of each conformed to fit the side of the supplemental hopper D in its cylindrical section and its upper flaring section and extending thence upward to the end of the diaphragm. The edge of said plates may be straight and vertical or may flare out beyond the upper edge of the supplemental hopper D, as may be found expedient. The inner edges of the diaphragm-plates, preferably straight, are far enough from the vertical center line of the supplemental hopper D to leave abundant room for the hanger *c* of the main charging-bell C and the hanger *e* of the supplemental bell E and all necessary movements thereof. To join the two main plates of the diaphragm and hold their inner edges in proper relation to each other, the center line of the main plates occupying the position

of the center radial line of the supplemental hopper, so that the cubical capacity of compartments d' and d^2 are approximately equal, I provide corrugated connecting-plates d^3 d^3, the central portions of which are preferably like half a tube with flat outer portions which virtually form flanges extending over the main plates, as plainly shown in Fig. 2, and by bolts or rivets through said connecting-plates d^3 and the main plates securely hold them together, forming, so to speak, a tubular enlargement of the diaphragm d, inside of which the hangers of the supplemental bell and the main charging-bell may be placed and freely operated without interference by the stock. While this vertical tubular enlargement of the center of the diaphragm is the most desirable arrangement, it may be dispensed with by either of several modifications, such as making the diaphragm one piece of plate, placed on one side of the center of the hopper, clearing the hangers of the bells, making one compartment larger than the other; also, by bending the diaphragm, preferably one piece of plate, at or near the middle to an obtuse angle, as in Fig. 9, by which the bell-hanger e may be in the interior of the angle and the diaphragm so placed that the compartments d' and d^2 on each side thereof may be of the same cubical capacity; also, by curving the diaphragm, as in Fig. 10, by which the central portion of the diaphragm may clear the bell-hanger e; also, by making the central portion of the diaphragm to consist of a corrugation either formed in the plate and integral therewith or made separately and secured in place, as shown in Fig. 11, by rivets or bolts passing through the flat parts of the diaphragm, the corrugated part being of such dimensions as to afford necessary clearance to the bell-hanger e. By either of the above modifications the supplementary hopper is divided into two separate compartments each of which will retain the stock charged therein.

It will be seen that the stock discharged from the lower skip I will always fall into the compartment d', and when charged into the main hopper B by the operation of supplemental bell E it will be so placed as to enter the side of the furnace nearest the bridge structure when the charging-bell C is operated. When stock is discharged from the upper skip K by the dumping thereof, owing to the elevation of the skip K and the distance to the supplemental hopper, there is liability of considerable scattering, also of breaking up lumps of the coke in the stock by the fall. I therefore provide a means for controlling the descent of the stock after it leaves the skip and of guiding its delivery into that part of the supplemental hopper which is not filled from the lower skip—namely, compartment d^2. This means consists, first, of a chute M, and, secondly, of a chute N. The chute M is suitably supported and so placed that when the stock slides out of the skip K said stock will slide on the chute M in the same direction of movement as when it leaves the skip, and thus be carried by the chute M across the central space over the hoppers. The devices for supporting the chute M will permit of adjustment, so that the relative elevation of the ends of the chute can be varied as may be necessary to cause different kinds of stock to slide at proper speeds over the chute.

When the stock leaves the chute M, it will be necessary to change the direction of its movement in order to direct it into the hopper, and for this purpose I employ chute N, which is suitably supported and placed opposite to the lower end of chute M with its bottom at nearly a right angle to the bottom of chute M, so as to receive the stock falling from chute M and conduct it into the supplemental hopper D, where it will fall into compartment d^2, whence it will by the operation of the bells E and C be finally deposited in that part of the furnace opposite the bridge structure.

The chute M extends across the central space over the hoppers, thus crossing the line of the hangers c and e, to which bells C and E are attached and by which they are respectively operated, and to avoid interference with said bell-hangers the bottom of chute M is provided with an opening through which the bell-hangers are passed. This opening is of size and shape to give ample clearance to the hangers in all the various positions to which the chute may be adjusted, and it is closed against the passage of stock into it by upwardly-extending flanges m m. Near the upper end of the chute M the flanges m m are curved toward each other, meeting at the ends to form the apex m', which serves to split the stream of descending stock, after which it is guided by the flanges m m around the opening in the chute.

While the foregoing describes my improvement as applied to blast-furnaces stocked by skips arranged to travel on two tracks one above another, arranged in substantially the same vertical plane, the advantages derived by use of the diaphragm making two separate compartments in the supplemental hopper are by no means confined to furnaces thus stocked, but are equally important in the case of furnaces stocked by skips arranged to travel side by side and dumping on opposite sides of the center of the hopper into lateral enlargements of the upper parts of the supplemental hopper or other means of conducting the stock into said hopper.

I claim as my invention—

1. In blast-furnace-charging apparatus, the combination of a main charging-hopper, a supplemental hopper located over said

charging-hopper and provided with means for discharging its contents into the main charging-hopper, and a diaphragm fixed vertically in said supplemental hopper, dividing same into compartments, substantially as described.

2. In blast-furnace-charging apparatus the combination of a main charging-hopper, a supplemental hopper located over said charging-hopper, and provided with means for discharging its contents into the main charging-hopper, and a central vertical diaphragm in said supplemental hopper, enlarged at the center to surround the bell-hanger, substantially as described.

3. In blast-furnace-charging apparatus, the combination of a main charging-hopper, a supplemental hopper located over said charging-hopper, a skip arranged for discharging stock therein, and a diaphragm fixed vertically in said supplemental hopper, substantially as described.

4. In blast-furnace-charging apparatus, the combination of a plurality of skips conveying stock to the furnace-top, a main charging-hopper, a supplemental hopper located over said charging-hopper and provided with means for discharging stock therein and divided by a vertical diaphragm into compartments each receiving stock from one particular skip, substantially as described.

5. In blast-furnace-charging apparatus, the combination of a main charging-hopper, a supplemental hopper located over said charging-hopper, skips discharging stock at different levels, in substantially the same vertical plane, and an adjustably-supported chute adapted to carry stock from the upper skip across the center line of said hoppers, substantially as described.

6. In blast-furnace-charging apparatus, the combination of a plurality of skips conveying stock to the furnace-top and discharging stock at different levels, a main charging-hopper, a supplemental hopper located over said charging-hopper, and means for chuting the stock from the upper skip across the center line of the furnace and delivering same into one side of said supplemental hopper, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN WEBSTER DOUGHERTY.

Witnesses:

GEO. W. PARSONS,

HOMER L. LITZENBERG.