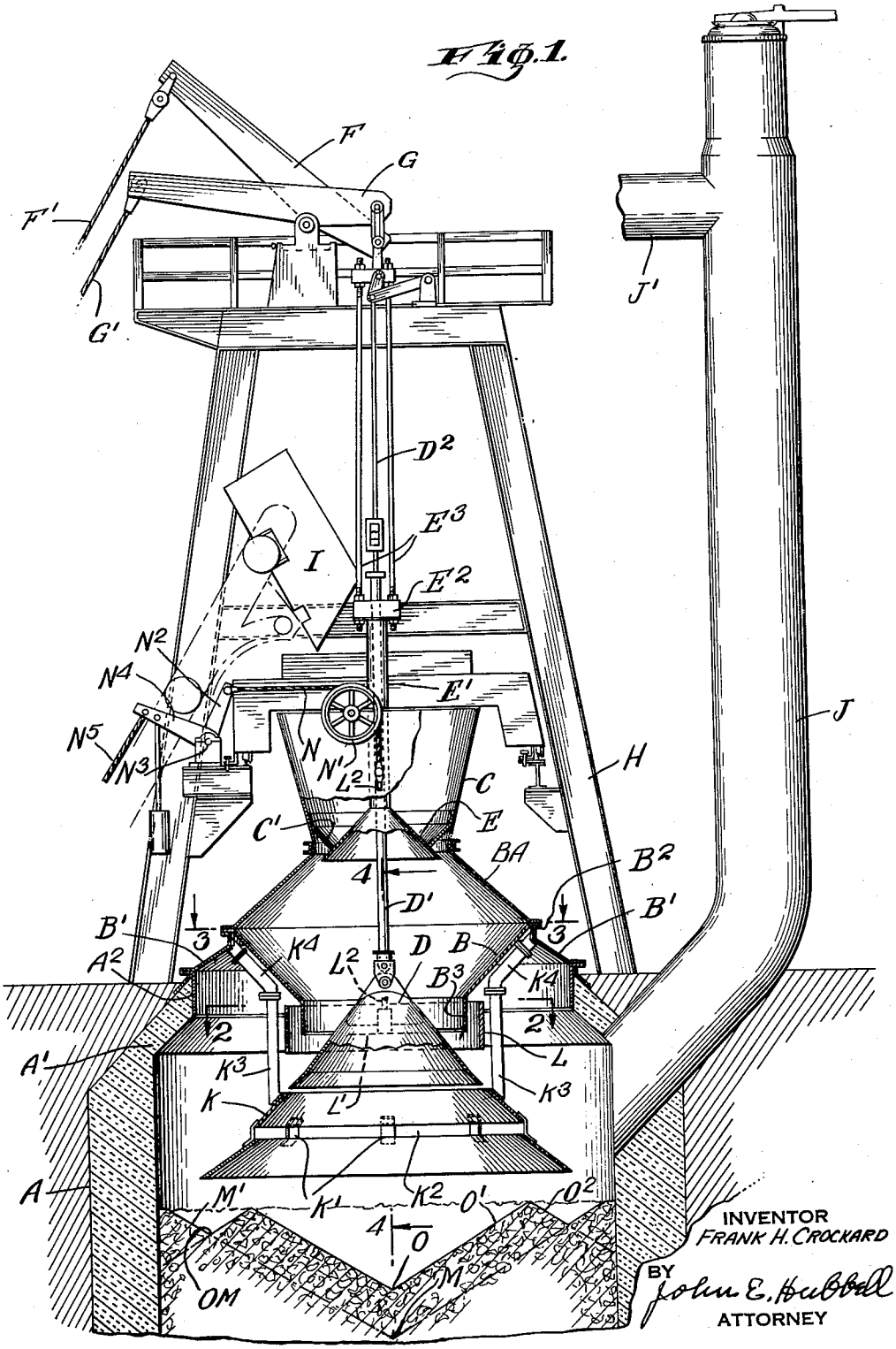
March 26, 1940. F. H. CROCKARD 2,194,971

BLAST FURNACE CHARGING

Filed June 1, 1938 2 Sheets-Sheet 1

Fig. 1.



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FIG. 2.

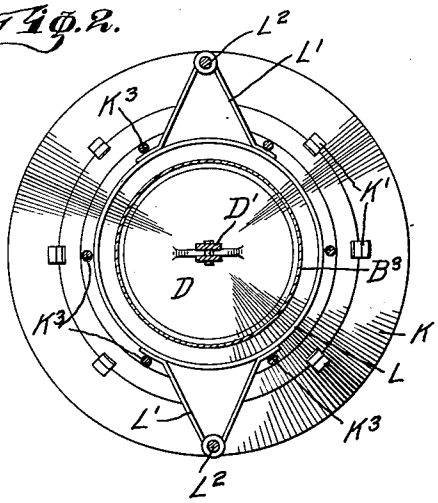


FIG. 3.

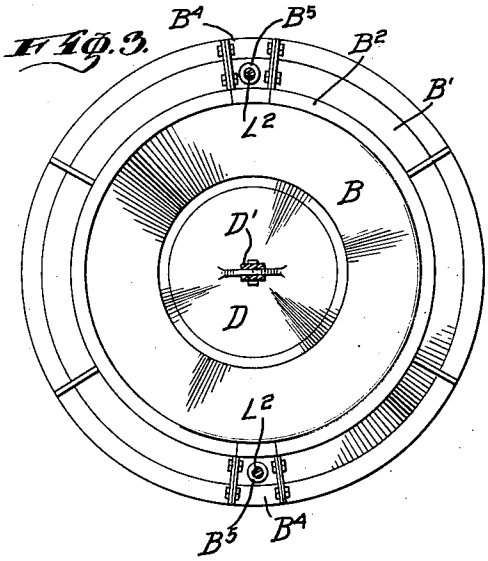


FIG. 4.

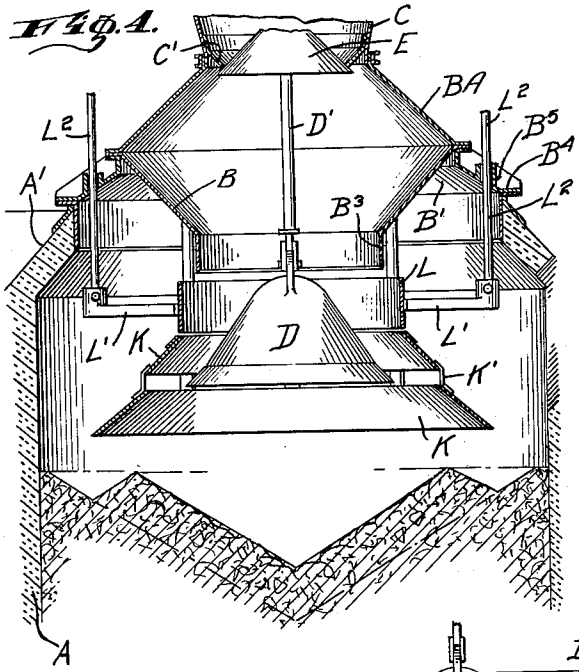
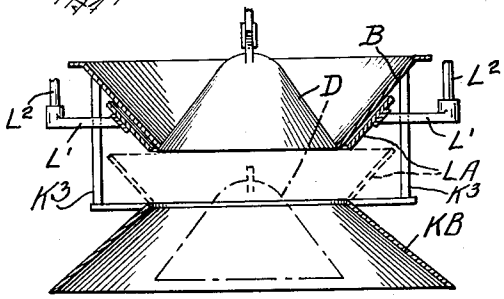


FIG. 5.



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UNITED STATES PATENT OFFICE

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BLAST FURNACE CHARGING

Frank H. Crockard, Birmingham, Ala.

Application June 1, 1938, Serial No. 211,159

5 Claims. (Cl. 214—36)

The general object of the present invention is to provide improved apparatus for charging blast furnaces with the material, commonly called stock, which is treated in the furnace, and which customarily comprises ore, fuel, and one or more fluxing agents. The invention was devised primarily to minimize inequalities in the distribution across the blast furnace stock of different constituents of the stock material, and to minimize inequalities in the stock level in the furnace, which are especially large and harmful in the case of the larger blast furnace units used in the reduction of iron ore, and charged in the manner heretofore customary. Those inequalities have prevented the construction of blast furnaces of as great dimensions and volumetric capacity as are now considered desirable, and the desire to minimize the inequalities has led to the use in large blast furnaces of a throat or stock line furnace cross section, smaller relative to the hearth cross section, than is desirable, or customary in smaller blast furnaces.

It has long been customary to provide a blast furnace with charging apparatus comprising a charging hopper mounted on the top of the blast furnace proper, and a bell which normally closes the bottom hopper outlet, but may be lowered into the blast furnace to permit the hopper to empty into the blast furnace. Customarily, the charging hopper is surmounted by a feed hopper with its bottom outlet normally closed by an auxiliary bell, which is lowered into the main hopper to permit the discharge into the latter of the contents of the feed hopper. Such bell and hopper charging apparatus is practically desirable because of its mechanical simplicity, its operative effectiveness, and the effectiveness of the gas seal which it provides, and a specific object of the present invention is to combine with such charging apparatus, certain distribution controlling means making possible a more uniform stock distribution across the furnace stock, than has heretofore been practically obtainable.

The stock distribution difficulties experienced in charging a large blast furnace in the manner heretofore customary, arise primarily from the fact that the stock rolling and sliding down the bell, impacts against the stationary stock previously charged into the furnace, along a relatively narrow annular zone coaxial with the bell. In consequence, the stock at the top of the charge builds into an annular ridge, or rim, surrounding a conical, crater-like, central cavity in the top surface of the charge. If the ratio of bell diameter to furnace throat diameter is small enough, the conical surface of the crater will intercept a conical outer charge surface sloping down to the surrounding furnace wall from the top of the ridge at which the two conical surfaces intercept one another. In such case, the top surface of the charge, as it appears in vertical diametral section, is suggestive of the shape of the latter M, and the charging operation, resulting in that section is sometimes referred to as "M type charging". With a larger ratio of bell diameter to furnace diameter, the top edge of the conical crater surface may be at, or close to, the furnace wall, and the top of the charge, as seen in vertical diametral section, is then suggestive of the shape of a V, and the charging operation is then sometimes referred to as "V type charging".

With either type of charging, more than an average amount of the coke and the larger lumps of ore and fluxing material will slide or roll down the inner inclined surface of the charge with V type feeding, and will move down both inclined surfaces of the charge with M type feeding, with the result that with the V feeding, a central core portion of the charge will be more open or pervious than the main body of the charge, and with M type feeding, there will be a relatively porous central core and a relatively porous annular outer portion of the charge.

The existence of any such vertically extending pervious charge section is directly detrimental, because it results in gas channeling, or excessive concentration of the upflowing gases in the pervious charge section, with resultant gas velocity and flue dust loss increases. The previously mentioned decrease in throat diameter relative to hearth diameter in large modern blast furnaces, also contributes to objectionably high gas velocities and resultant high flue dust losses. A reduction in gas velocities and flue dust losses, results in a reduction in the abrasion of the inner wall of the furnace particularly in the upper portion of the furnace. The concentration of coke and large lumps of heavier charge constituents, adjacent the furnace wall occurring with M type charging may also result in a severely detrimental furnace wall action.

The lack of uniformity, across the furnace chamber, in the stock composition, as well as in the volume of the upflowing gases, contributes to a lack of uniformity in, and general retardation of, the preparation or reduction of the charge, so that reactions which should occur wholly or mainly in upper portions of the furnace where the temperature does not exceed 1000° C., are largely effected in lower portions of the furnace

where the temperature is substantially in excess of 1000° C., with the result of increasing the fuel consumption per ton of ore treated. The reduction of the ore effected in the upper portion of the furnace at a temperature not in excess of 1000° C. results in large part, at least, from the exothermic formation of CO from the carbon in the coke and the oxygen content of the ore, while the reduction of the charge in the lower portion of the furnace, where the temperature is substantially in excess of 1000° C., results in a substantial conversion of previously formed CO_2 into CO, which is a highly endothermic reaction. The reduction of the ore in the lower hotter portion of the furnace, thus not only increases the fuel consumption per ton of ore treated, but is also objectionable because it withdraws heat from, and tends to cool the lower portion of the furnace, where high temperatures are desirable.

Sufficient uniformity across the furnace stock line, in stock composition and in charge perviosity, may be obtained by the use of the present invention in blast furnaces even larger in their stock level cross sections than the largest existing blast furnaces. The invention permits of the construction of blast furnaces having a larger and more desirable ratio of stock level diameter to hearth diameter than is found in existing large blast furnaces. The increase in the last mentioned ratio is desirable not merely because it tends to decrease furnace throat gas velocities, but also because it permits of an increase in the charge capacity of the blast furnace, which may amount to 16% with the same height of furnace. With the same rate of ore treatment, such increase in the volumetric capacity of the furnace, permits of a substantially slower downward movement of the charge in the furnace, and hence provides more time for the preparation or reduction of the charge.

With the more homogeneous mixture so obtained, the work of preparation (drying, calcining, and reduction) is effected with much greater uniformity throughout any given horizontal plane in the stock column, as a result of much more uniform temperature, velocity and composition of the ascending gases. Uniformity in each of these factors, contributes to the more efficient and economical operation of the furnace. The use of the invention in blast furnaces of the largest size, or super blast furnaces, thus permits of a substantially closer approach to the fuel economy theoretically obtainable in the operation of very large blast furnaces, than has heretofore been practically possible.

In accordance with the present invention, the stock fed into the furnace in different charging operations, is delivered to the charge top surface annular zones of different diameters. In the preferred practical mode in carrying out the invention, I make use of a main charging bell, somewhat smaller in diameter relative to the diameter of the top of the furnace than is customary, in combination with an annular distributing element, which acts as an extension of the main charging bell in certain charging operations which may be designated large bell operations, and which alternate with other charging operations, which may be called small bell operations, in which the distributing element does not serve as an extension of the main belt. In practice, the main bell and distribution element are advantageously so proportioned, that the effective bell diameter with the distribution element used as an extension of the main bell, is somewhat larger relative to the diameter of the furnace at the stock level, than would be practically permissible if all the charging operations were of the large bell type, and the main bell is somewhat smaller than would be practically permissible if all of the charging operations were small bell operations effected without the use of the distributing element.

Advantageously, my improved charging apparatus also includes a vertically movable annular barrier or sleeve which is held in an inoperative position during large bell charging operations, but is lowered for each small bell charging operation into a position in which it forms an uprising sleeve extension of the distributing member extending around the central opening in the latter. In its last mentioned position the barrier or sleeve prevents such stock movement down over the distributing element as occurs in a large bell charging operation.

In the practice of the present invention, it is not necessary that each large bell operation should precede one, and follow a subsequent small bell operation. On the contrary, groups each consisting of one or more large bell charging operations may alternate with groups, each consisting of one or more small bell charging operations. The large and small bell charging operations, tend separately to produce the characteristic V and M charging effects, respectively. With a suitable alternation of the large and small bell operations, the top surface of the charge will comprise a central crater or conical cavity and a surrounding groove or valley, V shaped in cross section, but the depth of the central crater will be appreciably less than the crater depth with ordinary M charging, and the depth of the surrounding groove will be appreciably less than that of the groove between the furnace wall and the conical outer top surface portion of the charge formed with ordinary M charging.

In constructing a blast furnace of increased capacity, an increase in the diameter of the charging hopper and main bell, in proportion to the increase in furnace diameter, not only fails to avoid improper stock distribution as the size of the furnace is increased, but gives rise to serious installation, renewal and operating cost problems. Those problems need not arise in the use of the present invention which permits the main bell for a very large furnace to be even smaller than is now customary in moderate-sized furnaces. My distribution element, while of large diameter, is a stationary element of relatively light weight, and in a preferred form of the invention, it may be readily removed from the furnace when necessary for replacement or repairs. My invention in its preferred form, also includes special provisions facilitating the removal of the above mentioned barrier or sleeve member.

To avoid, or correct for, non-uniformity in stock composition across the furnace stock line, it may be desirable in some cases to vary the relative amounts of stock supplied by large and small bell charging operations. The improved charging apparatus permits any particular stock constituent or variety, i. e. coarse or fine ore flux or fuel, to be delivered at any time to whichever of the two charge top zones then needs such stock constituent or variety. The use of the invention also contributes to a reduction in the temperature of the gases discharged from the furnace, and a consequent reduction in the amount of water needed in the preliminary gas washers to which the gas is customarily passed.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention. Of the drawings:

Fig. 1 is an elevation in section of the upper portion of a blast furnace and associated apparatus;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a partial section on the line 3—3 of Fig. 1;

Fig. 4 is a partial vertical section taken at right angles to Fig. 1, and showing parts in one furnace charging condition; and

Fig. 5 is a partial section taken similarly to Fig. 4, illustrating a second modification.

In the drawings, I have illustrated the use of my invention in a blast furnace, which, for the most part, is of conventional design and construction. As shown, the stock section A of the furnace terminates at its upper end in a conical masonry top portion A', supporting, and reinforced by an annular metallic casing A^2, at the margin of the charging mouth or top opening in the furnace masonry. As shown, the main charging hopper B is directly supported by an annular metallic top cover element B', in the general form of the frustum of a hollow cone, and the annular upper edge of which serves as an annular support for a circumferential rib portion B^2 of the hopper B at the upper end of the latter. The latter, as shown, is in the general form of a frustum of a hollow cone, with its large diameter end uppermost. As shown, the hopper B has a lower end portion in the form of a cylindrical flange or neck B^3.

A feed hopper C which may be rotatable, is shown as coaxial with, and above the hopper B, and in the form of a frustum of a hollow cone, with its lower and smaller end extending into the upper end of the hood BA for the main hopper B. The hopper C may be supported and rotated in the usual manner, which does not need to be illustrated or described herein.

Charging bells D and E are associated with the hoppers B and C, respectively, in the usual manner. In its closed position the outer edge portion of the conical upper surface of the main bell D, is in engagement with the lower edge of the cylindrical bottom flange portion B^3 of the main hopper, and in the closed position of the auxiliary bell E, the latter engages the lower edge of a conical bottom flange C' of the feed hopper. As shown, the main bell D is operated by a lever F through a suspension link comprising a lower section D', and an upper section D^2. The auxiliary bell E is operated by a lever G through a link conection comprising a lower tubular portion E' connected through a crosshead E^2 to rods E^3 forming the upper portion of the link connections. As shown, the main bell link connection D' passes axially through, and is guided by the tubular portion E' of the auxiliary bell linkage. The levers F and G are journalled in the upper portion of the usual metallic structure H extending upward from, and supported by the blast furnace shell A, and constituting a support for various operating mechanisms, work platforms, etc. Cables F' and G' connect the levers F and G to power actuated winches or other means (not shown) for oscillating the levers to raise and lower the bells D and E.

I have not thought it necessary to illustrate the conveyor or hoisting mechanism, which may be of the usual character, employed to move the usual skip car I, shown in Fig. 1, back and forth between the level at which it discharges stock material into the hopper C, and the ground or other level at which the skip car is loaded with stock material. J represents an uprising gas outlet pipe, open at its lower end to the top of the blast furnace chamber. Usually, there are a plurality of such outlets, each connected adjacent its upper end, as by means of a lateral connection J', to a downcomer (not shown) by which the blast furnace gas escaping from the blast furnace is ordinarily passed to gas cleaning apparatus, preparatory to its use as a fuel gas.

In respect to the features of construction and arrangement already referred to, the blast furnace and associated apparatus illustrated in the drawings, do not differ from the present practice, although it is to be noted that the ratio of the diameter of the main charging bell D and associated hopper B, to the diameter of the upper end or throat portion of the blast furnace stock, is smaller than is customary, and smaller than would be necessary, but for the use of the special distributing apparatus associated with the bell D in accordance with the present invention, and now to be described.

My novel distribution apparatus, comprises a distributor element K of the general form of a truncated hollow cone, coaxial with the bell D and hopper B, and having its smaller upper end located at a level somewhat below the lower edge of the bell D, when the latter is in its upper closed position. The distributor element may be a one-piece frustum of a hollow cone, as shown in Fig. 5, but the distributor K shown in Figs. 1–4, is divided into upper and lower annular sections, the lower section having its upper end below the lower end of the upper section, and being supported from the latter through connecting hanger parts K'. To increase its retarding effect on the velocity of stock moving downward over it, the lower distributor section has its outer surface to the horizontal at an angle smaller than the corresponding angle for the upper section. The spacing apart of the upper and lower sections provides an annular outlet K^2 between the two sections for blast furnace gas, desirable under some operating conditions.

As shown, the distributor K is supported through vertical suspension elements or arms K^3, each connected at its lower end to the upper section of the element K. In the construction shown in Fig. 1, each arm K^3 has its upper end connected to an inclined arm K^4 which is connected at its upper end to the annular metallic top wall element B'. In the modified construction shown in Fig. 5, the vertical arms K^3 are connected at their upper ends to the hopper B.

As shown, the top opening in the element K is just large enough to permit the vertical passage therethrough of the larger lower end of the main bell D. In the large bell charging condition of the apparatus D, shown in Fig. 1, the lower end of the bell D is at, or close to, the top level of the distributor K, and the latter is then adapted to serve in effect as an annular extension of the bell D, so that the latter in conjunction with the element K, is the equivalent for distribution purposes of a main bell substantially larger than the bell B.

In the small bell charging condition of the apparatus shown in Fig. 4, the lower portion of the bell D is within the element K, and its lower edge is at a level substantially below the top of that element, so that the stock may then pass from the hopper B down on to the stock pile, or charge, in the furnace through the annular space between the bell D and the element K.

To insure that in the small bell charging operations, none of the stock will move down over the distributor K, I advantageously make use of a vertically movable barrier or sleeve member L, in the form of a short cylinder coaxial with the bell D. Except during the small bell charging operations, the member L is held in an inoperative upper position, shown in Fig. 1, in which it surrounds, and is in telescopic relation with, the lower cylindrical flange portion B^3 of the hopper B. The internal diameter of the member L may be slightly less than the diameter of the lower edge of the bell D, in which case, the member L is allowed to remain in engagement, and move down, with the bell D, as the latter is lowered in each small bell charging operation, until the member L engages the member K. When the internal diameter of the member L is slightly larger than the diameter of the lower edge of the bell D, the member L may be moved down into engagement with the member K for each small bell charging operation, prior to any down movement of the bell D from its upper closed position. In each case, the member L prevents the stock material from moving downward over the member K, during any stage of the small bell charging operation.

As shown, the member L is supported and moved by means of horizontal arms L' secured to the member L and extending away from the latter in diametrically opposed directions, and each connected to the lower end of a corresponding suspension rod L^2. Each rod L^2 passes upward through a separable section B^4 of the metallic top cover element B'. The parts B^4 are formed with hollow bosses B^5 through which the rods extend, and which provide elongated bearings for the rods and give stuffing box protection against excessive leakage. The upper ends of the suspension rods L^2 may be connected to any suitable mechanism for raising and lowering the member L. As shown, each rod L^2 has its upper end connected to the lower end of a rope N running over a guide pulley N' and secured to an arm N^2 of a counterweighted rock shaft N^3. The latter is provided with an arm N^4 connected by a cable N^5 to a winch or other mechanism (not shown) for oscillating the rock shaft N^3 to raise and lower the element L.

Blast furnace charging apparatus is subject to relatively rapid deterioration, and it is highly desirable, if not practically essential, to provide for charging apparatus repairs and replacements, while the furnace is under blast. As those skilled in the art will recognize, the known bell and hopper construction illustrated is of a type permitting the relatively ready removal of the bell and hopper parts of the apparatus. With the internal diameter of the member L larger than the diameter of the bell D, the inclusion in the charging apparatus of the member L and element K does not interfere with the removal and repair or replacement of the bell and hopper parts in the manner heretofore customary. To permit the ready removal of the member L, when necessary, or desirable, for its repair or replacement, or because its diameter is so small as to require its removal in order that the bell may be removed, I make the sections B^4 readily separable from the remainder of the annular member B', and large enough for the passage of the ends of the arms L' through the gaps in the annular member B' opened by the removal of the parts B^4.

To permit the ready bodily removal of the element K from the furnace, while the latter is under blast, I so relatively proportion the casting A^2 and member K, that the latter may be bodily moved upward through the casing A^2 when the metallic top cover B' is removed. To facilitate its removal, I preferably form it of cast iron or steel sections, including the sections B^4, which are normally bolted together.

In Fig. 1, M designates the apex or bottom of the conical cavity which would be formed in the top of the charge if all of the charging operations were of big bell V type, effected with the bell D in its intermediate position shown in Fig. 1, and resulting in the formation of the conical charge surface portion M'. In Fig. 1, also, O designates the apex or bottom of the central cavity actually formed in the top of the charge, and O' designates the conical cavity surface, and O^2 the outer conical charge surface, formed by the small bell charging operations, effected with the bell D and element L in their positions shown in Fig. 4. If all of the charging operations were of the small bell type, the surface O^2 would continue, as indicated in dotted lines, into intersection with the inner wall of the furnace stock. With the alternate large and small bell charging operations, characteristic of the present invention, the surface O^2 and the surface M' each has its lower edge in the line OM, which is the line of intersection of the two surfaces. As those skilled in the art will understand, the position of the surfaces O' and O^2 relative to the surface M' varies somewhat with operating conditions. With those surfaces relatively disposed as shown in Fig. 1, if the next charging operation were of the big bell type, it would raise the surface M' relative to the surfaces O' and O^2, and would eliminate a lower portion of the surface O^2, while, if of the small bell type, the next charging operation would raise the surfaces O' and O^2 relative to the surface M' and shorten the latter.

As will be apparent, the dimensions of the different parts of the apparatus shown in the drawings, may vary with the size, type, and contemplated mode of operation of the blast furnace in which the invention is embodied. Furthermore, some variations in relative proportions may be made without significantly affecting the general operative results obtained. By way of illustration and example, and not by way of limitation, I note that if the diameter of the throat or upper portion of the furnace shown in Fig. 1, is twenty-five feet, as is possible when my invention is used, the diameter of the lower edge of the bell D may well be ten feet, and the diameter of the lower edge of the element K may well be twenty feet, thus providing an annular space of two and one half feet radial extent, between the lower edge of the distributor K and the furnace wall. While blast furnaces with hearth and bosh diameters as great as twenty five feet are now in use, the maximum throat diameter of any blast furnace in use, of which I have knowledge, is about nineteen feet.

The substantial character of the differences between the charge formed when a large blast furnace is charged in accordance with the pres-

ent invention, and the charge formed when the same blast furnace is charged in accordance with the regular practice of the prior art, will be readily recognized by those skilled in the art. The inclination to the horizontal of the conical surfaces M' and O' of Fig. 1, depends upon the angle of repose of the stock, and may vary somewhat with changes in the character of the stock, but ordinary variations in stock material will not result in much variation in the inclination of said surfaces.

In considering the stock distribution advantages obtained, by reducing the maximum distance between the top and bottom of a conical portion of the charge top surface, account should be taken of the fact that variations in the composition of the charge at different distances from the furnace axis, are dependent in part upon the velocity of movement of the larger stock lumps down said surface, and that said velocity is not in linear proportion to said distance, but is more nearly proportional to the square of the distance As will be apparent, the depth of the central cavity in the top surface of the charge shown in Fig. 1, may be reduced by reducing the diameter of the lower edge of the bell D, and correspondingly reducing the top diameter and increasing the vertical extent of the distributor K.

Experience has shown that in the charging of a blast furnace by means of a bell, the clearance between the lower edge of the bell and the inner wall of the furnace throat, should be about two and one half feet. Even with that amount of clearance the velocity of gas flow past the edge of the bell is quite high during the charging operation in which the down moving stock obstructs the flow path. The annular port K^2 formed in the distributing member K, is adapted to pass a considerable portion of the gas moving upward from the charge during the charging operation, and thereby makes the gas velocity less than it would be otherwise.

The general principles of the present invention may be utilized in, and by the use of, apparatus of widely different forms. For example, the distributor K may be replaced by a distributor in the form of a single hollow truncated cone section, like the distributor KB of Fig. 5.

Where, for any reason, it is desirable to dispense with the bottom cylindrical flange portion B^3 of the main hopper, while still making use of a stationary distributor and movable barrier element, the cylindrical sleeve L first described, may be replaced by a barrier element LA, as shown in Fig. 5, in the form of a frustum of hollow cone having approximately the same conical angle as the lower section of the hopper B. With this arrangement when the barrier member LA is raised to its upper, inoperative position, it is in nesting relation with the lower conical portion of the hopper B, and may have its lower edge at approximately the same level as that of the bottom opening in the hopper.

I regard the use of the special annular top cover member B' as generally advantageous not only in new furnace constructions, but also when my improved charging means are installed in existing blast furnaces, since, in such case, the use of my invention will make desirable a reduction in the original bell and hopper diameters. The special cover part B' may be omitted, however, without interfering with the use of a distributor member of as large diameter as is desirable, since, when necessary, the distributor may be formed in two parts separately inserted into the furnace and then welded or otherwise secured together. When distributor replacement becomes necessary, the old distributor may be cut into sections, as by means of a torch, small enough to be readily removed from the furnace.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the forms of the apparatus disclosed, and in the described charging procedure, without departing from the spirit of my invention as set forth in the appended claims.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a blast furnace, the combination with a main charging hopper at the top of the furnace, of a main charging bell adjustable from an upper hopper closing position downward into intermediate and lower charging positions and a stationary annular element within the furnace and through which said bell is adapted to pass as it is moved downwardly into its lower charging position, said bell when in its intermediate charging position having its lower edge at about the same level as the top of said element, and being then adapted to deflect stock onto said annular element, and being adapted when in its lower position to deflect stock beneath said annular element, and an annular sleeve or barrier member movable from an inoperative upper position into a lower position in which it surrounds the opening in said annular element and extends upwardly from the latter and is adapted to prevent stock from passing onto the annular element as the bell is being moved between its closed and lower charging positions.

2. A blast furnace combination as specified in claim 1, in which the lower portion of said hopper and said barrier member are cylindrical in form and in telescopic relation.

3. A blast furnace combination as specified in claim 1, in which the lower portion of said main hopper and said barrier member are of conical shape and in nesting relation when said barrier member is in its inoperative position.

4. In a blast furnace, the combination of an annular furnace top portion, an annular metallic cover plate having its outer edge removably supported by said top portion and having an internal diameter substantially smaller than the internal diameter of said top portion, a main charging hopper supported by said annular top plate and detachably connected thereto and having an external diameter smaller than the internal diameter of said top portion, a main bell adapted to close the lower end of said hopper when in its upper position and when in a lower position to deflect stock passing out of the hopper away from the axis of the furnace, and an annular element normally within the furnace and coaxial with said bell, and having an internal diameter larger than the diameter of the lower edge of the bell, and having an outside diameter smaller than the inside diameter of said top portion, whereby said annular element may be moved through said top portion when said annular wall member is removed, said bell and element being relatively adjustable into one charging condition in which stock passing out of the hopper is deflected by the bell on to said annular element, and into a second charging

position in which the stock deflected by the bell passes beneath said element.

5. In a blast furnace, the combination of an annular furnace top portion, an annular metallic cover plate having its outer edge secured to said top portion, and including two separable, diametrically opposed portions, a main charging hopper supported by said annular member and detachably connected thereto and of an external diameter smaller than the internal diameter of said top portion, a main bell adapted when in its upper position to close the lower end of said hopper and when in a lower position to deflect stock passing out of the hopper away from the axis of the furnace, an annular element normally within the furnace and coaxial with said bell, and having an internal diameter larger than the diameter of the lower edge of the bell, said bell and element being relatively adjustable into one charging condition in which stock passing out of the hopper is deflected by the bell onto said annular element, and into a second charging position in which the stock deflected by the bell passes beneath said element, an annular barrier member normally within the furnace and movable from an upper inoperative position into a lower position in which it surrounds the opening in said annular element and extends upwardly from the latter and is adapted to prevent stock from passing on to the annular element as the bell is being moved between its closed and lower charging positions, and means for raising and lowering said barrier member comprising supporting parts extending through said separable portions of said annular wall member, whereby when said portions and said hopper are removed, said barrier member may be moved out of the furnace through said top structure and annular wall member.

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