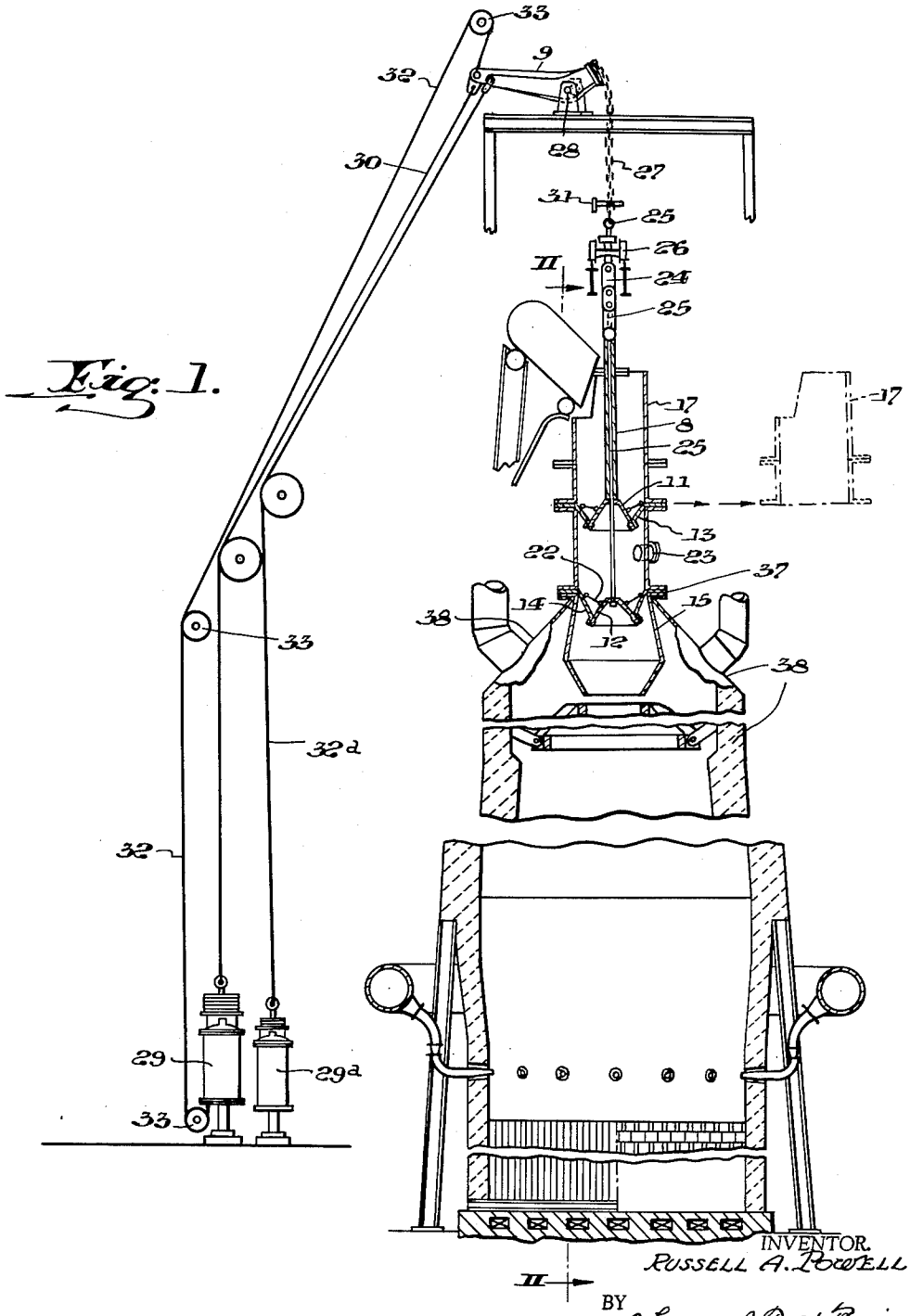
Oct. 2, 1962 R. A. POWELL 3,056,518

METHOD OF REPLACING BLAST FURNACE BELLS AND HOPPERS

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Fig. 1.



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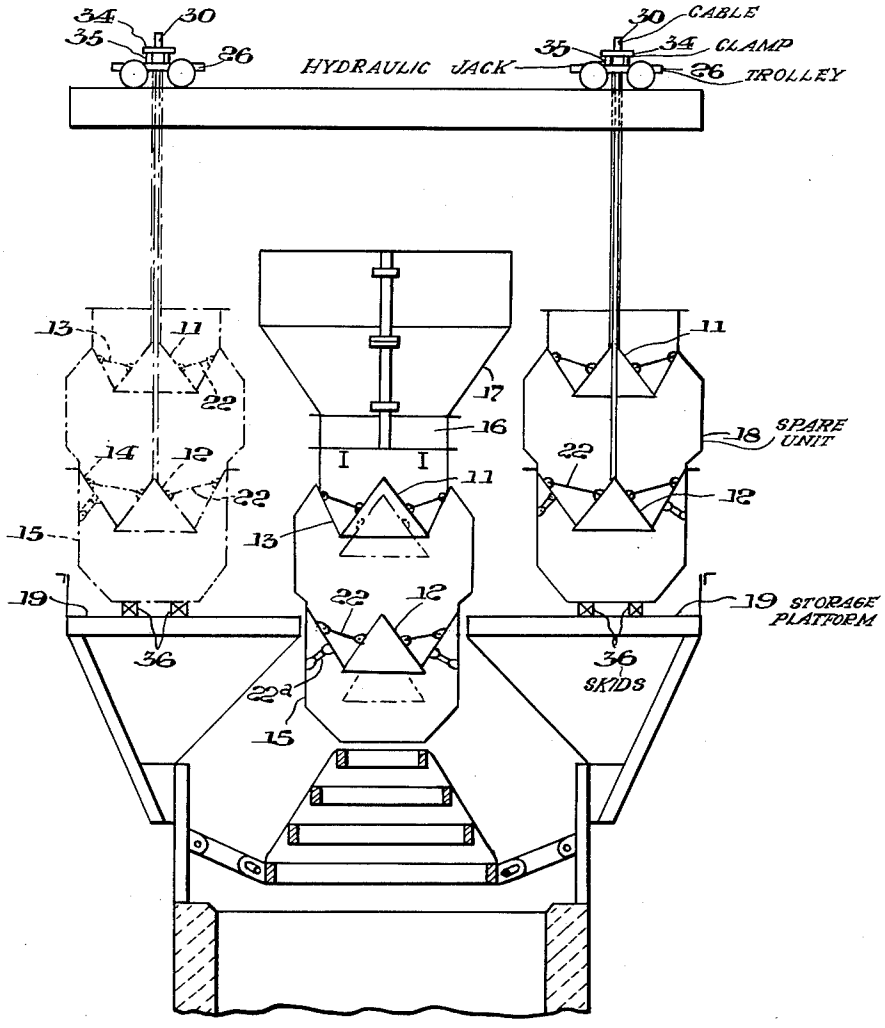


Fig. 2.

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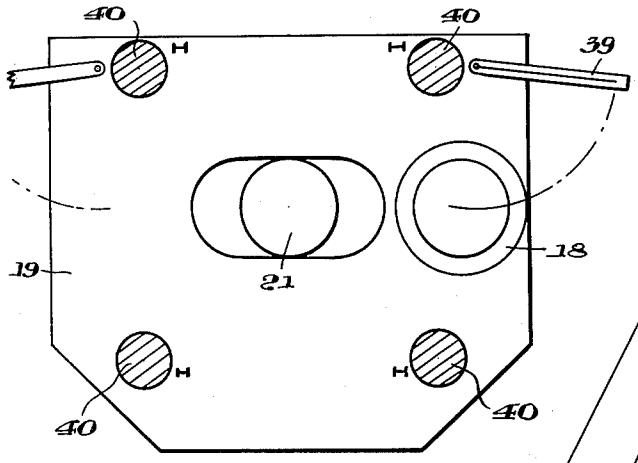


Fig. 3.

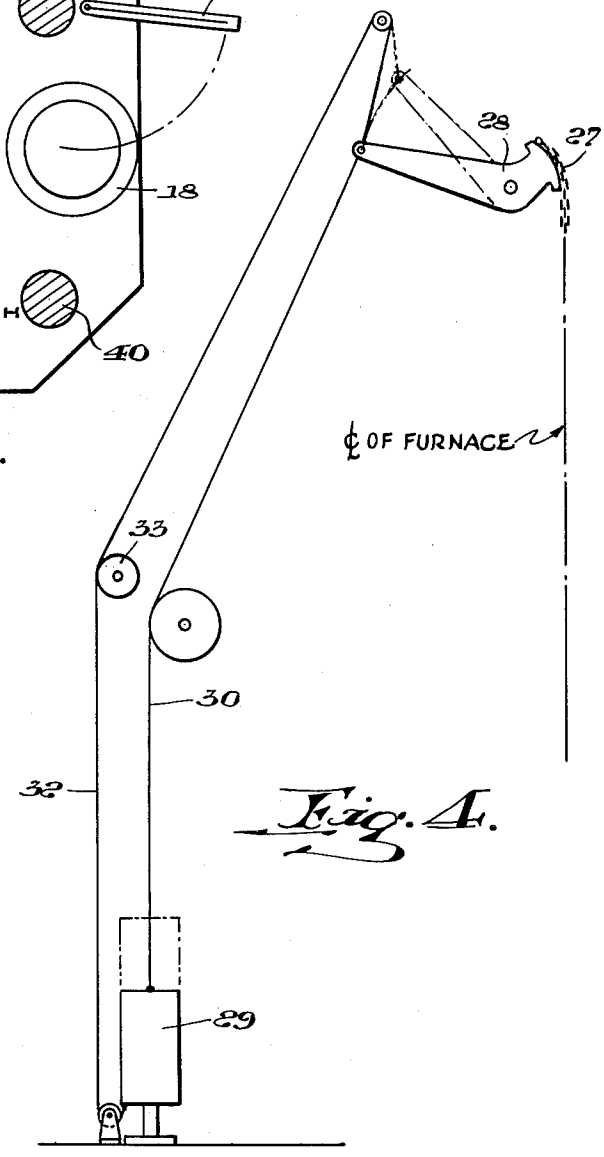


Fig. 4.

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METHOD OF REPLACING BLAST FURNACE BELLS AND HOPPERS

Filed Aug. 16, 1961 4 Sheets-Sheet 4

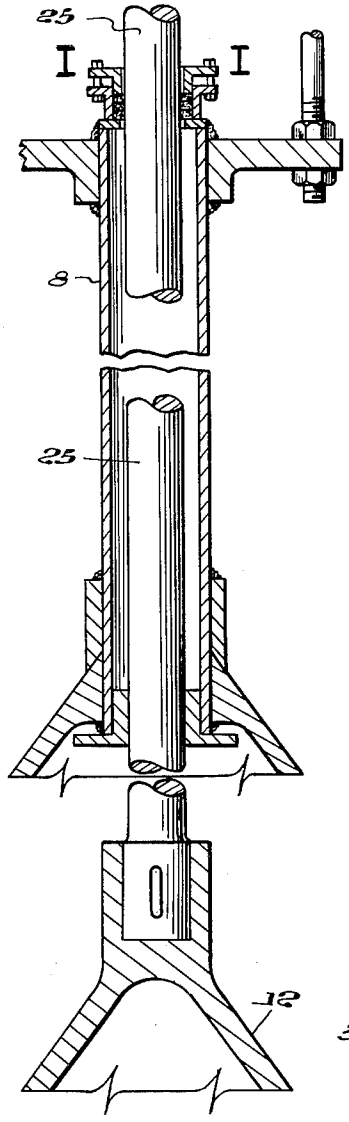


Fig. 5.

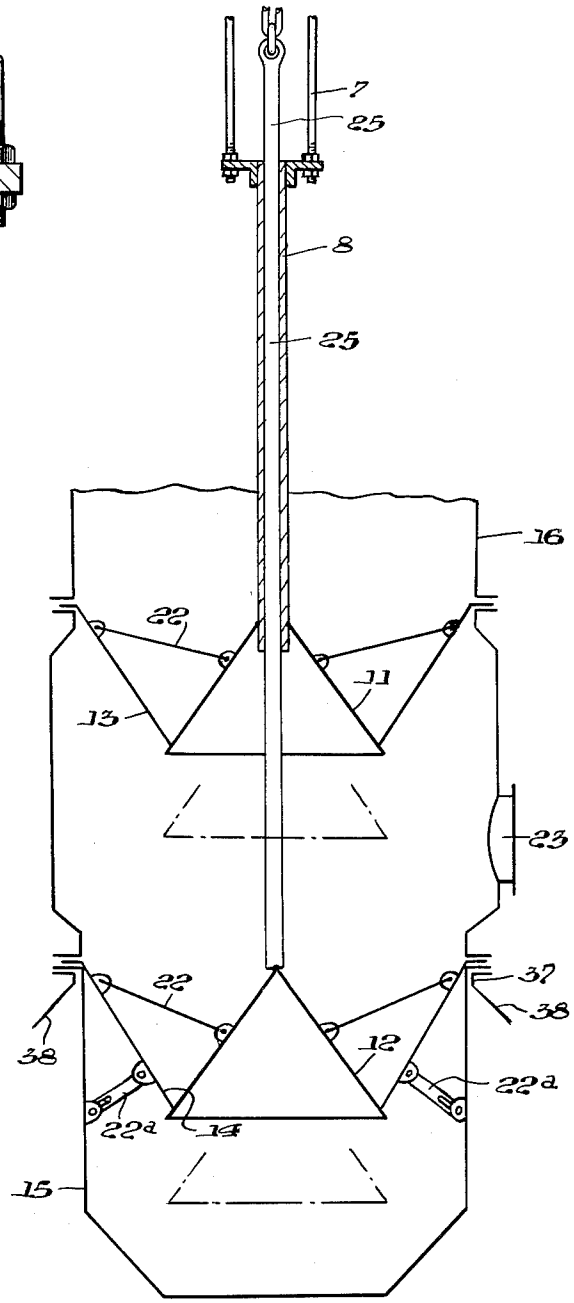


Fig. 6.

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United States Patent Office 3,056,518 Patented Oct. 2, 1962

3,056,518

METHOD OF REPLACING BLAST FURNACE BELLS AND HOPPERS

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Filed Aug. 16, 1961, Ser. No. 131,758
3 Claims. (Cl. 214—152)

This invention relates in general to the erection, installation and repair of the top construction of blast furnaces, and more particularly, to a novel method for the rapid removal and replacement of the bell and hopper assembly at the top of blast furnaces.

More specifically, the invention provides a novel method for quick change of the bells and hoppers in blast furnaces working at higher top pressures as compared with furnace operating as heretofore with top pressures of less than ten pounds.

A primary object of the invention is the provision for utilization of a spare assembly dismantled and reassembled at a region alongside the top of the furnace by means of the usual bottom bell lever hoisting mechanism and booms at the top of the furnace.

A further object of the invention is the provision of a method for the convenient replacement of bells and hoppers as aforesaid with a complete spare assembly, and the removal from and replacement in the furnace tops of the bells and hoppers in unison as a one-piece unit.

The novel features of the invention are equally applicable to conventional furnace top assemblies having means for rotating the small bell and hopper as well as to assemblies having nonrotating small bells and hoppers, as well as assemblies with a throat or skirt around the lower bell.

The method of the invention is especially suitable for and adapted to simply and more economically replace the bell and hopper assembly more frequently, such as, every year, as is or will be necessary with the more general operation of blast furnaces at super pressures as high as thirty pounds top pressure, instead of every few years as has been the practice with blast furnaces operating at low top pressures below ten pounds top pressure.

The methods of operation for change of the bells as practiced heretofore with furnaces operating at low top pressure do not lend themselves to use with furnaces operating at super high top pressures, since the steps and acts employed for changing the bells with the former, occur only at long periodic intervals and take too long a time for use in connection with faster operating furnaces operable with higher internal pressures, which require the bells to be more expeditiously changed more frequently, in order to keep the furnace efficiently operative to warrant their construction and operation at such super high top pressures.

As a matter of reference with a conventional furnace top assembly the removal and replacement of the bells entails the following operations.

A large bell and hopper are located at the top of a blast furnace to act as a valve closure to seal the top of the furnace against the escape of gas and to charge the furnace burden, comprising ore, coke, limestone and other materials. These are surmounted by a small bell and hopper to seal the furnace against escape of gas when the large bell opens to charge the furnace and to charge the large bell hopper with the furnace burden when the large bell is closed to seal the furnace. Each bell and its hopper are provided with mating seating surfaces which require accurate concentric mounting of the bells with their hoppers to provide the proper seating engagement for sealing against the escape of gas. The bells are operated by means of bell levers above the

furnace top to raise and lower the bells relative to their hopper seats. The bell levers act to hoist separate bell rods for the respective bells, which rods are secured to their bells at the vertical center of the furnace, with the large bell rod passing up through the small bell rod.

In charging burden into the furnace, the small bell and large bell are lowered in sequence to fill the furnace while preventing the escape of gas. With rotating bells, the small bell and the hopper are mechanically rotated to distribute the ore, coke and other materials on the large bell, which large bell is usually lowered by its bell lever and bell rod after three to seven lowerings of the small bell.

With nonrotating bells of the same size, these are opened in sequence after each skip car of material is brought to the top of the furnace and dumped into the receiving hopper above the upper bell hopper.

The bell levers are mounted on a platform above the receiving hopper and are operated through cables and sheaves by pneumatic cylinders or electric motive means based at ground level.

In erecting the charging system heretofore, several successive operations were required to install the large bell and hopper either during initial erection or repair of a blast furnace. The weight of the large bell and large hopper usually requires that they be hoisted one at a time, by using an outrigger and trolley provided for this purpose with a temporary construction hoist moved in alongside the furnace and located at ground level. This hoist mechanism hoists these parts during raising and lowering the large bell and hopper, to withdraw them from or insert them into the furnace top. For mounting them on the furnace, the large bell is first either suspended temporarily in the furnace stack by cables or chains from the furnace top or top ring, or else lowered in the furnace to rest on the furnace bottom. The large bell hopper is then installed in the top of the furnace, on the top ring. The large bell is then hoisted to seat against the large bell hopper and its bell rod is extended up through the hopper and connected to the large bell lever pivoted on a platform above the top of the furnace. The large bell is then centered with respect to its hopper in various ways.

The various parts of the complete top charging assembly are of such size and weight that the sequence of erection is: large bell, large bell hopper, large bell rod, gas seal, revolving distributor, small bell, small bell seat, revolving hopper and receiving hopper.

With the trend of the blast furnace industry working toward higher top pressures, larger furnaces, and higher throughput at an accelerated rate, such prior art time consuming methods do not lend themselves to use with the present trend of furnaces, especially since with the present trend, the furnace bells will require replacement more frequently. The replacement of the bells and hoppers by moving in auxiliary hoisting equipment to elevate replacement parts into position, is not expeditious.

Accordingly, the present invention provides for blast furnace designed and adapted for operation at high top pressure, with consumption of larger tonnages of raw materials, a method of quick change replacement that is more desirable because the bells and hoppers may be readily removed and replaced together in unison as a one-piece unit, with the replaced unit stored at the top of the furnace as a spare by means of booms, such as jib cranes to handle component parts to and from ground level while the furnace is back in operation with the other replaced spare. The hoisting to raise and lower the large bell and its hopper into and out of the furnace is effected by the large or bottom bell lever mechanism

already is position for operating the bottom bell in place in the furnace under full tonnage conditions.

The bottom bell lever mechanism and its hoisting components as usually installed in furnaces of this type are usually designed to provide for a weight of large bell plus charge materials supported by it before dumping, in the category of 100 tons. This method invention takes advantage of this fact to utilize this hoisting mechanism for hoisting the entire charging assembly as a one-piece unit into and out of seating relation with the top of the furnace for clearance, to replace it with a like spare unit, in rapid removal and replacement of the entire bell, hopper and auxiliary equipment.

When the bottom bell is detached from the bell lever for shifting the charging unit at the top of the furnace according to the method of this invention, an auxiliary cable is used between the pneumatic cylinder and the bell lever to provide control of lever movement in both directions.

While the method of this invention utilizes the bottom bell lever for the hoisting of the unit into and out of charging relation with the furnace top for quick change, the invention is not limited in all its aspects to such medium as the motive element for this purpose, since much of the advantage of the invention, insofar as quick change is concerned, may be attained by means of auxiliary hoisting means at ground level for the purpose whenever it is available. Hence, the invention is not limited in all the aspects to removal and replacement of the charging components, in unison as a one-piece unit by means of the bottom bell lever as one essential attribute, since the method of quick change of the components as a one-piece unit eliminates the necessity for and steps and acts of initially suspending the bottom bell by cables or chains from the top ring of the furnace, or initially depositing the bottom bell on the furnace bottom, and then hoisting the bottom bell to seating position with the bottom bell hopper before adjusting them together to provide a satisfactory gas seal by conventional centering procedures.

With the present method, the positioning of the bottom bell together with the bottom bell hopper for subsequent gas seal adjustment is effected while the units are put together as a spare at one side of the furnace top and while the latter is back in operation under high pressure conditions with a replacement. Hence, this feature of the novel method lends itself to use with an auxiliary hoist at ground level.

In addition to the general objects and advantages of the invention recited above, the invention has for further objects and advantages such improvements in operation as may be found to obtain in the method as hereinafter described in the accompanying drawings and claimed as the best mode of practicing the method of the invention.

Referring to the drawings:

FIGURE 1 is a fragmentary, elevational, diagrammatic view of a high pressure blast furnace with nonrotative upper hopper and upper bell parts being shown in section to which the method of invention is applied;

FIGURE 2 is a diagrammatic view taken on the line II—II of FIGURE 1, showing the furnace top platforms for the spare storage of the burden charging equipment;

FIGURE 3 is a top plan view of the furnace top platform, illustrating booms pivoted on uptakes for handling bell and hopper parts to and from ground level;

FIGURE 4 is a diagrammatic view of the bottom bell lever operating mechanism.

FIGURE 5 is an enlarged vertical diagrammatic crossseentional view illustrating the detail of the lower and upper bell rods and their connection to the lower and upper bells.

FIGURE 6 is a diagrammatic view illustrating the lashed bells and hoppers.

FIGURES 1, 2 and 6 of the drawings illustrate the assembly of the top **11** and bottom **12** bells and their hoppers **13**, **14**, throat **15** and hopper extension **16** all in assembled relation at the top of a blast furnace for operation thereof under high pressure while a spare unit **18** is ready for replacement on one storage platform **19** at one side of the top of the furnace for quick change in replacement with the unit **21** then in operation on top of the top furnace ring.

From FIGURES 1, 2 and 3, it will be apparent that the entire assembly **21** can be handled as a one-piece unit, in quick replacement at the top of the furnace, by shifting the multipart receiving hopper **17** to one side.

In accordance with the method of this invention, this is attained by: (1) with the assembly resting on the top furnace ring **37**, linking the bottom skirt **15** to the bottom hopper **14** by means of linkage **22***a*, and lashing the bottom bell **12** to its hopper **14** and the top bell **11** to its hopper **13** by means of wire rope lashing equipment **22** applied through an access door **23** in the lower hopper **14** and through the upwardly open hopper extension **16** and upwardly open upper hopper **13**, remove the top bell hangers **7**, FIGURE 6, between the top bell rod **8** and the top bell lever **9**; (2) disconnect and shift the receiving hopper **17** to one side and then remove the upper section **24**, FIGURE 1, of bottom bell (**25**) rod; (3) roll one 4-wheel trolley **26** into position at center of furnace; (4) install a heavy chain **27** to connect the bottom bell lever **28** to the lower section **25** of bottom bell rod; (5) utilize the pneumatic (or electric) bottom bell hoist **29**, cable **30** and bottom bell lever **28** to lift the assembly while raising it in increments of about 2 ft. 6 in., supporting the assembly of bells and hoppers between lifts by placing a heavy pin **31** through the chain **27**, to be carried on the 4-wheel trolley **26**; (6) use auxiliary cable **32** and sheave **33** arrangement as shown in FIGURE 1 to elevate the bottom bell lever **28** to position for succeeding lifts, using the bell hoist pneumatic cylinder **29** as a power unit, during changing of the lashed bell, hopper and throat assembly; (7) use the clamp **34** to clamp the lower section **25** of the bottom bell rod above the trolley, and rest the clamp member **34** on two hydraulic jacks **35**, in extended position, incorporated into the trolley design; (8) roll the removed assembly to storage position **19** shown in dotted lines in FIGURE 2; (9) lower removed assembly onto skids **36** by means of the hydraulic jacks **35**; (10) raise spare assembly shown in full lines at **19** from skids **36** by means of the hydraulic jacks **35** with bottom bell rod section **25** clamped above the trolley **26** on the jacks **35**; (11) roll the new spare assembly from its storage position **19** shown in full lines on the right hand side of FIGURE 2 into position at center of furnace; (12) install the heavy chain **27** to connect the bottom bell lever **28** to the lower section **25** of the bottom bell rod; (13) utilize the pneumatic, or electric, bell hoist **29**, cable **30**, **32** and lever **28** to lift or hoist the unit assembly while lowering it in increments of about 2 ft., 6 in., supporting the assembly between lifts by placing a heavy pin **31** through the chain **27**, to suspend the assembly on the 4-wheel trolley **26** while the lower bell lever **28** is moved to raise the short arm to position it for a succeeding lowering engagement with the chain **27**, roll the trolley **26** out of position; (14) restore upper section **24** to the bottom section **25** of bottom bell rod and to the bottom bell lever **28** and restore the hangers **7** to the top bell rod **8** and top bell lever with its cable **32***a* and hoist **29***a* attached thereto; (15) remove lashes **22** from the hoppers **13**, **14** and from the bells **11**, **12**; (16) adjust the bottom bell hopper on the top ring **37** of the blast furnace **38** to properly seat the bottom bell **12** to the bottom bell hopepr **14**; and (17) dismantle and reassemble the spare assembly on the platform **19** within the area of the gas uptakes **40**, using jib cranes **39**, or equivalent, as shown in FIGURE 3 to handle the component parts to and from ground at convenient time, while furnace **38** is back in operation. The jib cranes **39** can be arranged on other uptakes when required by the plant layout.

An auxiliary hoist, if available at ground level at the

time, may be used for the hoisting in lieu of the bottom bell lever **28**.

The method described is substantially the same when the assembly is one devoid of a skirt or throat **15** around the lower bell **12** or when it includes mechanical distributor. The main features of the method are essentially the same when it is found desirable to replace the lower bell and hopper without replacing the upper hopper and its bell in unison with the lower bell and its hopper.

The invention as hereinabove set forth is embodied in particular forms and manners but may be variously embodied within the scope of the following claims.

What is claimed is:

1. A method for the rapid removal and replacement of an assembly of bells and hoppers at the top of a blast furnace, the assembly including top and bottom bells and a hopper associated with each, as well as top and bottom bell rods for moving a respective bell relative to its hopper, which comprises: lashing the bottom bell to its hopper and top bell to its hopper of a first assembly while in place in the top of the blast furnace; removing the upper section of the bottom bell rod and disconnecting the top bell rod from its hoisting mechanism; shifting a suspension carriage into position above the center of the furnace; connecting linkage between the bottom bell lever and the lower section of the bottom bell rod whereby a lashed assembly is formed of said first assembly; operating the bottom bell lever through successive movements of its cable and motive means to raise said lashed first assembly in successive increments to clear the top of the furnace; operating the bottom bell lever to up position by an auxiliary cable mechanism operable by the reverse operation of the motive means for the bottom bell lever during said successive movements; clamping the raised lower bell rod to raised jacks on the suspension carriage; shifting the suspension carriage with said rod clamped thereon to a spare storage position at one side of the top of the furnace; lowering the jacks to set the so removed first assembly onto a platform at said side of the furnace; suspending the lower section of the bottom bell rod of a spare second assembly from an overhead carriage and shifting the carriage over the vertical center of the blast furnace, with the lower section of the bottom bell rod attached to a bottom bell that is seated against its seat on the bottom bell hopper of said spare second assembly having an upper bell seated on its upper hopper with the upper hopper attached to the bottom hopper and with the lower section of the bottom bell rod extending through the upper bell and upper hopper and with the bottom bell lashed to the bottom hopper and the upper bell lashed to the upper hopper; connecting linkage between the bottom bell lever and the lower section of the bottom bell rod of the spare second assembly; operating the bottom bell lever through successive movements of its cable and motive means to lower the thus lashed second assembly in successive increments to insert the bottom bell in position in the top of the furnace; operating the bottom bell lever to up position by the aforesaid auxiliary cable mechanism operable by the reverse operation of the motive means for the bottom bell lever during the last mentioned successive movements; reconnecting the top bell rod of said second assembly to its hoisting mechanism and the upper section of the bottom bell rod of said second assembly to the bottom rod section and the bottom bell lever and resuming operation of the furnace; dismantling and reassembling the so removed first assembly at said spare storage area at the top of the furnace using cranes at said area to handle component parts to and from ground level while the furnace is back in operation.

2. A method as claimed in claim 1, and which includes the act of skidding a receiving hopper out of and into position over the upper hopper prior to removing and subsequently to replacing the assemblies at the top of the furnace.

3. A method for the rapid removal and replacement of an assembly of bells and hoppers at the top of a blast furnace, the assembly including top and bottom bells and a hopper associated with each, as well as top and bottom bell rods for moving a respective bell relative to its hopper, which comprises: lashing the bottom bell to its hopper and top bell to its hopper while a first assembly is in place in the top of the blast furnace; shifting a suspension carriage into position above the center of the furnace; connecting linkage between the bottom bell lever and the bottom bell rod; operating the bottom bell lever through successive movements of its cable and motive means to raise the first assembly in successive increments to clear the top of the furnace; clamping the raised lower bell rod to the suspension carriage; shifting the suspension carriage with said rod clamped thereon to a spare storage position at one side of the top of the furnace; lowering the so removed first assembly onto a platform at said side of the furnace; suspending the bottom bell rod of a spare second assembly from an overhead carriage and shifting the carriage over the vertical center of the blast furnace, with the bottom bell rod attached to a bottom bell that is seated against its seat on the bottom bell hopper of said spare second assembly having an upper bell seated on its upper hopper with the upper hopper attached to the bottom hopper and with the bottom bell rod extending through the upper bell and upper hopper and with the bottom bell lashed to the bottom hopper and the upper bell lashed to the upper hopper; connecting linkage between the bottom bell lever and the bottom bell rod of the spare second assembly; operating the bottom bell lever through successive movements of its cable and motive means to lower the second assembly in successive increments to insert the bottom bell in position in the top of the furnace; dismantling and reassembling the so removed first assembly at said spare storage area at the top of the furnace using cranes at said area to handle component parts to and from ground level while the furnace is back in operation.

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