July 28, 1964 O. M. TWEIT 3,142,391

COKE OVEN CHARGING MACHINE HAVING MECHANISM FOR REMOVING AND REPLACING CHARGING HOLE COVERS

Filed July 17, 1961 6 Sheets-Sheet 1

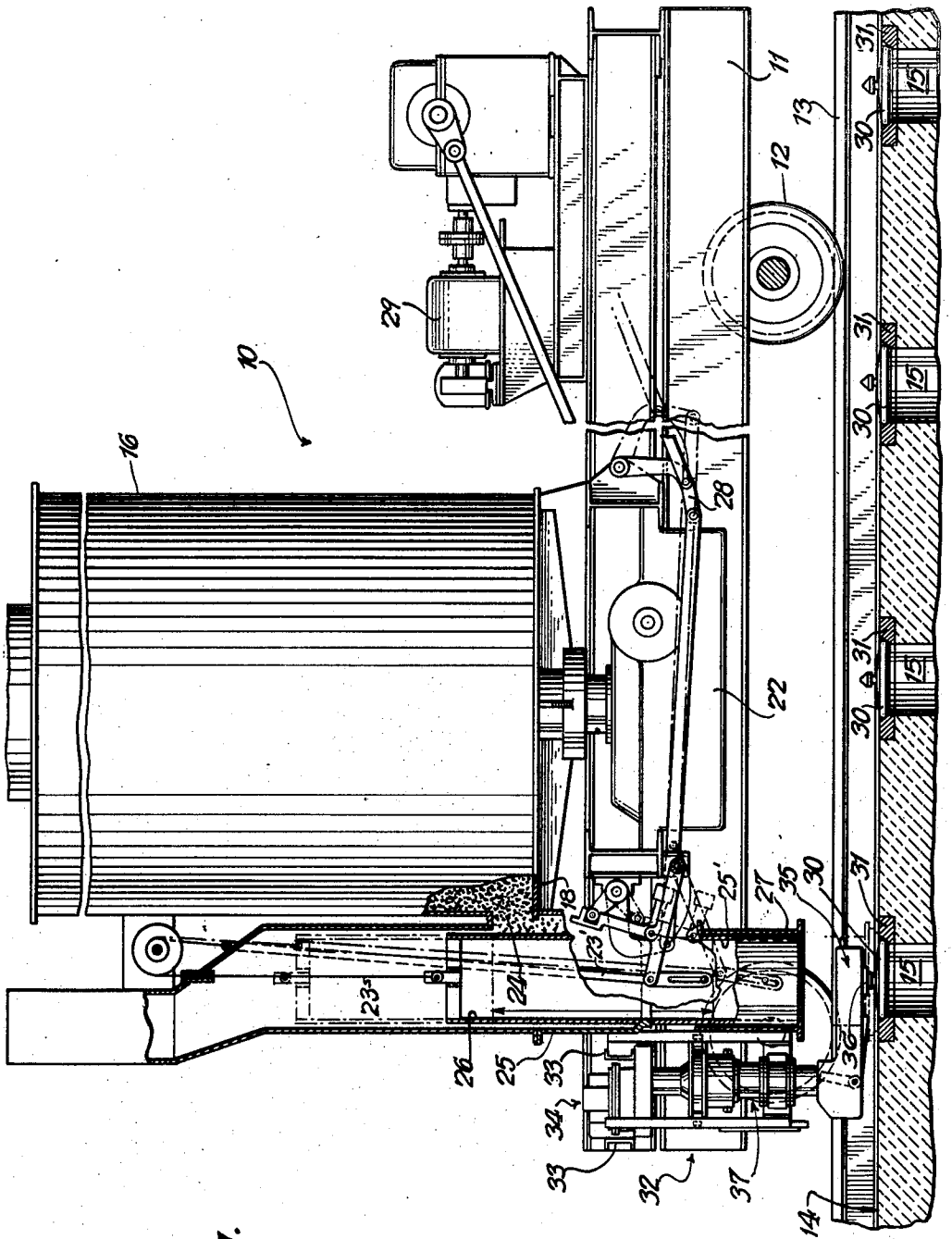


Fig. 1.

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Fig. 2.

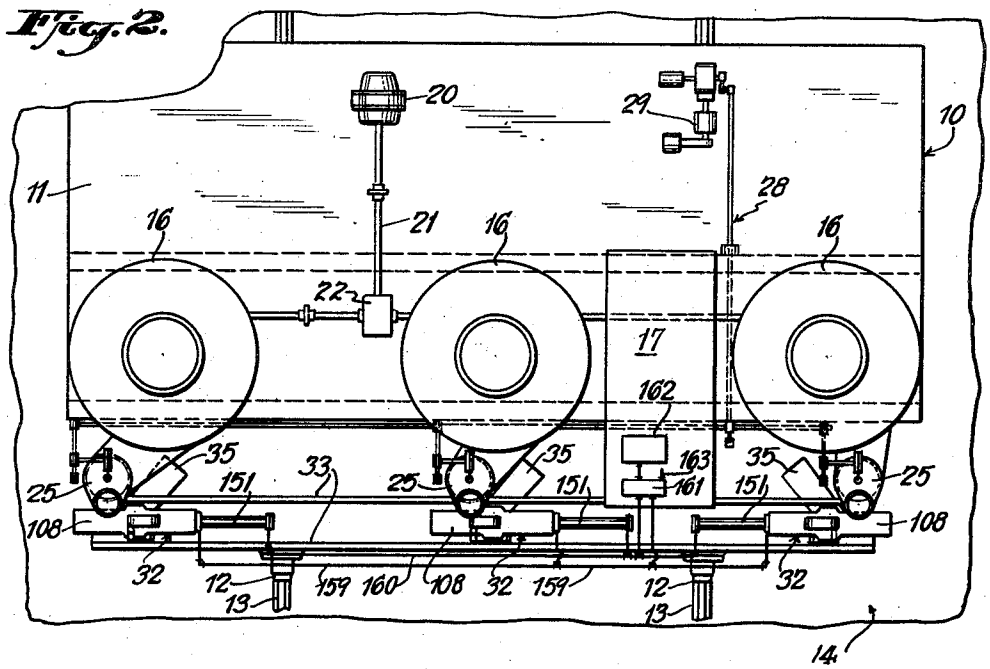
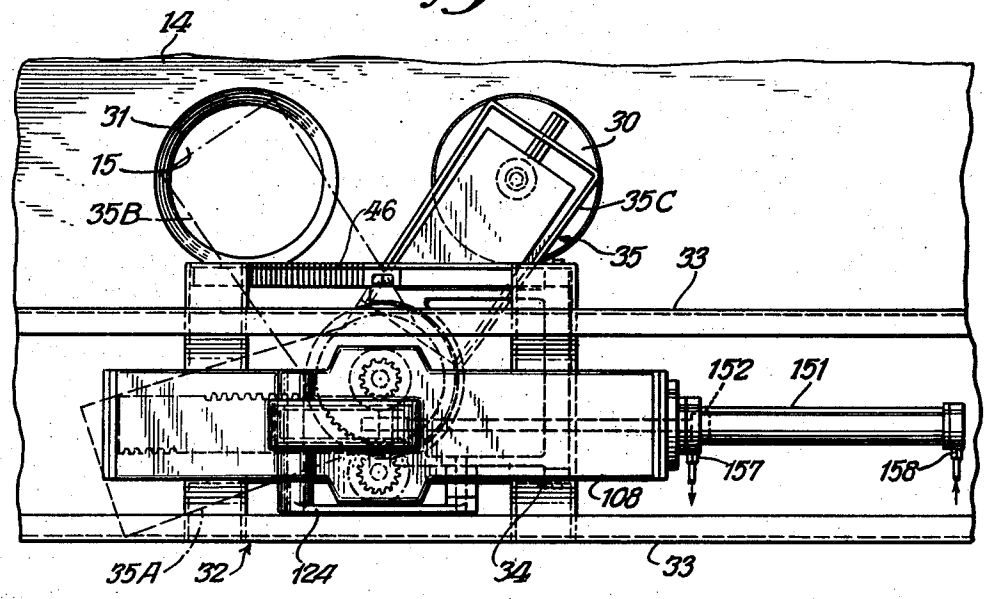


Fig. 3.



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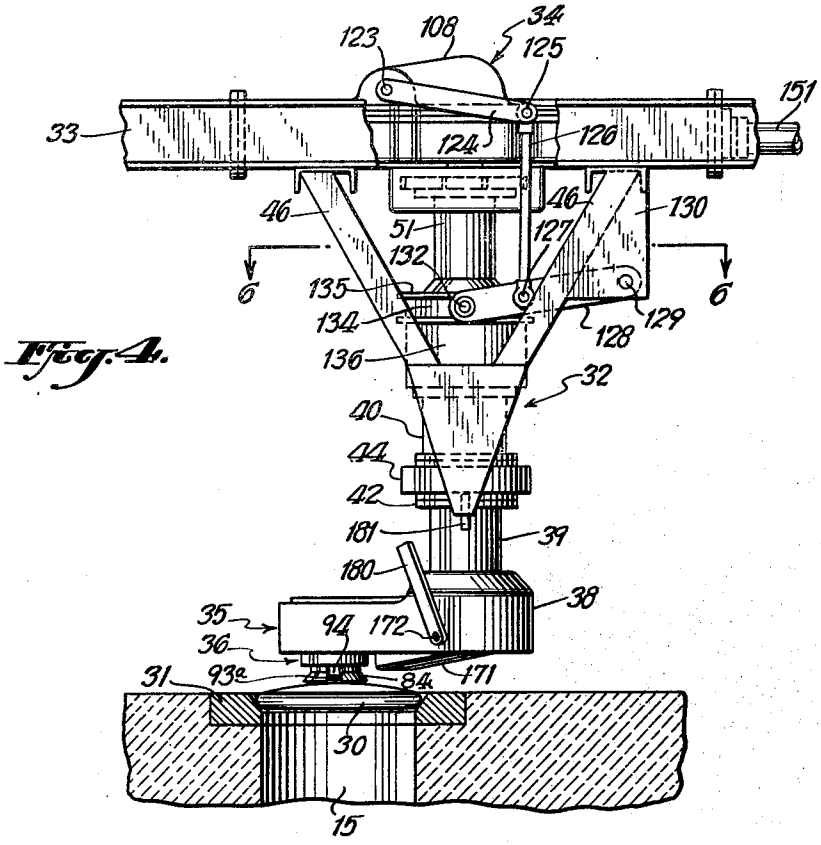


Fig. 4.

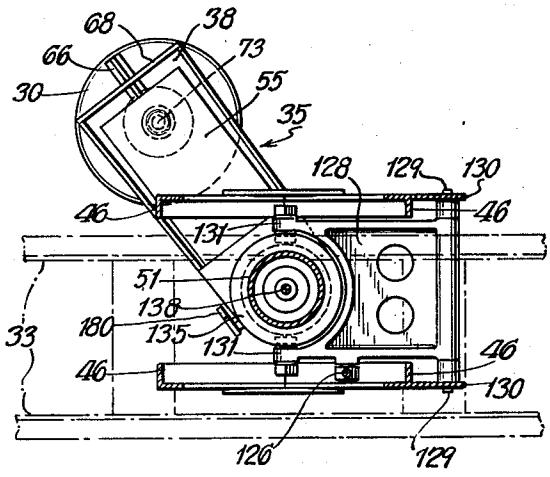


Fig. 6.

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Fig. 7.

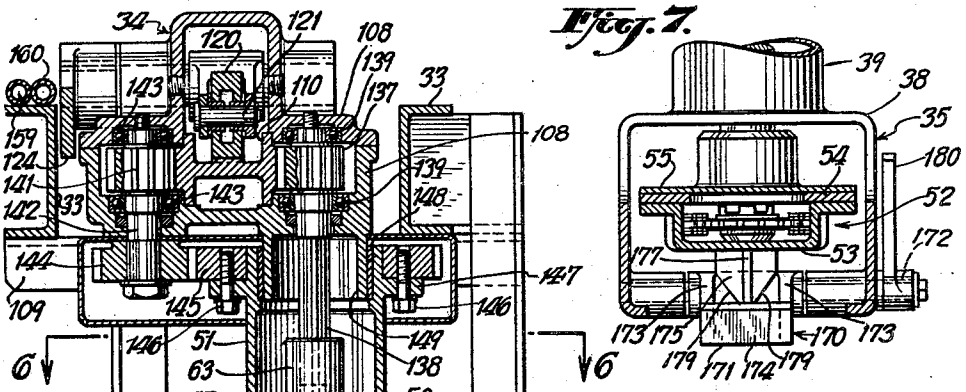


Fig. 5.

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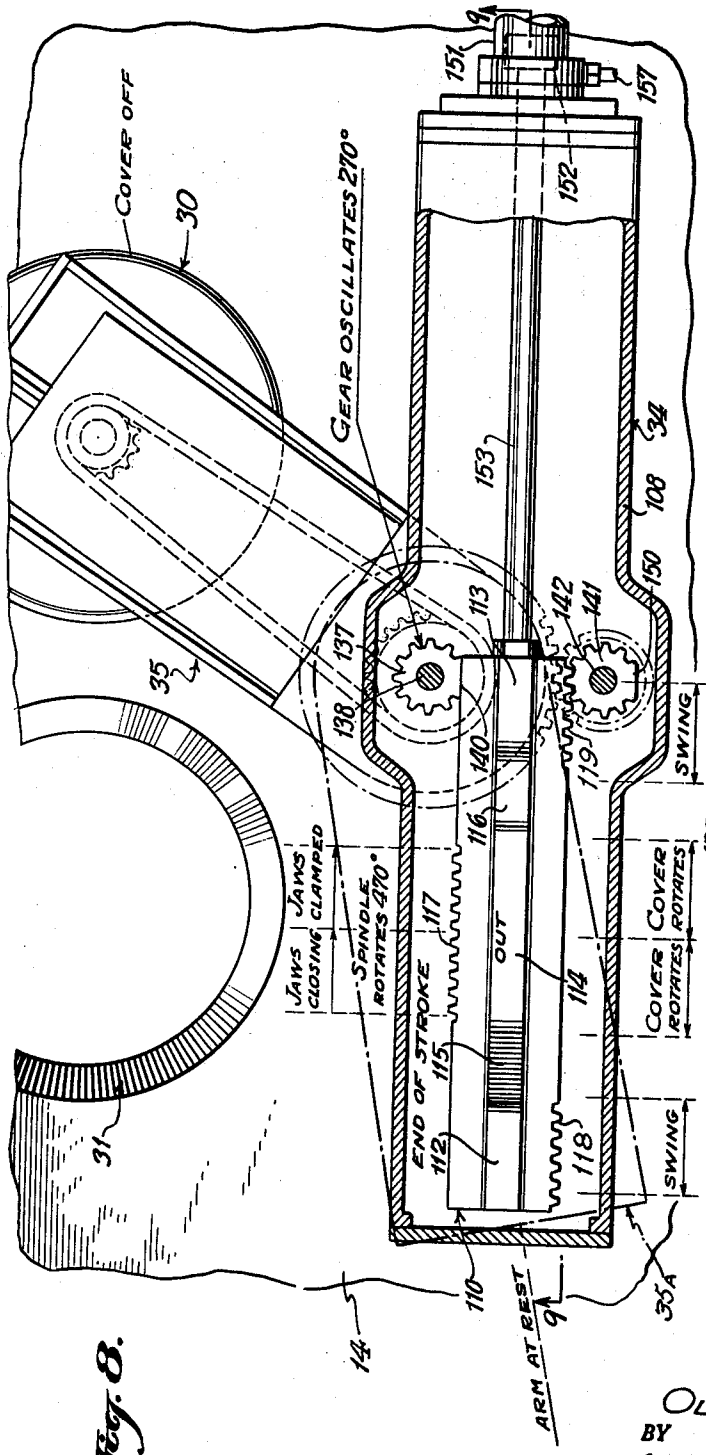


Fig. 8.

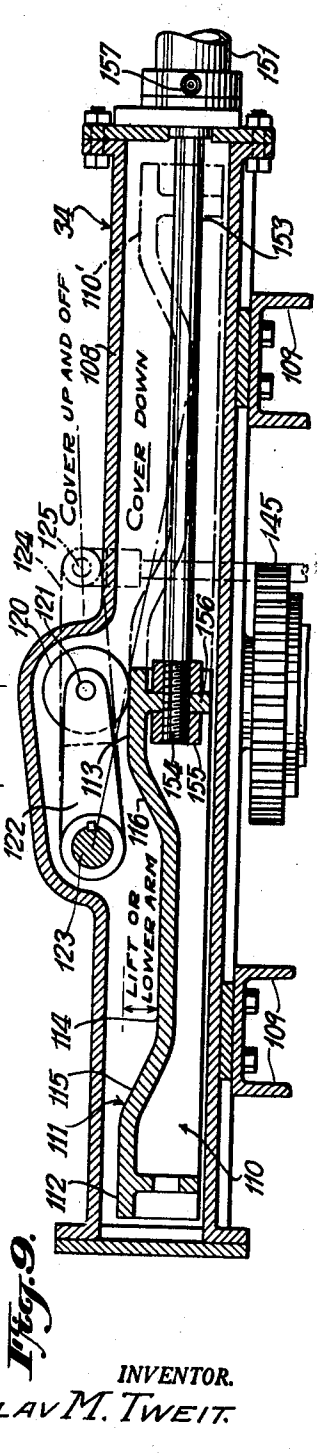


Fig. 9.

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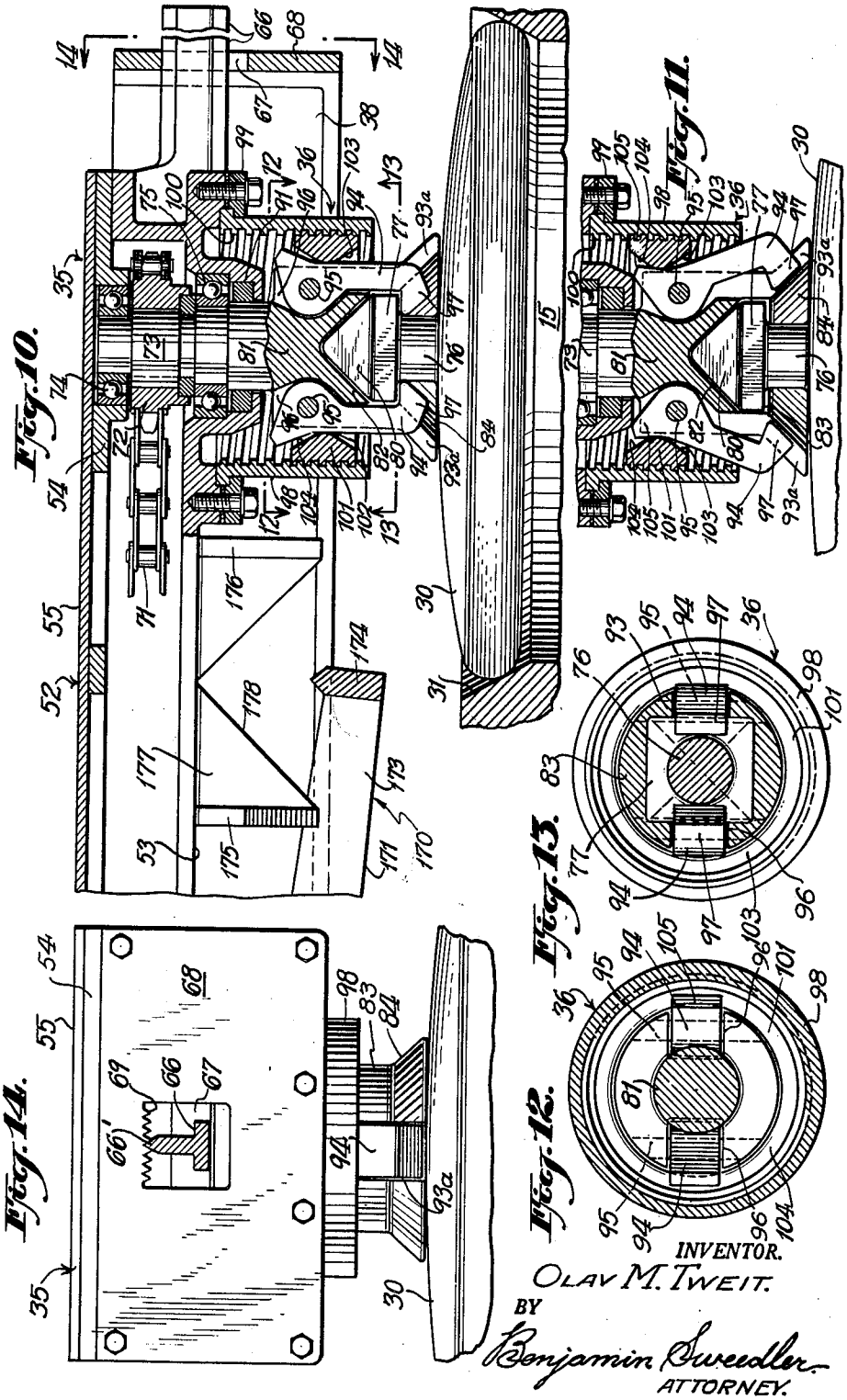


Fig. 10.

Fig. 11.

Fig. 13.

Fig. 12.

Fig. 14.

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3,142,391

COKE OVEN CHARGING MACHINE HAVING MECHANISM FOR REMOVING AND REPLACING CHARGING HOLE COVERS

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Filed July 17, 1961, Ser. No. 124,497
30 Claims. (Cl. 214—18)

This invention relates to charging machines for charging coking chambers and for automatically removing and replacing the charging hole covers or lids of the coking chambers of coke oven batteries.

Coke oven batteries, as is well known, comprise alternate horizontal tapered coking chambers and heating walls arranged side by side above the regenerators and have in the top of each coking chamber, usually three, spaced-apart charging holes. These charging holes are closed by removable covers during the coking cycle.

Charging apparatus for such coke oven batteries includes a wheeled charging car or larry movable along tracks on the roof of the coke oven battery under the control of an operator situated in a cab on the larry. A number of hoppers, the same as the number of charging holes in the roof of each coking chamber, are mounted on the larry. Each hopper contains a charge of coal for discharge through a chute into the communicating charging hole of the coking chamber over which the charging larry has been positioned; the total charge in all of the hoppers is such as to provide the coking chamber with the desired charge of coal for coking.

The covers of the charging holes of each coking chamber must, of course, be removed before charging is commenced, and replaced after the charge has been introduced into the coking chamber. Heretofore, it has commonly been the practice to remove and reseat or replace the covers manually by a workman stationed on top of the oven battery for this purpose. Such manual removal and replacement of the covers of the charging holes is time consuming and an unpleasant task for the workmen in view of the heat and fumes on the top of the oven battery to which the workman is subjected.

It has been proposed to employ magnetic cover removing and replacing mechanism mounted on the charging larry for removing and replacing the charging hole covers. Such mechanisms heretofore proposed have, among other objections, that they require initial movement of the cover handling machine to a position where the cover handling mechanism can engage the covers of a coking chamber to be charged and remove the same from the charging holes, the further movement of the machine to another position in which the chutes extending from the hoppers are aligned with the open charging holes for discharge of the coal into the coking chamber therebeneath, with the covers out of the way of the coal feed, and the return movement of the cover handling machine to its initial position relative to the charging holes so that the covers may be replaced or reseated. These multiple movements of the larry and cover handling mechanism required during each charging operation are obviously time consuming, resulting in an objectionably long charging period.

Particles of coal frequently remain on the seats for the covers at the mouth of the charging holes after the charge has been introduced therethrough into the coking chamber. It is necessary to remove such particles from the seat to obtain proper seating of the cover when replaced. In order to perform this function, it has been proposed to employ rotary scraping or cleaning discs which are brought into engagement with the seats of the

charging holes after the discharge of the charge of coal through the latter. Using such rotary scraping or cleaning discs, each charging operation involves the selective registration of three different devices with each charging hole for respectively removing and replacing the cover thereof, guiding the charge of coal into the open charging hole, and cleaning the seat of the charging hole prior to replacement of the cover thereon. Such equipment is relatively complex in construction and operation, and have the most serious drawback that they involve an excessively long charging cycle from the time the charging machine is in position to remove the covers to the time the seats are cleaned and the covers replaced.

It is among the objects of this invention to overcome the above-mentioned disadvantages of heretofore suggested charging and cover handling machines, and, more particularly, to provide a machine which is capable of reliable and rapid operation in removing and replacing charging hole covers so that each charging operation including removal and replacement of covers can be performed in appreciably less time.

Another object is to provide such machine which effects cleaning of the cover seat simultaneously with seating the covers.

Still another object is to provide a power operated machine for handling charging hole covers which permits the charging larry to be located in a single stationary position relative to the coking chamber to be charged, while the cover handling mechanism automatically performs the movements thereof necessary for removal of the charging hole covers to locations removed from the open charging holes so as to avoid interference with the introduction of the charges into the latter, and thereafter for replacement of the covers on the seats of the charging holes while simultaneously rotating the covers so that the latter clean the seats for proper seating of the covers.

A further object is to provide such machine for handling charging hole covers having the foregoing desirable characteristics, and in which the charging holes covers are mechanically engaged or gripped during this removal and replacement, and such mechanical engagement is reliably achieved even though the charging larry is not accurately spotted relative to the charging holes.

Still another object of the invention is to provide a machine for removing and replacing charging hole covers, which machine is of relatively simple, compact and rugged design, taking into account the necessary mechanical motions required to effect the removal and replacement of the covers and the movement of the coal discharge chutes to bridge the spaces between the discharge ports of the hoppers and the mouths of the charging holes and to return to their position on the larry where the discharge ports from the hoppers thereon are closed and the larry can be moved along the top of the battery.

In accordance with this invention, a coke oven charging apparatus comprising a carriage or larry movable along the top of the oven battery and carrying hoppers, each having a discharge chute with a sleeve extensible downwardly therefrom to bridge the space between the discharge port of the hopper and the charging hole receiving the charge in that hopper, is provided with mechanism for removing and replacing each charging hole cover, each individual to a hopper on the larry and each comprising an arm assembly mounted on the larry adjacent the associated discharge chute and carrying a cover gripping device. Each arm assembly is swingable about a vertical axis between a rest position where it is located during the intervals between successive charging operations, an angularly displaced cover removing and replacing position in which the arm extends under the related discharge chute and the gripping device is engageable with the cover

registered with the discharge chute, and a further angularly displaced charging position at which the arm assembly is located removed from the charging chute so as to avoid interference of the arm and cover suspended therefrom with the sleeve extended downwardly from the discharge chute during delivery of the charge of coal from the hopper into the open charging hole. Each arm assembly is further vertically movable between a lowered position in which the gripping device is engageable with and releasable from the charging hole cover during removal and replacement of the cover, and a raised position in which the arm assembly is swingable between the angularly displaced rest, cover removing and replacing, and charging positions thereof.

The gripping device carried by each arm assembly is in the form of a chuck having jaws which are rotated in order to effect the gripping engagement and release thereof with respect to a projection on the cover engaged thereby while the cover is situated on the seat of the charging hole so that, during engagement of the jaws with the projection of the cover preparatory to removal of the latter, the cover is rotated by the gripping device or chuck, thus breaking the seal between the cover and its seat and, during release of the cover, the latter is again rotated while in engagement with its seat so as to remove particles of coal or dust from the latter during replacement of the cover.

Preferably, a hammer blow clutch is positioned in the drive for the gripping device so that rotation of the cover is commenced with an initial sharp impact and the cover is thus "cracked" i.e., the seal between the cover and its seat is broken. Due to carbonization in the area of the cover seats, which takes place during the coking of the charges, the covers tend to resist rotary movement; such resistance is overcome by the provision of subjecting the cover to sharp impact at the commencement of its rotation.

The necessary sequences of the swinging and vertical movements of each arm assembly, as well as the rotational movements of the cover gripping device carried by the arm assembly, are effected in a predetermined sequence by an actuating assembly having a cam surface for controlling the vertical movements of the arm assembly and gear racks for controlling the swinging movements of the arm assembly and the rotational movements of the gripping device.

The machine of the present invention has, associated with each arm assembly, an outer housing or structure swingable about a vertical axis and vertically movable, as described above, and containing an inner arm structure from which the gripping device or chuck is suspended. This inner arm structure occupies a predetermined position with respect to the outer housing; however, it is so mounted, as will be explained more fully hereinafter, that it is free for relatively small horizontal displacements relative to the outer housing in any desired direction. Thus during initial engagement of the gripping device with a charging hole cover, the inner arm structure can move in any necessary direction, a small distance, say up to 1 to 2 inches, to accommodate misalignment when the charging machine is spotted in charging position. Hence each gripping device reliably engages a charging hole cover even when the charging larry has been inaccurately positioned, within practical limits. Each arm assembly also includes relocating mechanism for returning the inner arm structure to its predetermined position relative to the outer housing when the arm assembly is moved back to its rest position. Thus when starting the removal of covers, each arm assembly always occupies its desired predetermined position within its outer housing and will be free to accommodate inaccurate positioning of the larry relative to the charging hole covers during successive charging operations.

The above, and other objects, features and advantages of the invention, will be apparent from the following detailed description of an illustrative embodiment of the invention taken in connection with the accompanying drawings forming a part hereof, and wherein:

FIGURE 1 is a side elevational view, partly broken away and in section, of a coke oven charging and cover removing and replacing apparatus embodying this invention;

FIGURE 2 is a top plan view, on a reduced scale, of the charging apparatus and cover removing and replacing mechanism of FIGURE 1;

FIGURE 3 is an enlarged top plan view of one of the units for removing and replacing a charging hole cover, with the arm assembly of such unit being shown, in full lines, in its charging position and, in broken lines, in its rest position and its cover removing and replacing position;

FIGURE 4 is a front elevational view of the unit of FIGURE 3, with the arm assembly thereof shown in its cover removing and replacing position;

FIGURE 5 is an enlarged vertical sectional view through the arm assembly of FIGURE 4;

FIGURE 6 is a transverse sectional view taken along the line **6**—**6** of FIGURE 5;

FIGURE 7 is a vertical sectional view taken along the line **7**—**7** of FIGURE 5;

FIGURE 8 is an enlarged top plan view of the unit appearing in FIGURE 3, but with the upper housing thereof broken away so as to expose to view the control member by which the swinging and vertical movements of the related arm assembly, as well as the engagement and release of the gripping device, are effected;

FIGURE 9 is a longitudinal sectional view taken along the line **9**—**9** of FIGURE 8;

FIGURE 10 is an enlarged, detailed sectional view of the cover gripping device or chuck carried by the arm assembly of each unit, and shown in gripping engagement with a charging hole cover;

FIGURE 11 is a sectional view similar to a portion of FIGURE 10, but showing the gripping device or chuck in its released position;

FIGURE 12 is a detailed sectional view taken along the line **12**—**12** of FIGURE 10;

FIGURE 13 is another detailed sectional view taken along the line **13**—**13** of FIGURE 10; and

FIGURE 14 is an end elevational view of the arm assembly as viewed in the direction of the arrows **14**—**14** on FIGURE 10.

General Larry Structure

Referring to the drawings, and initially to FIGURES 1 and 2 thereof, **10** is a coke oven charging apparatus including a carriage or larry **11** supported by wheels **12** for travel on rails **13** extending along the length of the top of a coke oven battery **14**. The battery **14** has alternate coking chambers and heating walls (not shown) and each coking chamber of the battery is provided with a plurality of, for example, three, charging holes **15** in a roof thereof which are arranged in a row extending transversely with respect to the length of the battery **14**, as is conventional.

The charging apparatus **10** comprises hoppers **16** (FIGURE 2) equal in number to the number of charging holes **15** in each coking chamber; each hopper on the larry is arranged to deliver a charge to a charging hole and in the charging position is individual to that charging hole. The three hoppers, in the case of a three-hopper construction for three charging hole coking chambers, carry and supply the complete charge to a coking chamber, during charging thereof. The larry **11**, as conventional, is movable between a loading station at one end of the coke oven battery where the hoppers **16** each receive a charge of coal to a coking chamber to be charged where the charges of coal from all hoppers **16** are discharged through the charging holes **15** thereof. Such movements of the larry **11** are effected by suitable electric drive motors operatively connected to the wheels **12**

and under the control of an operator in a cab 17 (FIGURE 2) located on the larry, as is standard practice.

In order to effect the discharge of the coal in each hopper 16, a rotatable plate 18 (FIGURE 1) is disposed at the bottom of each hopper and is rotatably driven during charging, for example, by an electric motor 20 operatively connected to the several rotatable plates 18 through shafts 21 and speed reducing means 22 (FIGURE 2).

Each hopper has a discharge opening 24 at its base normally sealed by a plug 26 movable up and down in a chute 25. Plug 26 is connected by chain or rope 23 and link 23' with a drop sleeve 27 concentric with the charging spout 25' (FIGURE 5) so that plug 26 acts as a counter-weight for the drop sleeve 27. When the plug is in the position shown in FIGURE 1 it closes discharge opening 24, and drop sleeve 27 is then in its elevated position shown in FIGURE 1. When the larry is spotted, the covers have been removed, as hereinafter described, and the plug 26 is moved upwardly to permit discharge through opening 24, the drop sleeve 27 is simultaneously lowered so that the lower end thereof seats on the open charging hole. Thus in its extended or lowered position, sleeve 27 bridges the vertical gap between the bottom of discharge spout 25' and the mouth of the charging hole 15.

During movement of larry 11 to and from the loading station and the positions for charging the selected coking chambers, each sleeve 27 is held in its retracted or raised position counter-balanced by its plug 26 in position to close discharge opening 24. Should the sleeve move away from charging position for any reason the associated plug 26 will automatically move to close the discharge opening 24 of the associated hopper 16. Sleeves 27 and the associated plugs 26 are actuated by a linkage mechanism, indicated collectively by the reference numeral 28, in turn actuated by a motor assembly 29 under the control of the operator in cab 17.

The above described portions of the charging larry are known and represent but one type of larry construction to which this invention is applicable. Accordingly, it is believed that further description of the hoppers, associated plugs 26, sleeves 27 and the drive for effecting discharge of coal and movement of the bridging sleeves 27 and plugs 26 is unnecessary.

Cover Handling Mechanism

Each charging hole 15 of each coking chamber, during coking, is closed by a cover 30 which engages a tapered seat 31 at the upper end of the charging hole. These covers must be removed from their seats 31 prior to charging and, after charging of the coking chamber has been completed, covers 30 must be placed on the respective seats. The same covers need not be replaced on the charging holes from which they were removed. As explained hereinafter, the machine of this invention can be operated to replace the covers removed from and onto one and the same chamber, or can be operated to remove the covers from one coking chamber, then be moved to another chamber from which the covers have already been removed, charge the other coking chamber and seat the covers removed from the first mentioned chamber onto the seats of the charging holes of the chamber which had just been charged.

In accordance with the present invention, the charging apparatus 10 has thereon power operated mechanism for automatically removing the covers from their seats, positioning them so that they do not interfere with the flow of the coal from the hoppers 16 into the coking chamber and after the charging of a chamber has been completed and the sleeve 27 elevated, placing the covers on the seats of the charging holes of a charged chamber and simultaneously cleaning the seats 31 on which the covers are placed. There is one cover handling unit, identified by the reference numeral 32 for each covered charging hole of a coking chamber. Thus, in the illustrated embodiment of this invention involving coking chambers, each having three charging holes therein, the mechanism for handling the charging hole covers 30 includes three units 32 (FIGURE 2), each disposed adjacent a discharge chute 25' of a hopper 16 and individual thereto and mounted between parallel, spaced apart frame members 33 (FIGURES 1 and 2) extending transversely across the front of larry 11.

Referring now to FIGURE 5, each unit 32 of the cover handling mechanism includes an actuating assembly or control 34 situated at the top of the unit, an arm assemly 35 extending horizontally at the bottom of the unit and carrying a gripping device or chuck 36 for engagement with and release of a charging hole cover 30 and a structure 37 for supporting the arm assembly 35 for swinging movement about a vertical axis and also for vertical up and down movement effected by the control or actuating assembly 34.

During movement of larry 11 between the loading station and a selected charging position, arm assembly 35 of each unit 32 is raised, for example, as indicated by the broken lines at 35R on FIGURE 5, and is swung to a rest position, as shown in broken lines at 35A on FIGURE 3, so that the arm assembly then extends generally in a lateral direction below frame members 33 and an adequate vertical clearance is provided between the top or roof of the coke oven battery 14 and the gripping device 36 projecting downwardly from the arm assembly. After larry 11 is located in a selected charging position, that is, with its discharge chutes 25' in vertical alignment with the charging holes of the coking chamber to be charged, the arm assembly of each unit 32 is swung to a cover removing and replacing position indicated in broken lines at 35B on FIGURE 3, where the arm assembly projects between the retracted sleeve 27 of the related discharge chute and the roof of the oven battery and has its gripping device or chuck 36 substantially aligned with the center of a charging hole cover 30 therebelow.

When the arm assembly is in the angular position 35B, the arm assembly is lowered, for example, to the position indicated in full lines on FIGURE 5 at 35L, and the gripping device 36 is operated so as to effect gripping engagement thereof with the charging hole cover 30 and rotation of the latter, thereby breaking the seal between the cover and its seat 31.

Following such engagement of gripping device 36 with the charging hole cover, arm assembly 35 is again raised to the elevated position 35R, thereby effecting removal of the gripped cover from its seat 31, and the arm assembly is then further angularly displaced in the same direction, that is, in the clockwise direction as viewed in FIGURE 3, to the charging position indicated in full lines at 35C where the gripped cover 30 is held to one side of the charging hole 15 so as to avoid interference with the sleeve 27 which is then extended downwardly so as to conduct the coal discharged from the related hopper 16 into the charging hole 15. When charging has been completed, sleeve 27 is retracted and the arm assembly is angularly returned to the position 35B and lowered so as to replace the cover 30 on its seat 31, whereupon gripping device 36 is operated to rotate the cover on seat 31 for cleaning the latter and then to release the cover. After replacement of a cover on its seat, arm assembly 35 is raised to position 35R and angularly returned to its rest or initial position 35A so as to complete a cycle of operation of the cover handling mechanism.

Having briefly described the sequence of the vertical and swinging movements imparted to arm assembly 35 and the coordinated sequence of operations of gripping device 36, the structural arrangements included in the illustrated embodiment of the invention for permitting and effecting such movements and operations will now be described.

Arm Assembly 35

Referring to FIGURE 5, the arm assembly 35 includes a lower, horizontally elongated outer housing 38 integral with or otherwise rigidly joined to a hollow vertical hous-

ing 39 extending upwardly adjacent one end of lower horizontal housing 38. Housing 39 is vertically slidable in an outer shell 40, the lower end portion of which is formed with external, vertically spaced apart flanges 41 and 42 defining an annular, outwardly opening recess or raceway therebetween which is lined with a flanged bushing 43 in which is positioned a bearing ring 44. Bearing ring 44 is supported at diametrically opposed locations, specifically at the front and back thereof, by brackets, 45 which are secured to the lower ends of front and back pairs of frame members 46 extending downwardly from the transverse frame members 33 (FIGURE 4). Thus, outer shell 40 is free to rotate in bearing ring 44 while being held against vertical displacement relative to frame members 46 and 33.

Housing 39 carrying arm housing 38 is rotatably coupled with outer shell 40, while being free to move vertically or axially relative to the latter, by means of bolts 47 extending, in diametrically opposed directions, outwardly from the upper portion of housing 39 and carrying spacers 48 which are slidable in vertically elongated slots 49 formed in a thickened wall portion of outer shell 40. Housing 39 is formed with an axial extension 50 at its upper end having a reduced diameter end slidably engaging in a similarly reduced diameter upper end extension 51 of the outer shell 40.

The arm assembly 35 has an inner arm structure 52 extending longitudinally within housing 38 (FIGURES 5, 7 and 10) and including an elongated casing 53 having a removable top 54 and dust-proof cover 55. The inner arm structure 52 is suspended at the end thereof adjacent housing 39 from a rotatable stub shaft 56 mounted for rotation in anti-friction bearings 57 at the base of casing 53 and 58 carried by a hollow boss 59 formed in top 54 of the casing 53. The upper end of stub shaft 56 is connected by a universal joint 60 to the lower end of a drive shaft 61 extending axially in housing 39 and having its upper end connected by a universal joint 62 to a coupling sleeve 63 which is rotatable in a bearing 64 mounted in upper end extension 50 of housing 39. Coupling sleeve 63 has an external flange 65 resting on a flange at the upper end of bearing 64 so that the latter acts both as a radial and axial thrust bearing.

Rotatably mounted on stub 56 is a sprocket 70 having a drive chain 71 passing thereover and over a sprocket 72 (FIGURE 10) keyed to shaft 73 mounted for rotation in suitable anti-friction bearings 74 and 75 at the forward end of casing 53. Shaft 73 carries the gripping devices for the cover 30. Sprocket 70 is driven through a hammer blow clutch comprising clutch part 57*a* keyed to stub shaft 56 which has projections thereon extending downwardly and arranged to engage upwardly extending projections on clutch part 57*b* fixed to sprocket 70. These projecting parts, as conventional in clutches of this type, are separated by a space. Thus as clutch part 57*a* is rotated by rotation of stub shaft 56, movement of sprocket 70 is not initiated until the downwardly extending projections on clutch part 57*a* engage the upwardly extending projections on clutch part 57*b*. This takes place with a sharp impact which is imparted to the sprocket 70 driven thereby, as will be explained more fully hereinafter.

By reason of the universal joints 60 and 62, the inner arm 52 is free to move a limited distance horizontally, i.e., laterally in either direction relative to its normal or predetermined position within outer housing 38 and also forward and backward within this housing.

In order to stabilize arm structure 52, particularly when effecting movement of a cover 30, the outer ends of casing 53 is formed with a longitudinal extension 66 passing through an opening 67 formed in the outer end wall 68 of outer housing 38 and engageable with a top serrated edge 69 of such opening (FIGURES 5, 10 and 14). The extremity of extension 66 is preferably formed T-shaped in cross-section, as shown in FIGURE 14, and the pointed edge 66′ of the extremity of this extension seats in one of the serrations 69 in the outer end wall 68 of outer housing 38. In this way the inner casing, when the parts are in position to effect rotation of a cover, are locked or fixed relative to the outer housing 38.

As is apparent particularly from FIGURES 10 and 11, each charging hole cover has a centrally located projection or knob 76 extending upwardly from the top surface thereof and formed with an enlarged polygonal, preferably rectangular, head 77 having a pyramidical top or dome 80.

Gripping Device 36

The gripping device or chuck 36 of each unit 32 engages the head 77 of the cover, as will now be described. Each gripping device (FIGURES 10 and 11) is mounted on an extension 81 of the shaft 73. Extension 81 is located below the bottom of casing 53 adjacent the outer end of the latter as best shown in FIGURE 10 and is rotatable about a vertical axis. The base of extension 81 is formed with a pyramidical recess 82 substantially conforming to the shape of the pyramidical dome 80 of the cover 30. Extension 81 has a wrench-like portion 83 arranged to snugly engage the periphery of head 77 (portion 83 and head 77 are congruent) and a depending, outwardly flaring skirt 84. When arm assembly 35 is lowered while in its cover removing and replacing position 35B, the outwardly flaring skirt 84 and pyramidical recess 82 of extension 81 cooperate with the pyramidical dome 80 of the charging hole cover 30 to align the axis of extension 81 with the center of the cover. The mounting of extension 81, hereinabove described, permitting limited movement thereof transversely or forward or backward enables such alignment to be effected. Any inaccuracy in the location of the larry 11 relative to the charging hole covers is thus automateically compensated by the displacements of the arm structure 52 relative to the outer housing 38 of each unit 32.

The gripping device 36 includes a pair of jaws 94 rockably mounted adjacent their upper ends on pins 95 within diametrically opposed recesses 96 in extension 81. Jaws 94 have inwardly directed lower end portions 97 movable toward and away from each other (FIGURES 10 and 11) upon rocking of the jaws 94 on their supporting pins 95. Skirt 84 has diametrically opposed openings 93*a* in which the lower end portions 97 move towards or away from each other. When moved towards each other they are positioned, as shown in FIGURE 10, to engage the underside of head 77 to raise and hold the cover. When moved in the opposite direction, as shown in FIGURE 11, they release the cover.

Rocking of jaws 94 toward and away from each other is effected by the structure which will now be described.

A non-rotatable outer cylinder or sleeve 98 extending coaxially around extension 81 depends from the bottom of casing 53 to which it is secured by means of a clamping ring 99. The outer sleeve 98 has internal threads 100 with a relatively large pitch which are engaged by corresponding external threads on a cam ring 101 which is rotatable with extension 81 and movable axially (up and down) relative to the latter. The up and down movement is effected by the engagement of the external threads thereon with the internal threads on the fixed outer sleeve 98. This sleeve has a depth or height such that the cam ring 101 always remains in threaded engagement with the internal threads thereon.

Cam ring 101 has an intermediate bearing surface 102 engaging the outer sides of jaws 94, a downwardly diverging base portion 103, and an upwardly diverging upper portion 104. These diverging surfaces accommodate the jaws without causing rocking thereof. The jaws 94, it will be noted from FIGURES 10 and 11, have at their upper outer ends above the pivot pins 95, ears 105 which, when engaged by the bearing surface 102 as the cam

ring moves from the FIGURE 10 to the FIGURE 11 position, moves the jaws away from each other to the open position shown in FIGURE 11. Upon rotation of extension **81** in the reverse direction, so that the cam ring **101** moves from the FIGURE 11 to the FIGURE 10 position, the bearing surface **102** engages the sides of the jaws below the pivot pins **95** to move the jaws **94** towards each other to the position shown in FIGURE 10.

When jaws **94** are in their open or released position, the lateral distance between the inwardly directed ends **97** of the jaws is greater than the width or transverse extent of the enlarged head **77** of the projection or knob on each cover **30**, so that such head can pass between the ends of the jaws and into the wrench-like intermediate portion **83**. When jaws **94** are moved to their closed position after engagement of the dome or top **80** on the enlarged head **77** in recess **82**, the inwardly directed ends **97** of the jaws engage under the enlarged head **77** to lift the cover and hold it. Rotation of the cover is effected by the inter-engagement between the periphery of head **77** and wrench-like intermediate portion **83** when extension **81** carrying the latter is rotated.

The jaws **94** are in their open or disengaged positions when arm assembly **35** is moved to its lowered position for engaging the dome **80** of the projection on a cover **30** in recess **82**, as in FIGURE 11. In this position initial rotation of shaft **73** and extension **81** in the direction for moving cam ring **101** downwardly causes closing of jaws **94** to position them beneath head **77** and simultaneously through the hammer blow clutch parts **57***a* and **57***b* "cracks" the cover and rotates it. The cover is rotated somewhat more than one complete revolution, say about 470°. When the cover **30** is returned or placed on its seat **31**, shaft **73** and extension **81** are rotated in the reverse direction, moving cam ring **101** upwardly relative to extension **81**. Such rotation causes spinning of the cover **30** in the reverse direction effecting cleaning of the seat **31** and simultaneous opening of jaws **94**. Again rotation is for more than 360°, desirably about 470°.

Actuating Assembly 34

Assembly **34** is disposed within an elongated housing **108** positioned between the spaced frame members **33** and supported by frame members **109** extending between members **33**. A control element **110** is longitudinally slidable in suitable guides within housing **108** which, desirably, contains oil or other lubricant. Reciprocable control member **110** has a top cam surface **111** which has raised horizontal end portions **112** and **113**, an intermediate depressed horizontal portion **114**, and inclined portions or ramps **115** and **116** connecting the depressed central portion **114** with the raised end portions **112** and **113**, respectively (FIGURE 9). As shown in FIGURE 8, one side of control member **110** is formed with a gear rack **117** extending along the intermediate portion thereof a distance substantially coextensive with the length of depressed intermediate portion **114** of cam surface **111**. The opposite side of control member **110** is formed with gear racks **118** and **119** extending along the opposite end portions thereof and each substantially coextensive in length with the length of the raised end portions **112** and **113**, respectively, of cam surface **111**.

The cam surface **111** of control member **110** effects the vertical movement of arm assembly **35**; gear rack **117** effects the operation of the gripping device **36** and gear racks **118** and **119** effect the horizontal swinging movements of the arm assembly.

In order to effect the vertical movements of arm assembly **35**, actuating assembly **34** includes a roller **120** riding on cam surface **111** (FIGURES 5 and 9) and rotatable on an axle **121** carried by an arm **122** extending radially from, and fixed to, a shaft **123** (FIGURES 4 and 9) journalled in housing **108** above the path of travel of control member **110**. Thus, as member **110** is displaced longitudinally within housing **108**, the engagement of one of the inclined portions or ramps **115** and **116** with roller **120** causes rocking of shaft **123**. A lever arm **124** (FIGURES 4, 5 and 9) is fixed to an end of shaft **123** projecting from housing **108** and is pivotally connected at its other end, as at **125** (FIGURE 4), to the upper end of a connecting link or rod **126**. The lower end of rod **126** is pivotally connected, as at **127** (FIGURES 4 and 6), to a yoke **128** which has one end rockably mounted on an axle **129** supported by plates **130** extending from the frame members **46**. The opposite end of yoke **128** terminates in spaced apart arms **131** carrying inwardly directed stub shafts **132** on which rollers **133** (FIGURE 5) are rotatably mounted.

The rollers **133** are in rolling engagement with an annular, radially outward opening raceway **134** (FIGURES 4 and 6) defined by a collar **135** which extends around the upper portion of outer shell **40** as shown in FIGURE 5, and which has the lower portion **136**, at diametrically opposed locations, secured to inner housing **39** by the previously described bolts **47** (FIGURE 5) movable up and down in vertically elongated slots **49** in shell or housing **40**. Thus, rocking of lever arm **124** caused by engagement of roller **120** with the inclined or ramp portions **115**, **116** of cam surface **111** of control member **110** is transmitted to yoke **128**, and the rocking movement of the latter causes vertical displacement of housing **39** within shell **40** and hence of the arm assembly **35**.

Operation of the gripping device **36** by the gear rack **117** is effected by the structure which will now be described. Actuating assembly **34** includes a pinion **137** (FIGURES 5 and 8) mounted within housing **108** adjacent the side of control member **110** having gear rack **117** thereon. This pinion is keyed to a shaft **138** which is journalled in bearings **139** carried by housing **108** above and below pinion **137**. Shaft **138** projects downwardly from housing **108** (FIGURE 5) and is axially telescoped into the coupling sleeve **63** so that the latter can move vertically with cylinder **39** relative to shaft **138**. Shaft **138** is rotatably coupled to sleeve **63**, for example, by a key or splines, so that rotation of shaft **138** is transmitted to coupling **63** and hence to the drive shaft **61** for transmission to the shaft **73** of gripping device **36** by way of shaft **56**, the hammer blow clutch, sprocket **70**, chain **71** and sprocket **72**.

From FIGURE 8 it is evident that pinion **137** has a flattened or toothless portion **140** intended for sliding engagement with the adjacent flat side surface portions of control member **110**. When this flat portion **140** and the toothless portion of the side of control member **110** are in engagement, the shaft **138** is locked against rotation. Rotation of the gripping device **36** can only take place when the teeth of pinion **137** are in meshing engagement with gear rack **117**.

The swinging movements of arm assembly **35** are effected by gear racks **118** and **119** of control member **110** driving a pinion **141** (FIGURES 5 and 8) mounted within housing **108** adjacent the side of control member **110** having these gear racks **118** and **119** thereon. Pinion **141** is fixed on a rotatable vertical shaft **142** (FIGURES 5 and 8) journalled in bearings **143** (FIGURE 5) carried by housing **108** above and below pinion **141**. Shaft **142** projects downwardly from housing **108** and, at its lower end, carries a spur gear **144** which is in meshing engagement with a spur gear **145** fixed, as by bolts **146**, to a radially outward directed flange **147** provided on the upper end extension **51** of shell **40**. Thus, shell **40** is turned about its vertical axis through gears **144** and **145** in response to rotation of pinion **141** by meshing engagement of the teeth of the latter with either the gear rack **118** or the gear rack **119**. Turning of shell **40** is transmitted to the housing **39** of the arm assembly by the bolts **47** slidable in slots **49** of the outer shell (FIGURE 5) and fastened to housing **39** as shown in FIGURE 5. When shell **40** is thus rotated, rollers **133** travel in the raceway **134**.

Extension **51** of shell **40**, as shown in FIGURE 5, has an internal bearing **148** at its upper end which is rotatable on a hollow cylindrical boss **149** depending from housing

108 around shaft 138. The upper end of shell 40 is thus journalled for rotation about the bearing 148.

Pinion 141 has a flat or toothless peripheral portion 150 (FIGURE 8) which is slidably engageable with the intermediate flat side surface portion of control member 110 between gear racks 118 and 119. This construction effectively prevents turning of arm assembly 35 except when the teeth of pinion 141 are in meshing engagement with one or the other of the gear racks 118 and 119.

Reciprocatory motion is imparted to each control member 110 of each control assembly 34 by a pressure cylinder 151 (FIGURES 2, 3 and 9) secured to, and extending longitudinally from one end of each housing 108 (FIGURES 2 and 3). Cylinder 151 has a piston 152 (shown in broken lines on FIGURES 3 and 8) which is reciprocable therein. A piston rod 153 extends axially from piston 152 into housing 108 and is provided with a threaded end 154 (FIGURE 9) secured, as by nut 155, to an end wall or flange 156 of control member 110. Ports 157 and 158 at the opposite ends of each cylinder 151 are connected to manifolds 159 and 160, respectively, (FIGURE 2) supplied with pressure fluid from an accumulator 161 or other suitable source. Accumulator 161 may be supplied from an air compressor or pump 162 and, as conventional, is provided with a discharge duct or vent 163. The flow of pressure fluid is controlled by suitable valves, not shown, which valves are desirably operated by the operator in the cab 17. As any well known pressure fluid system may be used, further description thereof would serve no useful purpose.

FIGURE 9 shows, in full lines, the relative position of the control member 110, cam roller 120, pinions 137 and 141, at the end of one stroke. The legends on FIGURE 8 indicate the sequence of the respective movements of the arm assembly 35 and the gripping device 36 to effect engagement with the cover, its rotation, elevation and swinging movement to charging position (35C, FIGURE 3) in effecting a single stroke. Upon movement of control member 110 in the reverse direction (left to right, viewing FIGURE 9), the reverse movements take place, i.e., the arm assembly 35 and the gripping device 36 are first swung into position over the open charging hole, the cover moved downwardly and rotated to clean its seat, the jaws opened to release the cover, the arm assembly elevated and then swung to its rest position. The dotted line showing of control member in FIGURE 9 depicts the position of this member at the end of the return stroke which, of course, corresponds to its position when starting a cover-removing and coke oven chamber-charging operation.

As noted, the pyramidical top 80 cooperates with the flaring skirt 84 and recess 82 to insure that the head 77 enters recess 82 so that the wrench-like intermediate portion 83 engages the outer walls of head 77 and effects rotation thereof when extension 81 is rotated. The number of teeth on racks 118 and 119 and pinion 141 are chosen to give the desired swinging motion of the arm assembly. Pinion 141 having the flat toothless peripheral portion 150 cooperates with these racks to effect positioning of the flaring skirt 84 at the end of each swinging motion of the arm assembly relative to the pyramidical top 80 of the cover thereteneath to insure proper registry between the walls of head 77 and the wrench-link intermediate portion 83. The toothless periphery 150 of pinion 141 locks the arm assembly in such registered position at the end of each swinging movement of the arm assembly.

Relocating and Aligning Structure

The relocation and aligning structure is shown in FIGURES 4, 5 and 7. This structure functions to properly align inner arm structure 52 relative to its outer housing 38 at the end of each cycle during return of the arm assembly 35 to rest position to insure that the gripping device will be properly positioned to engage the cover head 77 when the machine is moved to remove the covers of another coking chamber. As hereinabove disclosed, the arm assembly will accommodate misalignment within limits in the spotting of the charging machine relative to a coking chamber from which the covers are removed. Thus, as the gripping device descends and skirt 84 engages the pyramidical top 80 of the cover, the inner arm assembly 52 will move laterally in either direction or forward or backward within housing 38, depending on the nature of the misalignment. The relocating structure serves to restore the arm assembly to its correct position within housing 38 at the end of each cycle.

Relocating assembly 170 includes a rockable member 171 fixed on a shaft 172 extending laterally across the bottom of housing 38 adjacent the inner end of the latter. Rockable member 171 extends generally towards the outer end of housing 38 below arm structure 52 and has parallel side arms 173 (FIGURES 5 and 7) extending from shaft 172 and a cross piece 174 extending between the free ends of arms 173 (FIGURIES 5, 7 and 10).

Transversely extending plates 175 and 176 depend from the bottom of casing 53 at predetermined locations spaced apart therealong. A longitudinally extending plate 177 depends from the bottom of casing 53 between plates 175 and 176 and has an inverted V-shaped bottom edge 178. As is apparent in FIGURE 5, rockable member 171 is dimensioned so that, when it is raised to the position shown in broken lines, cross piece 174 thereof rides along one or the other of the upwardly converging portions of edge 178 toward the center of the latter, thereby to locate arm structure 52 in the position relative to housing 38 at which cross member 174 is received in the apex or corner of the inverted V-shaped lower edge 178 of plate 177. This action properly aligns the arm structure 52 relative to the housing 38 in both forward and backward directions with respect to the longitudinal extent of housing 38 in the direction from left to right, viewing FIGURE 5.

As is apparent from FIGURE 7, transversely extending plate 175 has a width, where it is fixed to the bottom of casing 53, which is slightly less than the lateral distance between arms 173 of rockable member 171, and has inclined side edges 179 which diverge from their free ends towards the underside of casing 53. Thus, when rockable member 171 is raised from the full line position shown in FIGURE 5 to the dotted line position, in the event of lateral misalignment one or the other of the arms 173 thereof rides against the adjacent inclined side edge 179 of plate 175 so as to move the casing 52 laterally relative to housing 38 to restore the casing 52 to its proper position within this housing.

Such rocking movements of member 171 are effected by a lever arm 180 fixed to shaft 172 and extending generally upward therefrom at the outside of housing 38. Lever arm 180 engages a stop 181 (FIGURE 4) fixed on the frame of the machine when the unit is returned to rest position. This stop is so located that upon swinging motion of arm assembly 35 to rest position, arm 180 engages the stop causing rocking movement of arm 173 carrying the cross bar 174. The inclined edges 178 and 179, as hereinabove described, effect relocation and alignment of casing 52 whenever misalignment has occurred.

Operation

At the beginning of each operating cycle of the cover handling mechanism embodying this invention, the control member 110 of each unit 32 is disposed in the position shown in broken lines at 110' on FIGURE 9. The operation of all units 32 is the same; only one will be described hereinafter. The arm assembly 35 is in its rest position 35A (FIGURE 3) and in its raised position 35R (FIGURE 5) with jaws 94 of gripping device 36 in their open or released positions (FIGURE 11). After

the larry 11 has been positioned above a coking chamber to be charged so that discharge chutes 25' are substantially aligned with the charging holes 15 of that coking chamber, and while sleeves 27 of the discharge chutes are still in their retracted or raised positions, the operator in cab 17 on larry 11 manipulates the valve controlling the flow of pressure fluid to supply same to the cylinders 151 to effect movement of the piston 152 and control member 110 of each control assembly 34 toward the left, which movement of member 110 corresponds to the cover removing phase of the operating cycle of the mechanism, as viewed in FIGURES 8 and 9.

During such initial movement of control member 110, roller 120 is engaged by raised surface portion 112 of cam surface 111, so as to maintain the arm assembly 35 in its raised position, while pinion 141 is rotated by gear rack 118 to cause swinging movement of the arm assembly from its rest position 35A to its cover removing and replacing position 35B (FIGURE 3). As gear rack 118 moves out of engagement with pinion 141, flat or toothless portion 150 of the latter is slidably engaged by the smooth surface contiguous to gear rack 118 of control member 110 to lock the arm assembly in the position 35B where its gripping device 36 is disposed above the pyramidical dome 80 of the cover 30 to be removed. Roller 120, in the continued movement of control member 110, is engaged by downwardly inclined portion or ramp 115 of cam surface 111 so that the arm assembly is moved downwardly to its lowered position 35L (FIGURE 5). During the downward movement of arm assembly 35, the rockable member 171 of relocating assembly 170 is freed from the guide plates 175 and 177, thereby to release the inner arm structure 52 for displacement relative to housing 38 so that the flared skirt 84 and recess 82 of gripping device 36 can cooperate with the pyramidical dome 80 of the cover in guiding the gripping device to a centered position relative to the cover 30 to be removed.

When depressed intermediate portion 114 of cam surface 111 engages roller 120, arm assembly 35 remains in its lowered position, and the flattened or toothless portion 150 of pinion 141 continues to be slidably engaged by the flat side surface portion of control member 110, so that the arm assembly remains locked in its position 35B. During this movement of control member 110, pinion 137 is driven by gear rack 117. This causes closing or clamping of jaws 94 of gripping device 36 beneath cover head 77 and through the hammer blow clutch 57*a*, 57*b* "cracking" of the cover and rotation thereof through about 470°. The clutch parts 57*a*, 57*b* permit limited rotation of the gripping device 36 to effect proper seating thereof on head 77 of cover 30.

As gear rack 117 moves out of meshing engagement with pinion 137, the flat or toothless portion 140 of the latter is slidably engaged by a flat adjacent side surface portion of control member 110 so as to lock the gripping device 36 in its closed or clamped condition. Simultaneously roller 120 is engaged by the upwardly inclined ramp or portion 116 of cam surface 111 so as to effect upward movement of arm assembly to its raised position 35R (FIGURE 5) and thus elevate the cover.

During such upward movement of the arm assembly which raises the gripped cover 30 from its seat 31, the flat portion 150 of pinion 141 continues to be slidably engaged by the adjacent flat side surface portion of control member 110 so that the arm assembly remains locked in its position 35B. However, when the raised portion 113 of cam surface 111 comes into engagement with roller 120 to maintain the arm assembly in its raised position with the gripped cover 30 spaced upwardly from the top of the oven battery, gear rack 118 meshes with pinion 141 to cause further swinging movement of the arm assembly from the position 35B to its charging position 35C (FIGURE 3) where the gripped cover 30 is held to one side of the charging hole 15. This permits downward extension of the sleeve 27 of the discharge chute 25 preparatory to the discharge of coal from the associated hopper 16 into the charging hole. Such extension is effected by the operator in the cab actuating the motor which actuates the linkage mechanism 28.

At the conclusion of the above described cover removing phase or first half of the operating cycle of the cover handling mechanism, the control member 110 of each control assembly 34 is in the position shown in full lines on FIGURES 8 and 9 and remains in that position throughout the charging of the coking chamber. When charging of the coking chamber has been completed, the sleeves 27 are retracted, and the operator manipulates the control for the pressure fluid to the pressure cylinder 151 to move control member 110 toward the right, as viewed in FIGURES 8 and 9, from the position shown in full lines back to the position shown in broken lines at 110' on FIGURE 9. During such movement of control member 110, which corresponds to the cover replacing phase of the operating cycle, meshing engagement of gear rack 119 with pinion 141 causes swinging of the arm assembly from its charging position 35C to its cover removing and replacing position 35B (FIGURE 3); engagement of raised portion 113 of cam surface 111 with roller 120 maintains the arm assembly in its raised position and the slidable engagement of the smooth side surface portion of the control member with the flat portion 140 of pinion 137 maintains the gripping device 36 in its closed or clamped condition.

When arm assembly 35 reaches the cover removing and replacing position 35B, inclined portion 116 of cam surface 111 engages roller 120 to cause downward movement of the arm assembly, whereby the gripped cover is lowered onto its seat 31. The inclination of the seat 31 and the rounded edge (FIGURE 10) and weight of the cover insures its proper return to its seat. Upon return of the cover 30 to its seat 31, gear rack 117 comes into meshing engagement with pinion 137 to rotate the latter and thereby cause rotation of the gripping device 36 to rotate the cover and clean its seat. As rotation of the gripping device continues, the bearing surface 102 in its upward movement engages the ears 105 and thus opens the jaws to release the cover.

When the inclined ramp portion 115 of cam surface 111 comes into engagement with roller 120, the arm assembly is raised and leaves the replaced cover on its seat. While the arm assembly is maintained in its raised position by engagement of raised portions 112 of cam surface 111 with roller 120, gear rack 118 comes into meshing engagement with pinion 141 to cause further swinging of the raised arm assembly back to its rest portion 35A (FIGURE 3). During these latter stages of the movement, lever 180 strikes stop 181 to actuate the relocating and aligning mechanism 170, hereinabove described. At this point each control member has been returned to its broken line position 110' of FIGURE 9 with each arm assembly properly aligned relative to its outer housing 38, and the cover replacing phase of the operating cycle of the cover handling mechanism has been completed.

It will be appreciated that the machine need not operate to remove and replace covers on one and the same oven chamber of the battery. The machine, for example, after removing covers from one coking chamber, say near the end of its coking cycle, can proceed with the covers held in the discharge position 35C to an empty coking chamber, charge this chamber, place the cover on the charging holes of the charged chamber, then after the arm assemblies have been moved to the rest position, proceed to another oven, remove the covers, proceed to the bunker to receive another charge of coal and return to the first chamber, charge it, place the covers removed from a different coking chamber thereon and repeat the cycle. In this way covers from one chamber are employed to close the charging openings of another one. During the period at the end of the coking cycle while the charging holes are open to the atmosphere, air from

the atmosphere enters the tops of the hot coking chambers and supports combustion of carbon and carbonaceous deposits which invariably form there. The products of combustion thus produced flow into the uptakes, the discharge ends of which are then closed by the usual liquid seal valves and are vented to the atmosphere by opening the access port or other opening in the upper portion of the uptake pipe individual to each coking chamber.

From the above, it will be apparent that all of the control functions of each unit **32** of the cover handling mechanism embodying this invention are performed by the simple reciprocatory movement of the single control member **110** so that the various stages of each operating cycle are reliably performed in the necessary sequence. Further, the single control member **110** of each unit **32** and the cooperating elements actuated thereby constitute a reliable mechanical means for effecting the various movements and operations of the arm assembly **35** and the gripping device **36** so that consistent and reliable operation is ensured under the undesirable conditions to which the cover handling mechanism is subjected on the top of a coke oven battery.

It will also be noted that during operation of the cover handling mechanism, each unit **32** of the cover handling mechanism quickly and efficiently effects removal of a charging hole cover, swings out of the way of the coal charging chute, replaces the cover when the chute is removed and simultaneously cleans this cover seat. The time required for so doing is a fraction of what has been required by heretofore known machines.

Moreover each unit **32** of the cover handling mechanism effects removal of the charging hole covers even though the larry **11** is not accurately positioned so as to effect exact initial alignment of the gripping device **36** of each unit with the projection or knob on the related cover. Thus the machine provides a helpful tolerance for the operator in spotting the charging larry relative to the charging holes.

Although a particular illustrative embodiment of the invention has been described in detail herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to that embodiment, and that various changes and modifications may be made without departing from the scope of the invention. Thus, for example, the invention is not limited to a machine in which the arm assembly has three positions: (1) rest, (2) cover removing and (3) charging positions. Substantially the same mechanism can be used to effect movement in two positions only, namely, a cover removing position between the discharge chute and the cover, and a second position spaced therefrom permitting movement of the sleeve into charging position. The arm will, of course, be oscillated back and forth between these two positions. Nor is this invention confined to the removal of covers. The novel structure herein disclosed has other applications such as the automatic removal of a part with or without its replacement to give access to an opening covered by such part for charging or other purposes.

What is claimed is:

1. In combination with a coke oven charging apparatus including a larry movable along the top of an oven battery, and hoppers on said larry adapted to contain charges for discharge into the charging holes of a coking chamber of the battery and each having a discharge chute with a normally retracted sleeve which is extended downwardly to engage the mouth of a charging hole during discharge of the charge through the latter; a means for removing and replacing the covers of the charging holes before and after, respectively, the discharge of said charges into said coking chamber, said means comprising an arm assembly associated with each hopper, means mounting said arm assembly on said larry for vertical movement between raised and lowered position and for horizontal swinging movement under the discharge chute between rest and charging positions remote from said chute and an intermediate position where said arm assembly projects between said chute and a charging hole with which the latter is registered, control means operative to swing said arm assembly in said raised position from said rest position to said charging position and from said charging position back to said rest position with periods of dwell at said intermediate position during which said arm assembly is moved downwardly to said lowered position and returned to said raised position, and rotatable gripping means carried by said arm assembly and operated by said control means to grip and rotate a charging hole cover when said arm assembly is in said lowered position during the period of dwell in the swinging movement from said rest position to said charging position, and to rotate and then release the charging hole cover when said arm assembly is again in said lowered position during the period of dwell in the swinging movement thereof back to said rest position.

2. In a mechanism for removing and replacing the covers of charging holes, the combination of at least one arm assembly mounted for vertical movement between raised and lowered positions and for swinging movement across a charging hole, control means operative to swing said arm assembly and to raise and lower it, and gripping means carried by said arm assembly, said gripping means including a rotatable member, jaws rockably mounted on said member to move between clamped and released positions and means moving said jaws to said clamped position in response to rotation of said member in one direction and moving said jaws to said released position in response to rotation of said member in the opposite direction.

3. In a mechanism for removing and replacing the covers of charging holes, the combination of at least one arm assembly mounted for vertical movement between raised and lowered positions and for swinging movement across a charging hole between first and second extreme positions remote from the charging hole and an intermediate position where said arm assembly extends over the charging hole, control means including a reciprocable control member operative, during movement in one direction, to swing said arm assembly in said raised position from said first position to said second position and, during movement in the opposite direction to swing said arm assembly back to said first position with periods of dwell at said intermediate position during which said arm assembly is moved downwardly to said lowered position and returned to said raised position, and gripping means rotatably carried by said arm assembly and operated in response to movement of said control member in said one direction to grip and rotate a charging hole cover, when said arm assembly is in said lowered position during the period of dwell in the swinging movement from said first position to said second position, and, in response to movement of said control member in said opposite direction, to rotate and release the charging hole cover, when said arm assembly is again in said lowered position during the period of dwell in the swinging movement of the arm assembly back to said first position.

4. In a mechanism for removing and replacing the covers of charging holes, the combination of at least one arm assembly mounted for vertical movement between raised and lowered positions and for swinging movement across a charging hole between first and second extreme positions remote from the charging hole and an intermediate position where said arm assembly extends over the charging hole, a reciprocable control member having first and second gear means and a cam surface thereon, gear driven means meshing with said first gear means to swing said arm assembly from said first position to said second position in response to movement of said control member in one direction and then to swing said arm assembly back to said first position in response to movement of said control member in the opposite direction with periods of

dwell at said intermediate position, and cam follower means engaging said cam surface to maintain said arm assembly in said raised position, and to move the arm assembly downwardly to said lowered position and return the same to said raised position during each period of dwell.

5. In a mechanism for removing and replacing the covers of charging holes, the combination of at least one arm assembly mounted for vertical movement between raised and lowered positions and for swinging movement across a charging hole between first and second extreme positions remote from the charging hole and an intermediate position where said arm assembly extends over the charging hole, control means including a reciprocable control member operative, during movement in one direction, to swing said arm assembly in said raised position from said first position to said second position and, during movement in the opposite direction, to swing said arm assembly back to said first position with periods of dwell at said intermediate position during which said arm assembly is moved downwardly to said lowered position and returned to said raised position, gripping means rotatably carried by said arm assembly and operated in response to movement of said control member in said one direction to grip and spin a charging hole cover, when said arm assembly is in said lowered position during the period of dwell in the swinging movement from said first position to said second position, and, in response to movement of said control member in said opposite direction, to spin and release the charging hole cover, when said arm assembly is again in said lowered position during the period of dwell in the swinging movement of the arm assembly back to said first position, and fluid pressure operated means for moving said control member in said one direction and then in said opposite direction.

6. In a mechanism for removing and replacing the covers of charging holes, the combination of at least one arm assembly mounted for vertical movement between raised and lowered positions and for swinging movement across a charging hole between first and second extreme positions remote from the charging hole and an intermediate position where said arm assembly extends over the charging hole, control means operative to swing said arm assembly in said raised position from said first position to said second position and then to swing said arm assembly back to said first position with periods of dwell at said intermediate position during which said arm assembly is moved downwardly to said lowered position and returned to said raised position, and gripping means including a member rotatably carried by said arm assembly, drive means for said member operated by said control means to rotate said member in one direction when said arm assembly is in said lowered position during the period of dwell in the swinging movement from said first position to said second position, and to rotate said member in the other direction when said arm assembly is again in said lowered position during the period of dwell in the swinging movement of the arm assembly back to said first position, jaws rockably mounted on said member for rotation with the latter and being swingable toward and away from each other between cover gripping and releasing positions, a non-rotatable, internally threaded sleeve extending around said member, and a cam ring rotatable with said member and screwed into said sleeve, said cam ring engaging said jaws to move the latter to said gripping positions upon rotation of said member in said one direction and to move said jaws to said release position upon rotation of said member in said other direction.

7. A machine for removing and replacing a charging hole cover having a projection on the top thereof for the charging hole of a coking chamber of a coke oven battery, in combination, an arm assembly; means for moving said arm assembly vertically between raised and lowered positions above a charging hole; means for swinging said arm assembly across a charging hole between first and second extreme positions laterally remote from the charging hole and an intermediate position where said arm assembly is positioned directly above the charging hole with a period of dwell while so positioned above the charging hole; said arm assembly comprising a housing, a supporting structure within said housing mounted for limited horizontal displacements relative to the walls of said housing, and mechanical gripping means carried by said supporting structure, the mounting of said supporting structure for limited horizontal movement within said housing effecting alignment of said mechcanical gripping means relative to said projection on the top of a cover to center the said mechanical gripping means relative to said projection on the top of the cover; and control means operative to control the operation of (a) said means for moving said arm assembly, (b) said means for swinging said arm assembly, and (c) said gripping means, to move said arm assembly downwardly to said lowered position during the said dwell period and actuate said gripping means to grip the projection of a charging hole cover, to move said arm assembly carrying the cover to its elevated position, to swing the arm assembly and cover to the said second extreme position, to return the said arm assembly and cover to the position above said charging hole and during the period of dwell to move downwardly and position the cover on the charging hole, to release the cover, to thereafter move the arm assembly to its elevated position above a charging hole and to then swing the arm assembly to said first position.

8. A machine as defined in claim 7 in which the gripping means include guide means for centering said gripping means relative to the cover during the downward movement of said arm assembly to said lowered position.

9. A machine as defined in claim 7 having relocating means operative in response to return of said assembly to said first position to dispose said inner structure of said arm assembly at a predetermined location relative to said housing.

10. In combination with a coke oven charging apparatus including a larry movable along the top of an oven battery, and hoppers on said larry adapted to contain charges for discharge into the charging holes of a coking chamber and each hopper having a discharge chute with a normally retracted sleeve which is extended downwardly to engage the mouth of a charging hole during discharge of the charge through said chute, said charging holes each having a cover provided with a projection at the top thereof; means for removing and replacing said covers before and after, respectively, the discharge of said charges into the coking chamber, said means comprising an arm assembly associated with each hopper, means mounting said arm assembly on said larry for vertical movement between raised and lowered positions and for horizontal swinging movement under the discharge chute between extreme rest and charging positions laterally removed from said chute and an intermediate position where said arm assembly projects between said chute and a charging hole with which the latter is registered, power actuated control means operative alternately to swing said arm assembly in said raised position from said rest position to said charging position and from said charging position back to said rest position with periods of dwell at said intermediate position during which said arm assembly is moved downwardly to said lowered position and returned to said raised position, and mechanical gripping means carried by said arm assembly and operated by said control means to grip said projection of the cover when said arm assembly is in said lowered position during the period of dwell in the swinging movement from said rest position to said charging position, whereby the cover is lifted from the charging hole and carried to said charging position, and to release said projection of the charging hole cover when said arm as-

sembly is again in said lowered position during the period of dwell at said intermediate position in the swinging movement thereof back to said rest position so that the cover is replaced on the charging hole.

11. In combination with a coke oven charging apparatus including a larry movable along the top of an oven battery, and hoppers on said larry adapted to contain charges for discharge into the charging holes of a coking chamber of the battery and each hopper having a discharge chute with a normally retracted sleeve which is extended downwardly to engage the mouth of a charging hole during discharge of the charge through said chute, the charging holes each having a cover provided with a projection on the top thereof, and means for removing and replacing the covers of the charging holes before and after, respectively, the discharge of said charges, said means comprising an arm assembly associated with each hopper, means mounting said arm assembly on said larry for vertical movement between raised and lowered positions and for horizontal swinging movement under a discharge chute between extreme rest and charging positions remote from said chute and an intermediate position where said arm assembly projects between said chute and a charging hole with which the latter is registered, power actuated control means operative alternately to swing said arm assembly in said raised position from said rest position to said charging position and from said charging position back to said rest position with periods of dwell at said intermediate position during which said arm assembly is moved downwardly to said lowered position and returned to said raised position, and rotatable mechanical gripping means carried by said arm assembly and operated by said control means to grip said projection of a charging hole cover and rotate the latter when said arm assembly is in said lowered position during the period of dwell in the swinging movement from said rest position to said charging position, whereby the cover is lifted and carried by said arm assembly to said charging position during the continuation of said swinging movement after said period of dwell, and to rotate and then release said projection of the charging hole cover when said arm assembly is again in said lowered position during the period of dwell in the swinging movement thereof back to said rest position, so that the released cover is left on the charging hole as said arm assembly swings back to said rest position from said intermediate position.

12. In combination with a coke oven charging apparatus including a larry movable along the top of an oven battery, and hoppers on said larry adapted to contain charges for discharge into the charging holes of a coking chamber and each having a discharge chute with a normally retracted sleeve which is extended downwardly to engage the mouth of a charging hole during discharge of the charge through the chute, said charging holes each having a cover provided with central projection with an enlarged head at the top thereof, means for removing and replacing said covers of the charging holes before and after, respectively, the discharge of said charges, said means comprising an arm assembly associated with each hopper and having an arm housing, means mounting said arm housing on said larry for vertical movement between raised and lowered positions and for horizontal swinging movement under the discharge chute between rest and charging positions remote from said chute and in intermediate position where said arm housing projects between said chute and a charging hole with which the latter is registered, control means operative alternately to swing said arm housing in said raised position from said rest position to said charging position and from said charging position back to said rest position with periods of dwell at said intermediate position during which said arm housing is moved downwardly to said lowered position and returned to said raised position, an inner arm structure within said housing free for limited horizontal movement relative to said housing when the latter is in said lowered position, and rotatable gripping means carried by said inner arm structure and including rockable jaws operated by said control means to grip said projection of a charging hole cover and rotate the latter when said arm assembly is in said lowered position during the period of dwell in the swinging movement from said rest position to said charging position, and to rotate the charging hole cover and then release said projection of the cover when said arm assembly is again in said lowered position during the period of dwell in the swinging movement thereof back to said rest position, said gripping means including a downwardly flared skirt engageable with said enlarged head of the cover projection during said downward movement of the arm housing at said intermediate position to guide said gripping means onto said projection.

13. A machine for removing and replacing covers and other parts, comprising at least one generally horizontally extending arm assembly having a housing extending upwardly from one end portion thereof, an outer shell having said housing axially slidable therein and constrained against rotation relative to said shell, means supporting said shell for turning about a vertical axis, a control member, means supporting said control member for longitudinal reciprocation above said shell, said control member having a cam surface extending along the top thereof with raised and depressed portions, a cam follower roller riding on said cam surface, means connecting said roller with said housing to raise and lower said arm assembly in response to the engagement of said roller by said raised and depressed portions of the cam surface, first and second gear rack means extending along the opposite sides of said control member, first and second pinions rotatably mounted adjacent said opposite sides of the control member and rotated by meshing engagement with said first and second gear rack means, respectively, during movement of said control member, and gear transmission means between said first pinion and said shell to turn the latter and thereby swing said arm assembly in response to rotation of said first pinion.

14. A machine as defined in claim 13, having gripping means rotatably carried by said arm assembly adjacent the other end of the latter and including jaws rockable between clamped and released positions in response to rotation of said gripping means in opposed directions, and transmission means between said second pinion and said gripping means to rotate the latter upon engagement of said second pinion and second gear rack means during movement of said control member.

15. A machine for removing and replacing the covers of charging holes, as defined in claim 14, having an outer housing fixed relative to said first mentioned housing and an inner arm structure movable within said outer housing and having said gripping means rotatably suspended therefrom, and means locating said inner arm structure in a predetermined position relative to said outer housing.

16. A machine as defined in claim 15, in which said means locating said inner arm structure in a predetermined position relative to said outer housing comprises a member pivotably mounted on said inner housing and having parallel radial arms and a cross-piece between the latter, a guide member on said inner arm structure having perpendicular plates formed respectively with V-shaped and inverted V-shaped edges engageable by said radial arms and cross-piece, respectively, of the pivotal member to locate said inner arm structure laterally and longitudinally relative to said outer housing, a lever for effecting said pivoted movement of said lever and a stop on the frame of said machine engaged by said lever to effect movement of said lever whenever said inner arm structure is not in said predetermined position.

17. A machine for removing and replacing the covers of charging holes, as defined in claim 15, wherein said transmission means between the second pinion and the gripping means includes a stub shaft rotatable in said inner arm structure adjacent said one end of the arm assembly, chain and sprocket transmission means between said gripping means and said stub shaft, and drive shaft means extending axially through said shell from said second pinion to said stub shaft and having universal joints and a longitudinally extensible coupling permitting movement of said inner arm structure within said outer housing and vertical movement of said first mentioned housing and arm assembly relative to said shell.

18. Gripping means comprising, in combination, a rotatable member, rockable jaws on said member, a fixed internally threaded sleeve surrounding said member, an externally threaded cam ring in threaded engagement with said sleeve and rotatably coupled to said member to move axially relative thereto in response to rotation with said member, said cam ring slidably engaging said jaws to rock the latter to clamped and released positions upon axial movement of said cam ring in opposite directions relative to said member.

19. In combination with a coke oven charging apparatus including a larry movable along the top of an oven battery and carrying hoppers adapted to contain charges for discharge through chutes into the charging holes of a coking chamber of the battery, means for removing and replacing the covers of the charging holes before and after, respectively, the discharge of said charges into a coking chamber, said means comprising an arm assembly for each hopper, means mounting said arm assembly on said larry for vertical movement and for horizontal swinging movement under said discharge chute, mechanical gripping means carried by said arm assembly and operative to grip and release a charging hole cover, and power actuated control means for said arm assembly and gripping means operative first to swing said arm assembly, while in a raised position, under said chute from one side of the latter to another side of the chute with a period of dwell at an intermediate position where said arm assembly is lowered and said gripping means is operated to grip a cover therebelow, thereafter raise said arm assembly to lift the gripped cover and carry the latter to said other side of the chute, and second to swing said arm assembly in the opposite direction with another period of dwell at said intermediate position where said arm assembly is again lowered and said gripping means is operated to release the cover, and thereafter said arm assembly is raised and returned to rest at said one side of the chute.

20. A reciprocable control member, having a cam surface along the top thereof with raised and depressed portions, a cam follower riding on said cam surface, spaced gear racks along one side of said control member, a pinion having a portion of its periphery free of teeth arranged to be actuated by the spaced gear racks of said control member, the said toothless portion of said pinion cooperating with the area of said side of said control member between said gear racks to lock the member driven by said pinion against rotation, a gear rack along an intermediate portion of the other side of said control member and a second pinion having a portion of its periphery free of teeth actuated by said last-mentioned gear rack, the said toothless portion of said second pinion cooperating with the end portions of said last-mentioned gear rack to lock the member driven by said second pinion against rotation.

21. In a machine for removing and replacing covers having a projection thereon polygonal in cross-section, gripping means, a wrench-like member carried by said gripping means and arranged to snugly engage said projection on said cover, means for rotating said gripping means to effect rotation of said cover through said wrench-like member and said projection, means for lowering said gripping means to cause said wrench-like member to engage said projection and cooperating means on said gripping means and said projection on said cover to effect proper registry between said projection and said wrench-like member when said gripping means is lowered to engage the said projection on said cover.

22. The machine defined in claim 21, in which the gripping means comprises a pair of pivoted jaws to engage the underside of the projection on the cover when the gripping means are lowered and positioned on said cover, said machine having means for closing said jaws, means for raising said gripping means to remove the cover, means for lowering said gripping means to return the cover to its seat, means for opening the jaws to release the cover, and means for raising the gripping means with the jaws open to remove the gripping means from the cover.

23. In a machine for removing and replacing covers, a housing, an arm assembly mounted in said housing for limited movement relative to said housing, means for moving said housing from an initial position into position to engage a cover, means for moving said housing and simultaneously move said gripping means to remove said cover from its seat when moved in one direction and to return said cover to its seat when moved in another direction, means for returning said housing to said initial position, and means for centering said gripping means relative to said housing upon said return of said housing to its said initial position.

24. In a machine for removing covers, in combination, a housing mounted for swing movement, an arm assembly in said housing movable therewith, gripping means carried by said arm assembly, means for rotating said gripping means, said arm assembly being movable relative to said housing from an initial predetermined position relative to said housing to a position spaced from said predetermined position, said housing and arm assembly being constructed and arranged to permit said gripping means to engage said cover even though said housing is not accurately spotted relative to said cover and means for returning said arm assembly to said predetermined position after return of a cover to its seat and before the machine is spotted to remove another cover.

25. In a charging apparatus for a coke oven battery, in combination,

(*a*) a larry movable along the top of a coke oven battery;

(*b*) a hopper on said larry adapted to contain a charge for discharge into a charging hole of a coking chamber of the battery;

(*c*) a sleeve for said hopper movable downwardly from an upper position to a lower position to engage the mouth of a charging hole during discharge of the charge from the hopper through said sleeve into and through the charging hole;

(*d*) means for moving said sleeve from its upper position to its lower position to engage the mouth of a charging hole;

(*e*) means for removing and replacing the cover of the charging hole before and after, respectively, the discharge of said charge from said hopper into a coking chamber, said means comprising:

(1) an arm assembly associated with said hopper;

(2) mechanical gripping means on said arm assembly, said mechanical gripping means having movable jaws which in closed position engage and grip the cover and in open position release the cover;

(3) means for actuating said mechanical gripping means to close the jaws and grip the cover and open the jaws to release the cover;

(4) means for moving said arm assembly vertically upwardly from a lower position in which said gripping means engages the cover on a charging hole to a first raised position in which

said gripping means holds said cover above said charging hole;

(5) means for swinging said arm assembly while in said raised position with the gripping means gripping the cover from said first position to a second position spaced latterally from said charging hole, in which second position the arm assembly and the cover held thereby do not interfere with the movement of said sleeve downwardly to engage the mouth of a charging hole;

(6) means for swinging said arm assembly back to said first position;

(7) means for moving said arm assembly vertically downwardly after it is swung back to said first position into position where said cover is seated on said charging hole; and

(8) control means on said larry for controlling the operation of (i) said means to move the arm assembly vertically upwardly, (ii) said means for actuating said mechanical gripping means to close the jaws and grip the cover and open the jaws to release the cover; (iii) said means for swiging the arm assembly while in a raised position, (iv) said means for swinging the arm assembly back to said first position, and (v) said means for moving said arm assembly vertically downwardly.

26. A machine as defined in claim 25 having means for rotating said cover while gripped by said mechanical gripping means, and means for imparting a sharp impact to the cover when initiating the rotation thereof to break the seal between the cover and its seat and thus facilitate the removal of the cover.

27. A machine as defined in claim 25 having means for rotating the mechanical gripping means to effect rotation of the cover, said means including a hammer blow clutch to impart a sharp impact to the cover when initiating its rotation and thus break the seal between the cover and its seat.

28. In a charging apparatus for a coke oven battery, in combination,

(*a*) a larry movable along the top of a coke oven battery;

(*b*) hoppers on said larry each adapted to contain a charge for discharge into a charging hole of a coking chamber of the battery;

(*c*) a sleeve for each hopper movable downwardly from an upper position to a lower position to engage the mouth of a charging hole during discharge of the charge from the hopper through said sleeve into and through the charging hole;

(*d*) means for moving said sleeve from its upper position to its lower position to engage the mouth of a charging hole;

(*e*) means for removing and replacing the covers of the charging holes before and after, respectively, the discharge of said charge from said hoppers into a coking chamber, said means comprising:

(1) an arm assembly associated with each hopper;

(2) mechanical gripping means on each arm assembly, said mechanical gripping means having movable jaws which in closed position engage and grip the cover and in open position release the cover;

(3) means for actuating said mechanical gripping means to close the jaws and grip the cover and open the jaws to release the cover;

(4) means for moving said arm assembly vertically upwardly from a lower position in which said gripping means engages the cover on a charging hole to a first raised position in which said gripping means holds said cover above said charging hole;

(5) means for swinging said arm assembly while in said raised position with the gripping means gripping the cover from said first position to a second position spaced laterally from said charging hole in which second position the arm assembly and the cover held thereby do not interfere with the movement of said sleeve downwardly to engage the mouth of a charging hole;

(6) means for swinging said arm assembly back to said first position;

(7) means for moving said arm assembly vertically downwardly after it is swung back to said first position into position where said cover is seated on said charging hole; and

(8) control means on said arm assembly for controlling the operation of (i) said means to move the arm assembly vertically upwardly, (ii) said means for actuating said mechanical gripping means to close the jaws and grip the cover and open the jaws to release the cover, (iii) said means for swinging the arm assembly while in a raised position, (iv) said means for swinging the arm assembly back to said first position, and (v) said means for moving said arm assembly vertically downwardly.

29. A charging apparatus for a coke oven battery including, in combination,

(*a*) larry movable along the top of a coke oven battery;

(*b*) hoppers on said larry adapted to contain a charge for discharge into and through the charging holes of a coking chamber of the battery;

(*c*) a sleeve for each hopper movable downwardly from an upper position to a lower position to engage the mouth of a charging hole during the discharge of the charge from the hopper through said sleeve into and through the charging hole;

(*d*) means for moving said sleeve from its upper position into said lower position to engage the mouth of a charging hole; and

(*e*) means for removing and replacing the covers of the charging holes, said means comprising:

(1) an arm assembly for each hopper;

(2) means mounting said arm assembly on the larry for vertical movement between raised and lowered positions and for horizontal swinging movement under the sleeve when in its upper position between rest and charging positions remote from said sleeve and an intermediate position where said arm assembly projects into the path of movement of said sleeve from its upper position to its lower position;

(3) means for moving said arm assembly vertically between said raised and lowered positions;

(4) means for swinging sair arm assembly horizontally under the sleeve when in its upper position between the rest and charging positions remote from said sleeve and an intermediate position where said arm assembly projects into the path of movement of said sleeve from its upper position to its lower position with periods of dwell when said arm assembly is in said intermediate position;

(5) mechanical gripping means carried by each arm assembly and including jaws arranged to be moved from open position to closed position to grip the cover and from closed position to open position to release the cover;

(6) means for actuating said jaws from open position to closed position to grip the cover and from closed position to open position to release the cover; and

(7) control means on said arm assembly for effecting actuation of (i) said means for moving said arm assembly vertically between its raised and lowered positions, (ii) said means for swinging said arm assembly horizontally under the sleeve when in its upper position between

the rest and charging positions remote from said sleeve and into said intermediate position with periods of dwell in said intermediate position, and (iii) said means for actuating said jaws from open position to closed position to grip the cover and from closed position to open position to release the cover, in timed sequence to swing the arm assembly in its raised position from its rest position to said intermediate position, to lower the arm assembly during said period of dwell in said intermediate position so that said jaws engage the cover of a charging hole, to close the jaws to grip the cover, to raise the arm assembly while gripping the cover, to swing the arm assembly gripping the cover to said charging position out of the path of movement of said sleeve, and after discharging of the charge through said sleeve into the coking chamber and withdrawal of said sleeve to its upper position, to swing the arm assembly from said charging position to said intermediate position and during the period of dwell in said intermediate position to lower the arm

assembly carrying the cover to place the cover on its seat on said charging hole, to open said jaws to release the cover and thereafter elevate said arm assembly, and then swing the arm assembly to its rest position.

30. A coke oven battery as defined in claim 29 having means for rotating the jaws while gripping said cover to rotate the cover, said means for rotating said jaws including means for imparting a sharp impact to said cover when initiating the rotation thereof to break the seal between the cover and its seat.

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