Dec. 29, 1942. F. B. ALLEN 2,306,926

MATERIAL HANDLING METHOD AND APPARATUS

Filed Sept. 12, 1938 7 Sheets-Sheet 1

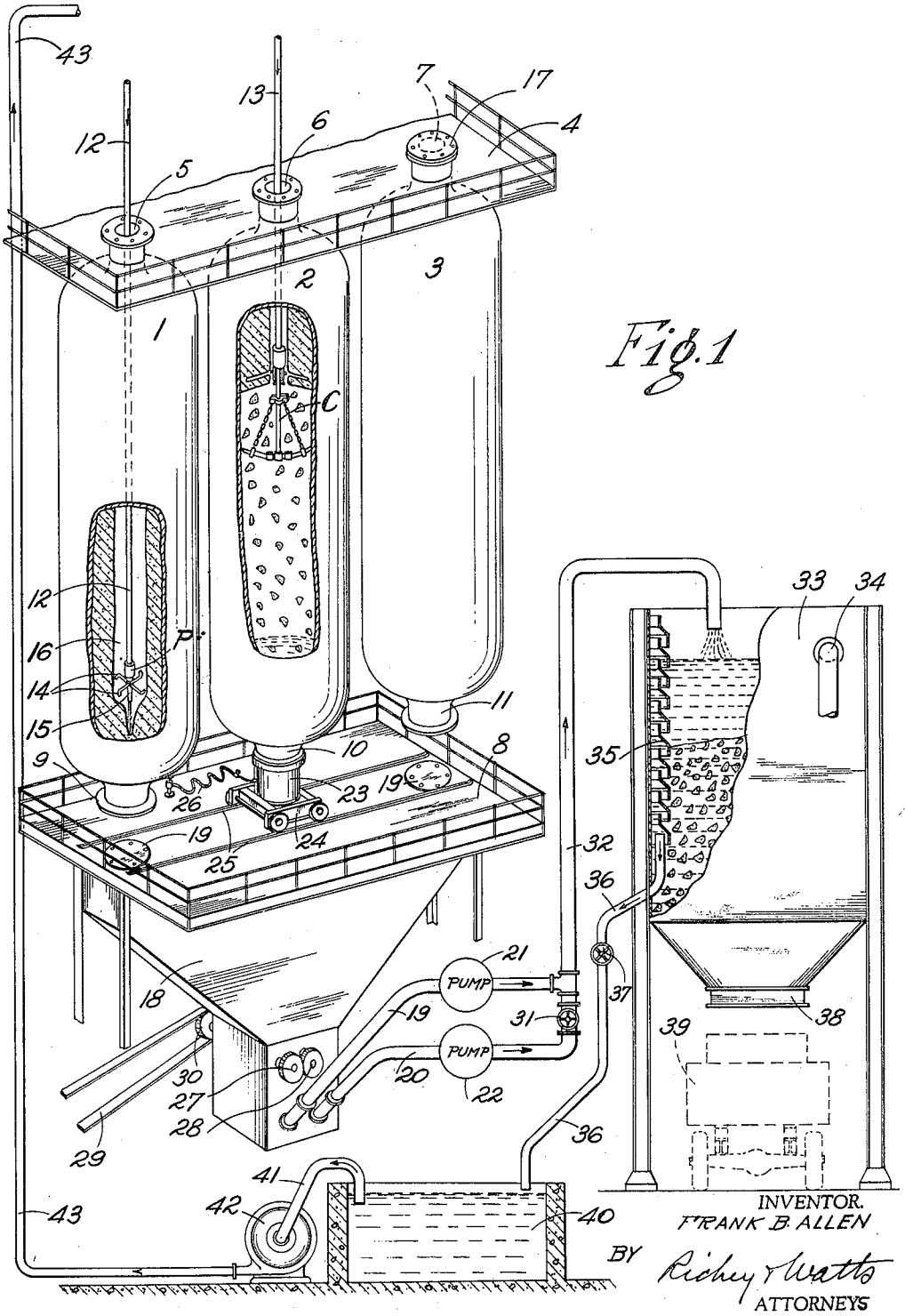


Fig. 1

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MATERIAL HANDLING METHOD AND APPARATUS

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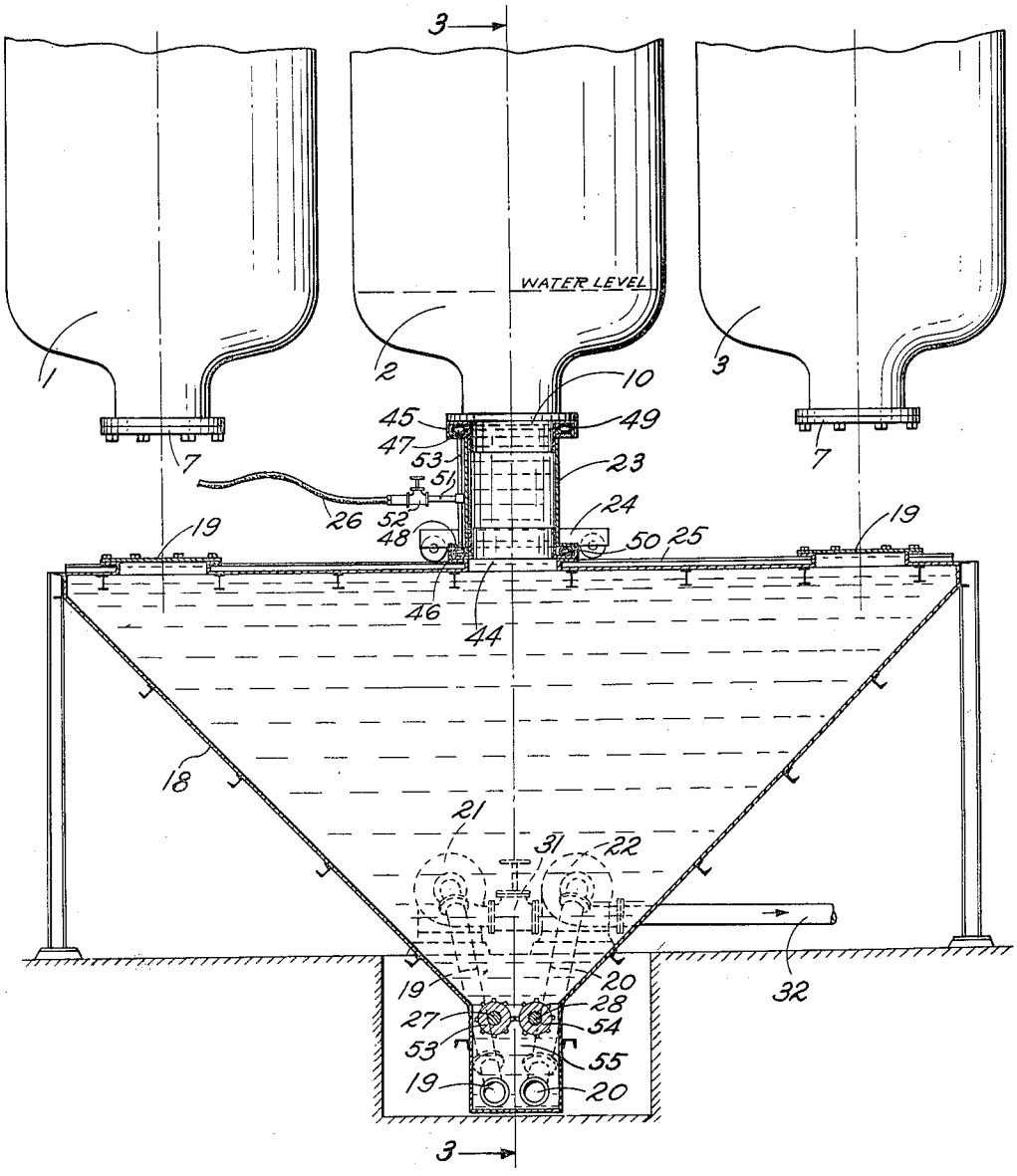


Fig. 2

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MATERIAL HANDLING METHOD AND APPARATUS

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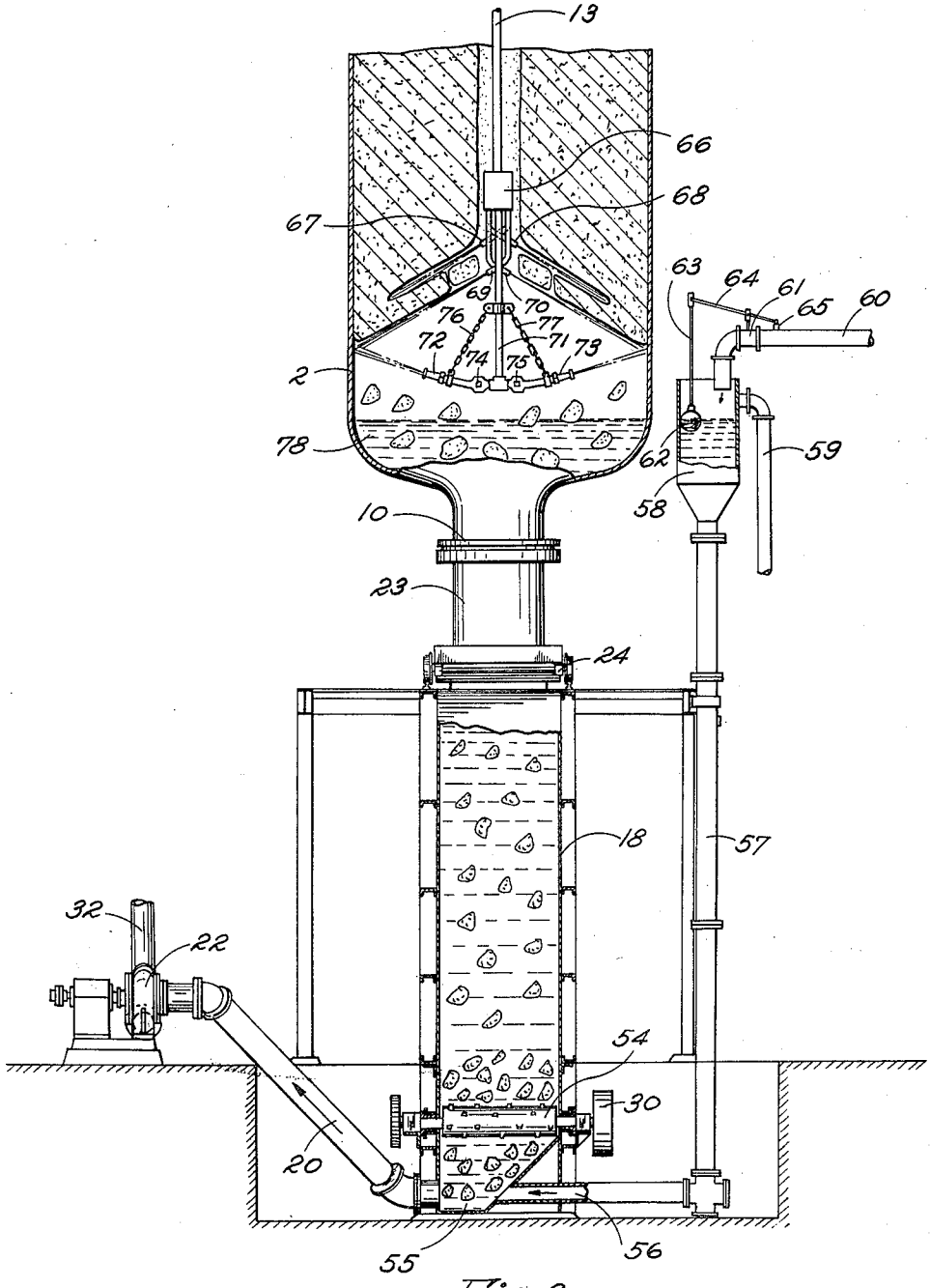


Fig. 3

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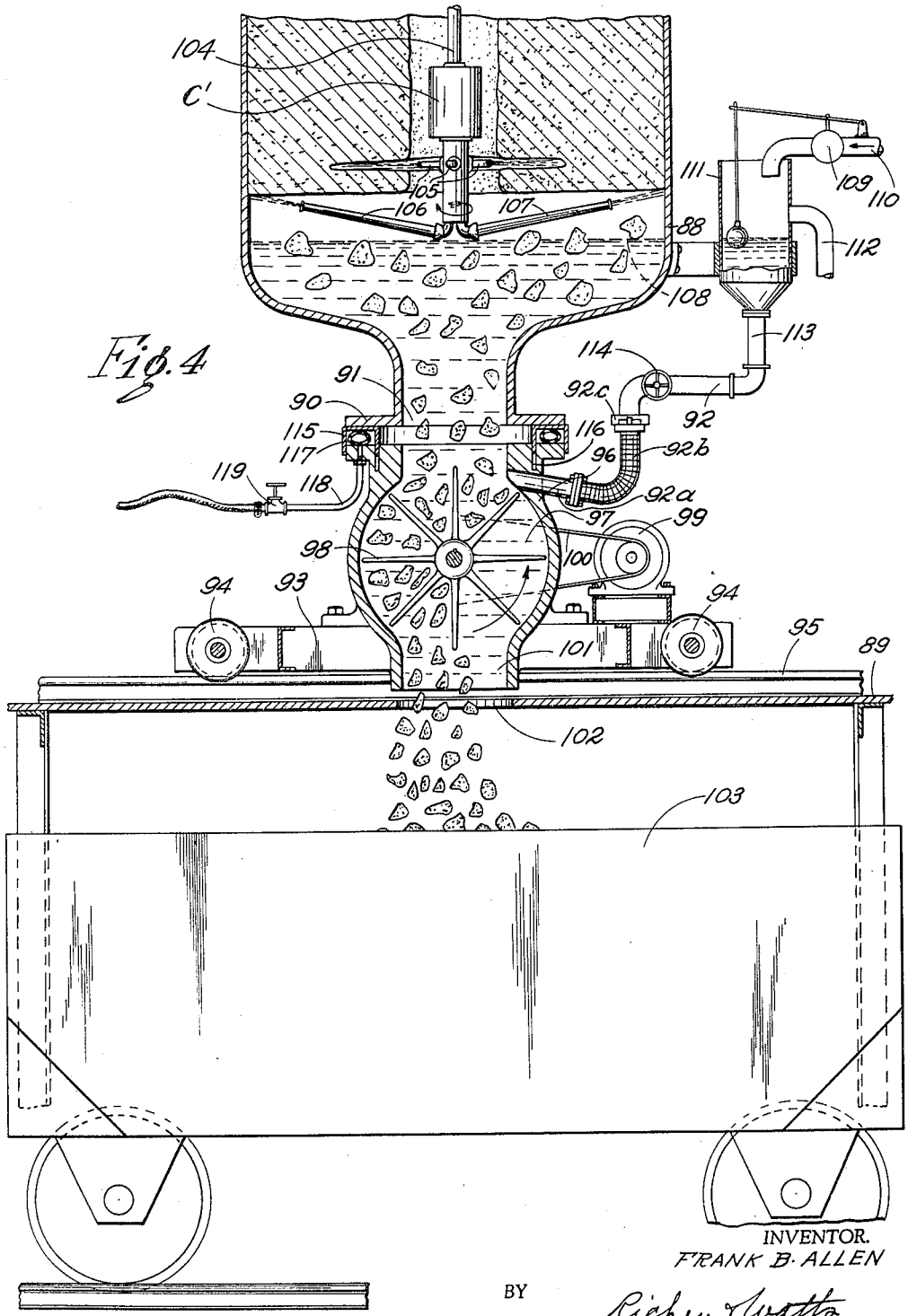
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Dec. 29, 1942. F. B. ALLEN 2,306,926

MATERIAL HANDLING METHOD AND APPARATUS

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Fig. 4



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MATERIAL HANDLING METHOD AND APPARATUS

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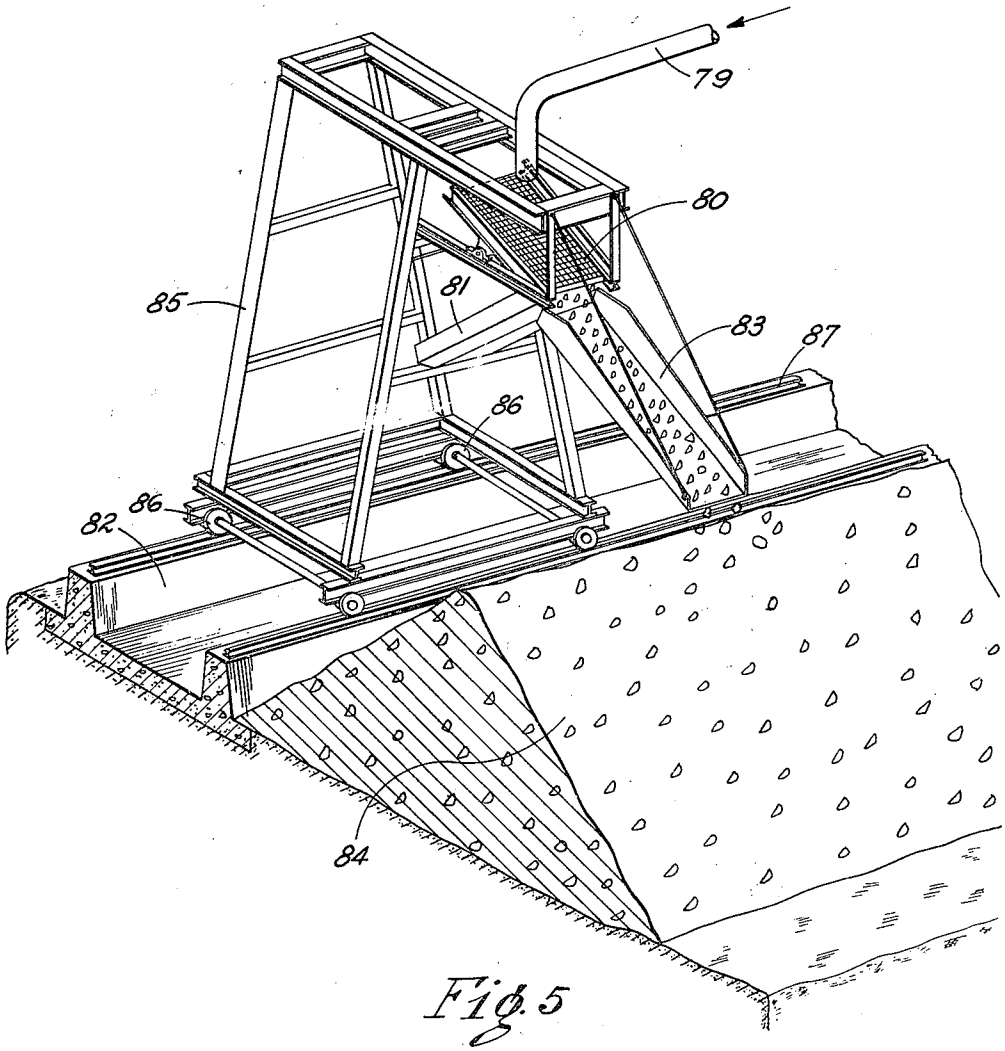


Fig. 5

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MATERIAL HANDLING METHOD AND APPARATUS

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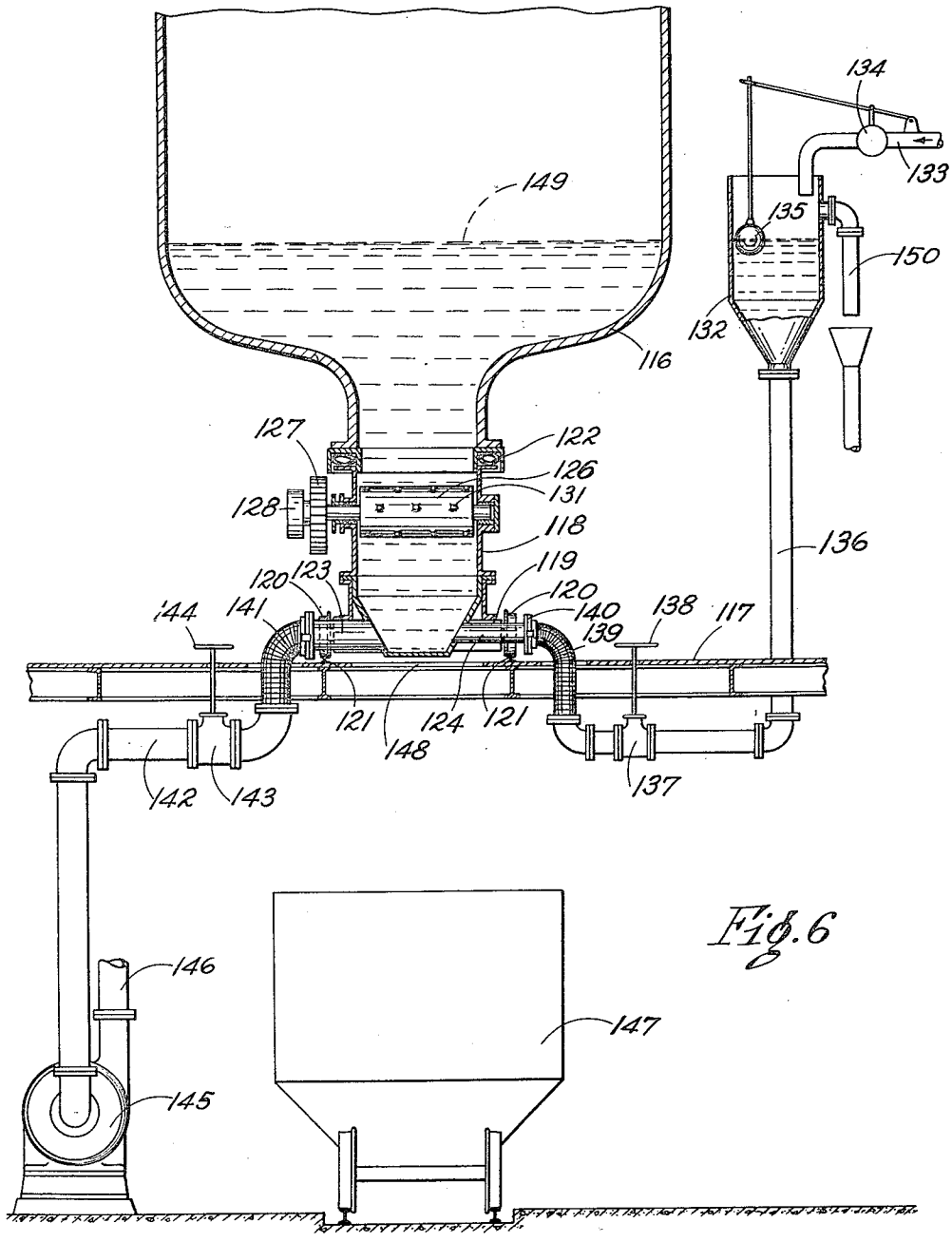


Fig. 6

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MATERIAL HANDLING METHOD AND APPARATUS

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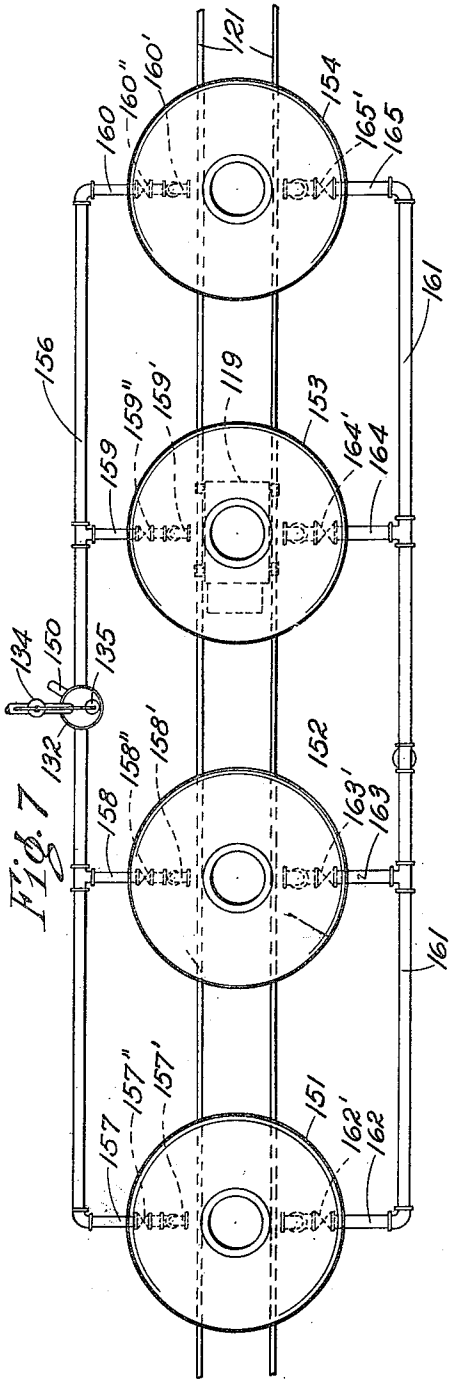


Fig. 7

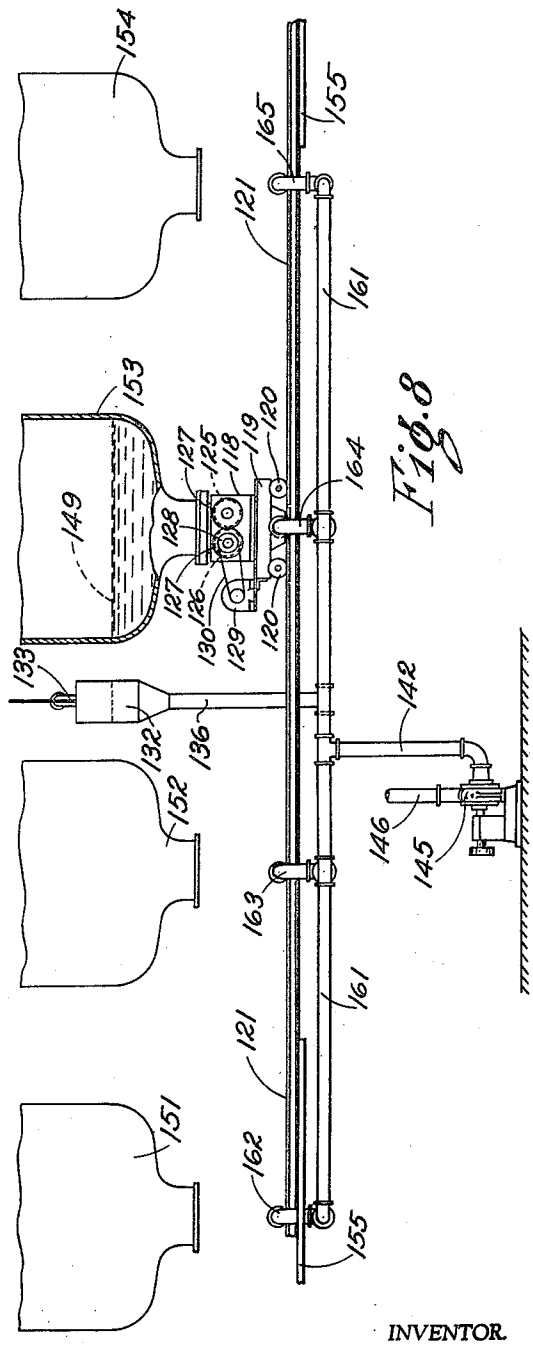


Fig. 8

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UNITED STATES PATENT OFFICE

2,306,926

MATERIAL HANDLING METHOD AND APPARATUS

Frank B. Allen, Lower Merion Township, Montgomery County, Pa., assignor to The Allen-Sherman-Hoff Company, Philadelphia, Pa., a corporation of Pennsylvania

Application September 12, 1938, Serial No. 229,561

22 Claims. (Cl. 141—1)

This invention relates to material handling and more particularly to an improved method of and apparatus for handling coke or the like.

In the production of petroleum coke, hot fluid coke is charged into large vessels or coking chambers in which the liquid material cools and solidifies into its solid state. These coking chambers are commonly vertical vessels in the neighborhood of from 15 feet to 20 feet in diameter and from 50 feet to 60 feet high and having relatively small top and bottom openings which are provided with removable cover plates. Prior to my invention the solidified coke has been removed from the coking chambers by passing a hydraulic piercing tool downwardly through the mass of coke in the vessel from the top opening or manhead to the bottom opening or manhead and drilling a hole about 3 feet in diameter entirely through the body of the coke. The piercing tool is then removed from its support and a hydraulic cutting tool attached and moved upwardly through the hole in the body of the coke. This cutting tool, as will later be more fully described, cuts and breaks up the coke in layers, the tool being lifted a predetermined distance, usually about 18", after each cut. In the procedure commonly followed prior to my invention the coke cut from the body or mass of coke in the vessel has dropped down upon the floor of the coking chamber, passed out of the bottom manhead and then dropped into a railroad car positioned therebelow. The pieces of coke which are cut from the main body or mass in large part are broken up into small particles by impact against the bottom of the coking chamber and are further considerably broken by impact when they fall from the coking chamber into the receiving car. In this industry coke is classified according to size as follows:

Lump coke	plus 4" screen
Nut coke	minus 4" screen, plus 1¼" screen
Domestic coke	minus 1½" screen, plus ⅛" screen
Industrial coke	minus ⅛" screen

With the previous handling procedure the percentage of the larger sizes of coke was relatively small and the percentage of the fine domestic and industrial coke was very high, a typical screen analysis being somewhat as follows:

	Per cent
Lump coke	5
Nut coke	15
Domestic coke	40
Industrial coke	40

As the larger size lump and nut cokes carry a substantial market premium and are considered more desirable for many uses, it is among the objects of my invention to provide an improved method of and apparatus for handling coke whereby a relatively large percentage of large size lump and nut coke and a relatively small percentage of fine domestic and industrial coke will be produced. Other objects of my invention are the provision of a method of removing coke from coking chambers and handling same whereby distintegration and reduction in size of the coke due to impact is eliminated or greatly reduced; the provision of a simple and economical apparatus for handling coke whereby breaking down of the coke into fine particles is prevented; the provision of an improved coke removing and handling apparatus which has a minimum of moving parts subjected to wear and in which the consumption of water used for cutting and conveying the coke may be reduced to a minimum; the provision of apparatus for establishing a pool of water in the lower portion of a coking chamber and maintaining said pool of water sufficiently deep to form a cushion for falling coke; the provision of an improved method of and mechanism for removing coke from a battery of two or more coking chambers whereby different operations may be carried out in the various coking chambers simultaneously and coke production maintained at a high rate with a minimum of apparatus and equipment.

I have determined that the large portion of fine domestic and industrial coke produced by the prior apparatus and procedures is, to a large degree, caused by the impact of the falling coke upon the bottom of the coking chamber and the impact of the coke when it drops into the car below the coking chamber. My invention contemplates the provision and maintenance of a pool of water in the bottom of the coking chamber sufficiently deep to form an effective cushion preventing breakage of the coke pieces as they drop from the main body to the bottom of the chamber. In some installations I propose to maintain such a pool of water in the bottom of the coking chamber and discharge the coke directly therefrom into a railroad car or the like, while in other installations the coke is permitted to sink to the bottom of a sump or hopper from which it is hydraulically conveyed to a reservoir where it is discharged into water and maintained under water until it is withdrawn for use. In the latter procedure the coke may at all times be maintained under water and is never per-

mitted to drop upon itself or upon a hard surface. Slacking is prevented by maintaining the coke submerged at all times until it is desired to remove it for use and a large percentage of the entire mass of coke removed from the coking chamber will be in the larger lump and nut coke size.

The above noted objects of my invention and the preferred steps of my improved method will appear from the following description of several types of apparatus which embody my improvements, reference being had to the accompanying drawings, in which—

Figure 1 is a diagrammatic view, partly in perspective, showing an arrangement of apparatus for carrying out my improved coke handling system.

Figure 2 is an enlarged vertical cross-sectional view showing the bottom portions of a bank of coking chambers, a sump therebelow and means for connecting the coking chambers and sump to establish a pool of water in the bottoms of the chambers.

Figure 3 is an enlarged vertical cross-sectional view, taken on line 3—3 of Figure 2, illustrating a coking chamber and sump of the type shown in Figure 1 and showing a means for maintaining a pool of water in the bottom of the vessel or chamber.

Figure 4 is an enlarged vertical cross-sectional view of a modified form of my invention in which means are provided for creating and maintaining a pool of water in the bottom of the coking chamber and discharging the broken coke and water directly into a railroad car.

Figure 5 is a fragmentary view of a modified arrangement for disposing of the coke after removing it from the coking chamber, in which the coke is screened and piled rather than stored under water in a reservoir.

Figure 6 is a fragmentary vertical cross-sectional view of another form of apparatus embodying my invention.

Figure 7 is a diagrammatic plan view of an installation of the apparatus of Figure 6 with a battery of coking chambers.

Figure 8 is a diagrammatic side elevation of the apparatus shown in Figure 7.

Referring now to Figure 1 of the drawings, three coking chambers 1, 2 and 3 are arranged in a bank and supported in any suitable manner (not shown). An upper platform 4 is provided just below the upper manheads 5, 6 and 7. A platform 8 is disposed below the lower manheads 9, 10 and 11. For purposes of simplified illustration the means for filling the vessels 1, 2 and 3 with hot fluid coke are omitted as are the mechanisms for lifting and lowering the piercing and cutting tool supporting pipes 12 and 13. These supporting pipes 12 and 13 (and an additional similar pipe, not shown, for the coking chamber 3) are adapted to be lifted and lowered so that their bottom ends may be withdrawn completely from the top manheads and dropped below the bottom manheads of the coking chambers.

A portion of the wall of the chamber 1 is shown broken away to illustrate the piercing tool P which is attached to the bottom of the supporting pipe 12. This piercing tool P is swivelly supported at the bottom of the pipe 12 and includes a plurality of radial outlet pipes 14 having outlet nozzle ends bent backward and having a bottom discharge outlet 15 directed vertically downwardly. When water under high pressure is discharged through the pipe 12 into the piercing tool or head this tool will be given a rapid rotary movement due to the "pinwheel" effect of the nozzles 14 and the impact of the water from the nozzles 14 and 15 will cut a cylindrical hole 16 through the mass of solidified coke in the vessel 1.

In Figure 1 the wall of the coking chamber 2 is also broken away to show the coke cutting tool and its action in cutting the mass of coke within the chamber 2 into relatively small pieces after the piercing tool has finished cutting the hole 16. This cutting tool is generally indicated at C and will be described in detail and its operation expained in connection with Figure 3. A removable cover plate 17 is shown in position on the manhead 7 of the coking chamber 3 and it will be understood that the top and bottom manheads of each coking chamber will be provided with such covers.

A sump or coke receiving chamber 18 is disposed below the bottom manheads of the coking chambers 1, 2 and 3. This sump is entirely enclosed except for removable cover plates 19 directly below the bottom manheads of the coking chambers 1, 2 and 3, and the outlet pipes 19 and 20 which lead to the pumps 21 and 22. The connecting conduit or chute 23 is mounted on a car 24 which in turn is movable along the tracks 25 extending below the bottom outlets of the coking chambers 1, 2 and 3. A flexible hose connection 26 is adapted to connect the sealing mechanism (more fully described later) of the chute 23 to a source of supply of operating fluid under pressure while permitting the car 24 and chute 23 to be moved from one coking chamber to another without disconnecting the fluid pressure connection. In the lower portion of the sump 18 is a pair of shafts 27 and 28 which are geared together for simultaneous rotation in opposite directions. The belt 29 engages a pulley 30 on the shaft 27 and extends to any suitable source of power for driving the shafts 27 and 28. As will be explained later, the shafts 27 and 28 carry coke sizing and feeding rolls through which the coke passes before it enters the pipes 19 and 20 under the influence of the suction of the pumps 21 and 22. A valve 31 may be provided whereby the pump 22 can be cut out when desired and both pumps 21 and 22 discharge into a pipe 32 which conveys a mixture of water and coke from the sump 18 to the receiving tank or reservoir 33. This reservoir 33 preferably includes an overflow outlet 34 and means for draining the water from the reservoir when it is desired to remove the coke therefrom which means may include a plurality of louvres 35 and a pipe 36 into which the louvres discharge water while preventing the outflow of solid material. A valve 37, when closed, will prevent the outflow of water from the reservoir or receiving tank 33. A bottom outlet having a suitable closure gate 38 is provided for the reservoir 33. This outlet 38 may conveniently be located above the ground so that the reservoir 33 may be discharged directly into a motor truck 39 or other conveyance for hauling the coke away. The pipe 36 discharges into a settling tank 40 in which any solid material or small particles of coke in the water may settle to the bottom and from which relatively clean water may be withdrawn from adjacent the surface of the tank through the pipe 41 by means of a pump 42. This pump 42 is preferably designed to create a sufficiently high pressure to operate the piercing and cutting tools P and C and the outlet pipe 43 from the pump 42

is connected, through suitable valves and connections (not shown), to the tool supporting pipes 12 and 13.

Figure 2 shows, in enlarged cross-section, the bottom portions of the coking chambers 1, 2 and 3 and the sump 18. As is clearly seen in Figure 2 the chute or connecting conduit 23 is carried by the car 24 which is adapted to be supported by and have movement along the tracks 25. The conduit 23 establishes a water and coke conducting connection between the closed sump 18 and the chambers 1, 2 and 3, it being illustrated in position to connect the chamber 2 with the sump, the lower manheads of the chambers 1 and 3 being closed by their cover plates 7. In order to facilitate the creation of a substantially fluid-tight joint between the opening 44 in the top of the sump 18 and the bottom manhead opening 10 of the coking chamber 2, I provide sleeves 45 and 46 which slide vertically within the conduit 23. Top and bottom flanges 47 and 48 are provided on the conduit 23 and annular flexible tubes 49 and 50 of rubber or other suitable material are disposed in the spaces between the flanges 47 and 48 and the sleeve members 45 and 46 respectively. A pipe 51 supplied with a valve 52 connects to a pipe 53 which in turn is connected to the inflatable tubes 49 and 50. As the flexible connection 26 joins the pipe 51 and supplies fluid under pressure thereto which is controlled by the valve 52, it will be seen that, when pressure is applied to the inflatable tubes 49 and 50, the sleeve members 45 and 46 will be forced upwardly and downwardly into close fitting engagement with the bottom flange of the lower manhead 10 of the coking chamber 2 and the flange of the center opening 44 of the sump 18. When it is desired to connect either of the other coking chambers 1 or 3 to the sump 18 it is only necessary to remove the proper cover plates 7 and 19, move the car 24 along the track 25 until the conduit 23 is in alignment with the openings in the chamber and sump and then turn on the fluid pressure, preferably air, to inflate the tubes 49 and 50 and establish a water-tight joint between the connecting chute or conduit 23 and the coking chamber and sump.

Figure 2 also shows the lower portion of the sump in which the shafts 27 and 28 are disposed. The sizing rolls 53 and 54 are mounted on the shafts 27 and 28 and rotate therewith. These rolls are adapted to give a steady feed of coke into the lower portion 55 of the sump 18 and also to break down any large pieces of coke into a size which can be handled by the discharge pumps 21 and 22 and which will pass through the pipe 32 to a place of disposal. The water inlet pipe 56 enters the bottom portion 55 of the sump 18 and connects to a vertical pipe 57 having an enlarged chamber 58 at its upper end. An overflow pipe 59 is adapted to prevent the level of the water in the chamber 58, and likewise in the coking chamber 2 which is directly connected thereto through the conduit 23, the sump 18 and the pipes 56 and 57, from rising above a predetermined level. The flow of water through the supply pipe 60 is controlled by a float controlled valve 61 actuated by a float 62. The float carrying rod 63 is pivotally connected to the end of a lever 64 which operates the valve 61 and has a fixed pivot at 65.

From the above description it will be seen that when the chute or conduit 23 is in position to connect one of the coking chambers, for example coking chamber 2, to the sump 18 water may be added to the sump 18 until the level thereof rises in the conduit 23 and the bottom portion of the coking chamber to establish a pool of water in the bottom of the chamber. The level of this pool may be maintained substantially constant by means of the float controlled valve 61, it being merely necessary to supply sufficient make-up water to the system to compensate for the volume of water and coke withdrawn through the outlet pipes 19 and 20 by the pumps 21 and 22.

The hydraulic coke cutting tool which is indicated at C in Figure 1 is shown in detail in Figure 3. This tool is swivelly connected at 66 to the supporting pipe 13 and includes a pair of oppositely directed nozzles 67 and 68 below which are disposed another pair of oppositely directed nozzles 69 and 70. The nozzles 69 and 70 are adapted to direct streams of high pressure water in a direction substantially parallel to the jets from the nozzles 67 and 68. As illustrated these jets are directed radially outwardly and somewhat downwardly. A pipe 71 extends down from the swivel 66 and carries at its lower end radially extending nozzles 72 and 73 which are pivotally connected to the pipe 71 at 74 and 75. Chains or other suitable connections, 76 and 77, prevent the nozzles 72 and 73 from dropping below the positions shown in Figure 3, while permitting them to swing upwardly into a position parallel to the pipe 71 so that the cutting tool unit can be inserted into the bottom of the coking chamber 2 through the lower manhead opening 10. The nozzles 67, 68, 69 and 70 are also directed somewhat circumferentially in order to impart a rotary movement to the entire cutting tool assembly in the same manner as the nozzles 14 of the piercing tool P. As is indicated in Figure 3, the nozzles 67, 68, 69 and 70 cut annular grooves in the body of coke to make generally disc-shaped cuts therein and the nozzles 72 and 73 are directed outwardly towards the walls of the chamber 2 to remove and break up any coke which may adhere thereto.

In the operation of the apparatus the cutting tool is inserted into the coking chamber through the bottom opening therein and the tool is allowed to rotate and the jets to cut until the upper jets cut through completely to the wall of the chamber. When this occurs a relatively large mass of coke will drop down, particles striking against the nozzles 72 and 73 and the lower part of the cutting tool, thus giving an indication to the operator, who may be on the upper platform 4, that the cut is completed. The operator then lifts the pipe 13 and the cutting tool into position to start another pair of cuts and this operation is repeated until the entire body of coke in the chamber is cut into relatively small pieces and removed. The coke which is cut away by the high pressure water jets, in my improved procedure, drops into the pool of water 78 which is maintained at the bottom of the chamber. This pool of water acts as a cushion and prevents shattering and breaking of the coke into undesirable fine particles. After striking the surface of the pool 78 the coke passes down through the conduit 23 into the sump 18, which, of course, is also full of water, and drops down to the bottom of the sump where it passes through the feeding and sizing rolls 53 and 54 and is taken up through the pump inlet pipes 19 and 20 to the pumps 21 and 22 which force it, along with water from the sump 18, to a place of disposal such as the reservoir 33 or the screening and piling apparatus shown in Figure 5.

The pipe 79 of Figure 5 may be considered to

be a continuation of pipe 32 leading from the discharge pumps 21 and 22. This pipe discharges the mixture of coke and water upon a screen 80 through which the small particles and the water pass onto a chute 81 which discharges them into a canal 82 from which they may be removed in any suitable manner. The material which does not pass through the screen 80, for example coke of nut size or greater, passes down a chute 83 onto a pile 84. The screen 80 and chutes 81 and 83 may be supported on a frame structure 85 which is mounted on wheels 86 for movement along the tracks 87. When the pile 84 has reached the desired dimensions at one point the frame can be moved along the tracks 87 to distribute the coke in well known manner.

It will be understood that the coke may be subjected to additional screening operations to separate it into the desired commercial grades and these operations may be carried out at any desired time after the coke has been removed from the coking chambers and withdrawn from the sump 18.

It appears from observations of the prior method of removing and handling coke from coking chambers that the greatest breakage of the coke into undesirable small particles occurs when the coke falls upon the bottom of the coking chamber as it is cut by the jets of the cutting tool. In Figure 4 I have shown a modified form of my apparatus in which a pool of water is created and maintained in the bottom of the coking chamber during the cutting of the coke therefrom and thus the breakage of coke caused by the impact thereof against the bottom of the chamber is eliminated. With this arrangement the coke is discharged directly into railroad cars, and although all of the advantages of the apparatus of Figures 1 to 3 inclusive are not obtained a substantial improvement over present practice is effected. The apparatus of Figure 4 possesses the further advantage that it may readily be applied to existing installations without extensive and expensive changes. The coking chamber 88 may be supported in any suitable manner above the platform 89. A circumferential flange 90 defines the bottom outlet opening 91 of the coking chamber 88 and a water inlet pipe 92 is adapted to supply the water which forms the pool in the bottom of the chamber 88. A car 93 is mounted on wheels 94 and movable on the tracks 95 into and out of position below the outlet 91. The car 93 supports a housing having a cylindrical bore portion 97 in which a rotatable vaned feeding member 98 is positioned. This member 98 has suitable bearings in the housing 96 and may be driven by a motor 99 through a belt 100 or other suitable driving means. The ends of the vanes of the rotor 98 have a reasonably close fit within the bore 97 and it will be seen that, as the vanes rotate they will successively discharge the water and coke which is deposited into the compartments between the vanes downwardly through the bottom outlet opening 101 of the housing 96. An opening 102 is provided in the platform 89 directly in line with the bottom opening 91 of the coking chamber 88 and the coke and water discharged by the rotatable feeder 98 will drop down into the railroad car 103 below the platform 89. A pipe 92^a extends int othe upper part of the housing 96 and a flexible pipe or tube 92^b completes the connection from the pipe 92 to the coking chamber. A quick operating coupling 92^c may be provided to facilitate making and breaking the water connection when the car 93 is moved into or out of position. The water will, of course, leak out of the car and the coke may be hauled to any desired location. The rotating cutting tool C' is swivelly mounted on the lower end of the supporting water supply pipe 104. The outlets of the jets 105 are directed radially outwardly and slightly rearwardly in order to impart a rotary movement to the cutting tool and jets 106 and 107 are pivotally connected to the body of the cutting tool at their inner ends in order to permit them to be swung upwardly while being inserted into the bottom opening 91 of the chamber 88. Any suitable stop means (not shown) may be utilized to limit the downward movement of the nozzles 106 and 107 and retain them in cutting position. The level of the pool of water within the bottom of the chamber is maintained at approximately the position shown at 108 by any suitable means, such as a float controlled valve 109 in the water supply pipe 110. The pipe 110 is adapted to discharge into a standpipe 111 having an overflow outlet 112 and connected by a pipe 113 to the inlet pipe 92. A shut-off valve 114 may be provided for closing in the pipe 92.

A fluid pressure sealing means is provided for quickly and easily making a tight joint between the housing 96 and the bottom flange 90 of the coking chamber. This comprises an annular member 115 of channel cross-section which has vertical movement relative to the housing 96. The inner flange of the channel member 115 slides in a groove 116 in the housing 96. An expansible tube 117 is connected to a suitable supply of air or other fluid under pressure by a pipe 118 controlled by a valve 119. When the air pressure is turned on the sealing member 115 will be moved up into tight fitting engagement with the bottom flange 90 of the coking chamber and when the air is released the seal will be broken and the car 93 can readily be moved away from the position shown in Figure 4 to permit closing of the bottom opening 91 of the coking chamber or any other necessary operation. A single car and feeding mechanism may be utilized for operating two or more coking chambers. The rate of discharge of coke and water from the chamber 88 will depend upon the speed of rotation of the vaned feeding member 98.

The coking chamber 116 shown in Figure 6 is of the same type previously described and is suitably supported above a platform 117. In this embodiment of my invention a relatively small coke receiving sump chamber 118 is mounted on a car 119 supported by wheels 120 on tracks 121 on the platform 117. The sump 118 comprises an open topped chamber having a fluid pressure actuated sealing mechanism 122 which is of the same type illustrated and described in connection with Figure 2. The bottom of the sump or hopper 118 is closed except for a coke and water outlet pipe 123 and a water inlet pipe 124 which pipes enter opposite sides of the bottom portion of the sump. Feeding and sizing rolls 125 and 126 (see Fig. 8) are supported in suitable bearings in the side walls of the sump 118 and are geared together by gears 127 for simultaneous rotation in opposite directions. A pulley 128 may be connected to a suitable motor 129 by means of a belt 130 as shown in Figure 8, or any other suitable driving means may be provided for rotating the sizing rolls 125 at the desired speed. As is seen in Figure 6 the sizing rolls are preferably provided with projecting lugs 131 and the bearings for the rolls are made sub-

stantially leak proof as shown or in any other suitable manner.

The water supply for maintaining the pool level in the bottom of the chamber 116 is discharged into a standpipe 132 through a pipe 133. The flow through the pipe 133 may be controlled by a float actuated valve 134, the float 135 of which operates in the same manner as the previously described float 62. The water supply pipe 136 extends down below the platform level 117 and a shut-off valve 137 is operable by a handle 138 extending above the platform level. A flexible pipe 139 extends up through a suitable slot in the platform 117 and is provided with a coupling 140 (preferably of the quick detachable type) whereby it may be secured to the water inlet pipe 124 of the sump 118. In like manner a flexible pipe 141 is adapted to be coupled to the coke and water outlet pipe 123 and is secured at its lower end to the pump inlet pipe 142. The shut-off valve 143 in the pipe 142 is also operable by a handle 144 located on the operating platform 117. The pipe 142 extends to the pump 145 and the outlet pipe 146 of this pump extends to any suitable means of separating the coke and water and disposing of the coke. For example, an arrangement such as that shown in Figure 1 might be used. A railroad car 147 is shown in position below the platform 117 and an opening 148 is provided in the platform 117 in line with the bottom opening of the coking chamber 116, for purposes which will be described later.

In the operation of the apparatus shown in Figure 6 the car 119 is rolled into position below the coking chamber 116 and a fluid tight joint created between the sump 118 and the chamber 116 by means of the fluid pressure seal 122. After the bottom coke has been removed to a height sufficient to permit the formation of a pool in the coking chamber water is discharged through the pipes 133, 136 and 139 and 124 into the sump 118 and the level is maintained at 149 by means of the float valve 134 or by means of the over-flow pipe 150 from the standpipe 132. In some instances the quantity of water discharged through the cutting jets of the cutting tool may be sufficient to maintain the desired level in the bottom of the coking chamber without the addition of extra water through the pipe 133 and under these circumstances the over-flow pipe 150 will maintain this level.

The sizing rolls 125 and 126 are rotated and the coke which drops down into the pool is fed through the sizing rolls into the bottom portion of the sump 118 where it is picked up by the suction of the pump 145 and conveyed to a place of disposal. With this arrangement, if the pump 145 should fail for any reason, discharge of the coke from the chamber 116 may be continued by merely disconnecting the pipes 139 and 140 and moving the car 119 out from under the outlet of the coking chamber. By continuing the operation of the cutting tool in the chamber the discharged coke and water will drop down through the hole 148 into the railroad car 147 and thus, although the advantages of my coke handling system will not be obtained, the plant may be kept in operation during whatever time is necessary to repair the pump or other parts of the equipment.

The apparatus shown in Figure 6 is particularly adaptable for use with a bank of coking chambers. An arrangement is shown in Figures 7 and 8 in which four coking chambers 151, 152, 153 and 154 are suitably supported above a platform 155. The car 119 is mounted on the tracks 121. The water supply is furnished through the standpipe 132, the outlet of which is connected to a supply header 156. Branches 157, 158, 159 and 160 extend from the header to the flexible pipes 157', 158', 159' and 160'. Shut-off valves 157'', 158'', 159'' and 160'' are provided in the branch pipes so that the water supply can be shut off from those coking chambers which are not being discharged. In a similar manner a discharge header 161 is connected to the pump inlet pipe 142 of the pump 145 and is provided with branches including connecting pipes 162, 163, 164 and 165 having shut-off valves 162', 163', 164' and 165'.

As is seen in Figures 7 and 8, the car 119 is disposed below the coking chamber 153 and the pipes 159 and 164 are connected to the bottom of the sump on the car 119. The valves 159'' and 164' will be open and thus water may be supplied to the chamber 153 through the supply pipe 136 and coke and water may be discharged from the sump 118 through the pump 145. The water inlet valves 157'', 158'', 160'' and the outlet valves 162', 163' and 165' will all be closed during this operation. When it is desired to empty any one of the other coking chambers it is merely necessary to move the car 119 into position therebelow, making the connections between the inlet water and coke discharge pipes on the car to the corresponding branches of the headers 156 and 161, open the valves which control the flow to and from the chamber being emptied, and close the other valves. With this system the entire bank of coking chambers can be operated with a minimum of apparatus. Any trouble which may cause the discharging sump mechanism to be rendered inoperative or any failure of the discharge pump will not necessitate the shutting down of the entire bank of coking chambers as operation may be continued in the manner commonly employed prior to my invention in which the coke is permitted to drop directly down onto the bottom of the shell and from there fall into a railroad car.

In the operation of the apparatus shown in Figures 1, 2, 3, 4 and 6, the piercing tool is first fed downwardly entirely through the mass of coke in the coking chamber until it comes out of the bottom opening in the chamber. During this operation the cover plates 7 and 19 are removed so that coke broken by the piercing tool will fall into the sump when the piercing cut is completed. The piercing tool is then removed from its supporting pipe and a cutting tool attached thereto. The cutting tool is lifted up into the bottom opening of the chamber and the conduit 23 positioned to connect the vessel outlet to the sump inlet and the high pressure water turned on. The cutting operation will immediately start and this operation is continued until sufficient coke is removed from the bottom of the coking chamber to permit a pool of water to be formed and maintained therein. This need only be a relatively short distance, for example, about 6 feet from the bottom of the lower manhead of the coking chamber, and although the first coke so cut may be subjected to impact against the bottom of the coking chamber, this coke is a very small proportion of the total charge and as soon as the cutting tool is lifted about 6 feet from the bottom of the bottom outlet of the coking chamber the protecting pool of water is established and maintained, as has been previously described.

Although I have described in considerable de-

tail the illustrated embodiment of my invention, It will be understood by those skilled in the art that numerous modifications and variations may be made in the form and arrangement of apparatus for carrying out my improved material discharging and handling method. I do not, therefore, wish to be limited to the particular arrangements and procedures herein described in detail, but claim as my invention all embodiments thereof coming within the scope of the appended claims.

I claim:

1. The method of breaking up and removing a substantially solid mass of material from a vessel which includes the steps of creating and maintaining a pool of water at a substantially constant level in the bottom of said vessel below said mass of material, breaking up the mass of material into relatively small pieces, said breaking being effected progressively from the lower part of said mass to the upper part thereof and said broken pieces dropping from the underside of said mass into said pool of water whereby further substantial breaking of said pieces is prevented, and continuously discharging said broken up material from said vessel.

2. The method of removing a substantially solid body of coke from a coking chamber which includes the steps of breaking up and removing sufficient coke from the lower part of the chamber to permit the establishment of a pool of water in the bottom of said chamber below the body of coke, creating and maintaining a pool of water at a substantially constant level in said chamber below said body of coke, and progressively breaking up the remaining coke in said chamber from the bottom to the top thereof whereby said broken up coke will fall into said pool of water without further substantial breakage.

3. The method of removing a substantially solid body of coke from a coking chamber which includes the steps of breaking up and removing sufficient coke from the lower part of the chamber to permit the establishment of a pool of water in the bottom of said chamber below the body of coke, creating and maintaining a pool of water at a substantially constant level in said chamber below said body of coke, progressively breaking up the remaining coke in said chamber from the bottom to the top thereof whereby said broken up coke will fall into said pool of water without further substantial breakage, and continuously discharging said broken up coke from said chamber.

4. The method of removing a body of coke from an elongated vertical vessel having a bottom opening smaller than the cross-sectional area of the vessel immediately thereabove, which includes the steps of causing water to enter said vessel and establish a pool of water in the lower portion of said vessel, directing a stream of high pressure water against the lower portion of the body of coke in the vessel, progressively elevating said stream of water as the coke is broken up in said vessel while permitting the water from said stream and the coke broken from the main body to drop into the pool of water in said vessel and pass through the bottom opening thereof.

5. The method of removing a body of coke from an elongated vertical vessel having a bottom opening smaller than the cross-sectional area of the vessel immediately thereabove, which includes the steps of causing water to enter said vessel and establish a pool of water in the lower portion of said vessel, directing a stream of high pressure water against the lower portion of the body of coke in the vessel, progressively lifting said stream of water as the coke is broken up in said vessel while permitting the water from said stream and the coke broken from the main body of coke to drop into the pool of water in said vessel and pass through the bottom opening thereof, and maintaining a substantially constant water level in said lower portion of said vessel during the coke breaking and removing operation.

6. The method of removing a substantially unbroken mass of coke from a vessel having a bottom opening which includes the steps of creating and maintaining a pool of water in the bottom of the vessel below the mass of coke, directing a stream of high pressure water against the bottom part of said body of coke and cutting and breaking said body into relatively small pieces which drop into said body of water along with the water from said high pressure cutting stream, and continuously discharging water and broken up coke from said vessel.

7. The method of removing a substantially unbroken mass of coke from a vessel having a bottom opening which includes the steps of creating and maintaining a pool of water in the bottom of the vessel below the mass of coke, directing a stream of high pressure water against the bottom part of said body of coke and cutting and breaking said body into relatively small pieces which drop into said body of water along with the water from said high pressure cutting stream, continuously removing water and broken up coke from said vessel, and maintaining the level of water in said vessel substantially constant.

8. The method of removing a mass of coke from a coking chamber having a bottom opening which includes the steps of establishing a water body below the bottom opening in said chamber, drilling or piercing the mass of coke from top to bottom to form a hole therethrough, establishing a connection from the bottom opening of said chamber to said water body, breaking and removing coke from the bottom of the chamber to permit the establishment of a pool of water in the lower part of the chamber, adding water to said body to raise the level to form a pool covering the bottom of said chamber below the mass of coke, breaking said mass of coke into pieces which will pass through the bottom opening of the chamber and permitting said pieces to drop into said pool, removing broken coke and water from the lower part of said body, and maintaining the water level of said pool in said chamber sufficiently high to provide a coke cushioning pool in the chamber during the breaking of coke from the mass therein.

9. In apparatus of the type described, the combination of a coking chamber having a bottom opening, hydraulic means for breaking up coke within said chamber, a conduit movable into and out of alignment with said bottom opening, means for forming a substantially liquid tight joint between the end of said conduit and the chamber about said opening, and means for creating and maintaining a body of water in said conduit and in the lower portion of said chamber.

10. In apparatus of the type described, a vessel having a bottom opening, a sump having a top opening disposed below said bottom opening, a conduit supported to be moved into and out of position to connect said bottom opening of said vessel and said top opening of said sump, means for forming a substantially water-tight joint be-

tween said vessel and conduit and between said conduit and sump, means for establishing and maintaining a pool of water filling said sump and having its level above said bottom opening in said vessel, means for breaking up solid material in said vessel above said water level whereby said broken up material will fall into said pool and sink to the bottom of said sump, and means for removing water and broken material from the lower portion of said sump.

11. In apparatus of the type described, a coking chamber having a bottom opening, a closed sump below said chamber, said sump having an outlet from its lower portion and an inlet below said bottom opening of said chamber, a conduit, means for supporting said conduit whereby it may be moved into and out of position to connect said chamber opening and said sump inlet, means for forming a substantially fluid-tight joint between said conduit and chamber and between said conduit and sump, a standpipe connected to said sump and extending upwardly to a level above the bottom opening of said chamber, and means for discharging water into said standpipe whereby said sump and conduit may be filled with water and a pool formed in the lower part of said chamber.

12. In apparatus of the type described, a coking chamber having a bottom opening, a closed sump below said chamber, said sump having an outlet from its lower portion and an inlet below said bottom opening of said chamber, a conduit, means for supporting said conduit whereby it may be moved into and out of position to connect said chamber opening and said sump inlet, means for forming a substantially fluid-tight joint between said conduit and chamber and between said conduit and sump, a standpipe connected to said sump and extending upwardly to a level above the bottom opening of said chamber, means for discharging water into said standpipe whereby said sump and conduit may be filled with water and a pool formed in the lower part of said chamber, and means for maintaining a substantially constant water level in said standpipe and chamber.

13. In apparatus of the type described, a coking chamber having a bottom opening, a closed sump below said chamber, said sump having an outlet from its lower portion and an inlet below said bottom opening of said chamber, a conduit, means for supporting said conduit whereby it may be moved into and out of position to connect said chamber opening and said sump inlet, means for forming a substantially fluid-tight joint between said conduit and chamber and between said conduit and sump, a standpipe connected to said sump and extending upwardly to a level above the bottom opening of said chamber, means for discharging water into said standpipe whereby said sump and conduit may be filled with water and a pool formed in the lower part of said chamber, means for maintaining a substantially constant water level in said standpipe and chamber, a hydraulic coke cutting and breaking nozzle movable in said chamber, and means for removing coke and water from said sump.

14. In apparatus of the type described, a coking chamber having a bottom opening, a closed sump below said chamber, said sump having an outlet from its lower portion and an inlet below said bottom opening of said chamber, a conduit, means for supporting said conduit whereby it may be moved into and out of position to connect said chamber opening and said sump inlet, means for forming a substantially fluid-tight joint between said conduit and chamber and between said conduit and sump, a standpipe connected to said sump and extending upwardly to a level above the bottom opening of said chamber, means for discharging water into said standpipe whereby said sump and conduit may be filled with water and a pool formed in the lower part of said chamber, means for maintaining a substantially constant water level in said standpipe and chamber, coke feeding and sizing means in said sump, an outlet for coke and water at the bottom of said sump, and a pump for withdrawing coke and water through said sump outlet.

15. In apparatus of the type described, a coking chamber having a bottom opening, a closed sump below said chamber, said sump having an outlet from its lower portion and an inlet below said bottom opening of said chamber, a conduit, means for supporting said conduit whereby it may be moved into and out of position to connect said chamber opening and said sump inlet, means for forming a substantially fluid-tight joint between said conduit and chamber and between said conduit and sump, a standpipe connected to said sump and extending upwardly to a level above the bottom opening of said chamber, means for discharging water into said standpipe whereby said sump and conduit may be filled with water and a pool formed in the lower part of said chamber, means for maintaining a substantially constant water level in said standpipe and chamber, coke feeding and sizing means in said sump, an outlet for coke and water at the bottom of said sump, a pump for withdrawing coke and water through said sump outlet, means for separating the coke and water discharged from said pump, coke cutting and breaking jet means movable in said coking chamber, and means for returning the separated water to said jet means.

16. In apparatus of the type described, a coking chamber having a bottom outlet for broken coke and water, a housing, means for moving said housing into and out of position to receive material from said outlet, a vaned member rotatably mounted in said housing, means for rotating said vaned member whereby broken coke and water are discharged from said chamber and means for supplying water to said chamber and maintaining a pool in the lower portion thereof.

17. In apparatus of the type described, a coking chamber having a bottom outlet, a sump chamber movably supported below said coking chamber and adapted to be moved into and out of material receiving position below said bottom outlet, means for establishing a substantially fluid tight connection between said sump and coking chamber, means for discharging water into said sump and means for removing water and coke from said sump.

18. In apparatus of the type described, a coking chamber having a bottom outlet, a sump chamber movably supported below said coking chamber and adapted to be moved into and out of material receiving position below said bottom outlet, means for establishing a substantially fluid tight connection between said sump and coking chamber, means for discharging water into said sump chamber, a pair of coke feeding and sizing rolls in said sump chamber, means

for rotating said rolls, and means for removing water and coke from said sump.

19. In apparatus of the type described, a coking chamber having a bottom outlet, means for reducing a substantially solid mass of coke in said chamber into relatively small pieces, a coke receiving housing positioned below said outlet, means for connecting said housing to said outlet, and means for creating a pool of water in said housing extending up into said chamber and maintaining the level of said pool of water substantially constant in the lower part of said chamber.

20. The method of handling material formed as a solid mass in a vessel, which includes the steps of forming a pool of liquid in the lower part of the vessel, progressively breaking up said solid mass of material into relatively small pieces from the bottom to the top of said mass, permitting the broken pieces thereof to fall directly from the mass into said liquid pool, and discharging said broken pieces from said vessel.

21. The method of removing a substantially solid body of coke from a coking chamber which includes the steps of breaking up and removing sufficient coke from the lower part of the chamber to permit the establishment of a pool of water in the bottom of said chamber below the body of coke, creating and maintaining a pool of water in said chamber below said body of coke, and progressively breaking up the remaining coke in said chamber from the bottom to the top thereof whereby said broken-up coke will fall into said pool of water without further substantial breakage.

22. The method of removing a substantially unbroken mass of coke from a vessel having a bottom opening which includes the steps of creating and maintaining a pool of water in the bottom of the vessel below the mass of coke, directing a stream of high pressure water against the bottom part of said body of coke and cutting and breaking said body into relatively small pieces which drop into said body of water along with the water from said high pressure cutting stream, and discharging water and broken-up coke from said vessel.

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