Dec. 4, 1945. V. VOORHEES ET AL 2,390,197

METHOD OF REMOVING COKE

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Fig. 1.

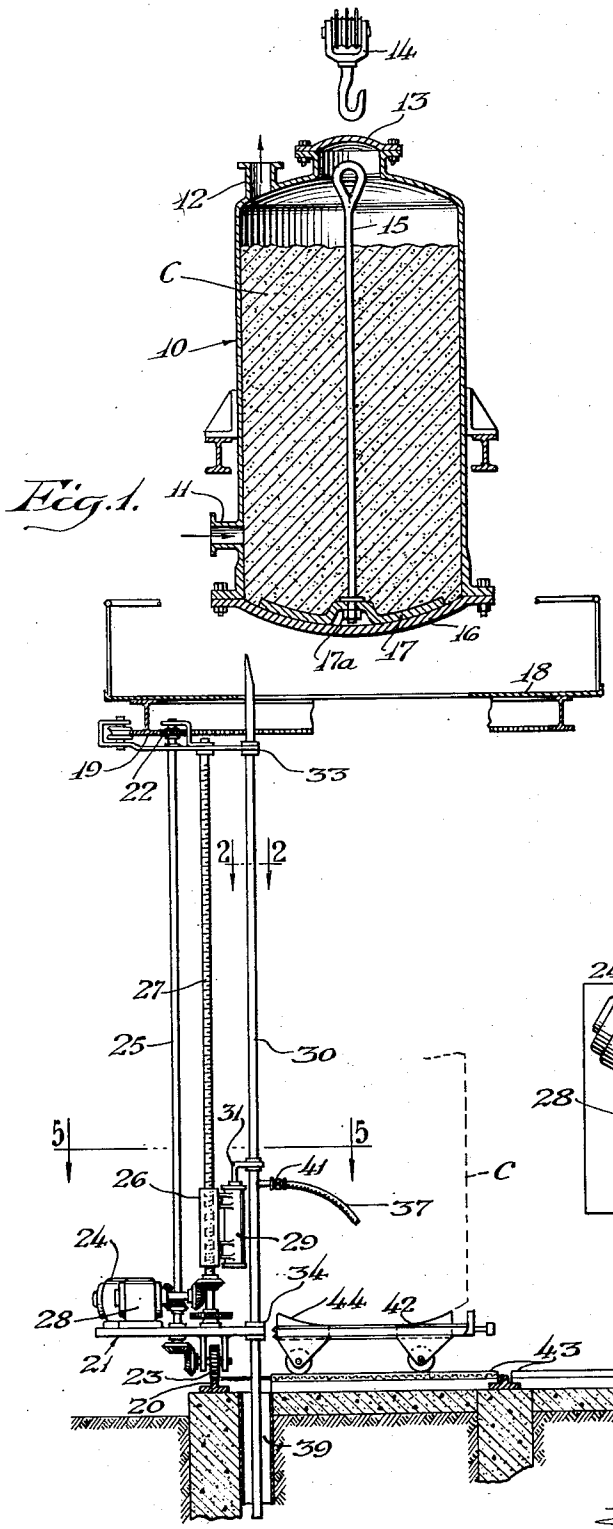


Fig. 2.

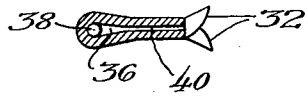


Fig. 3.

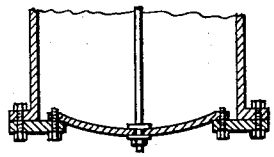
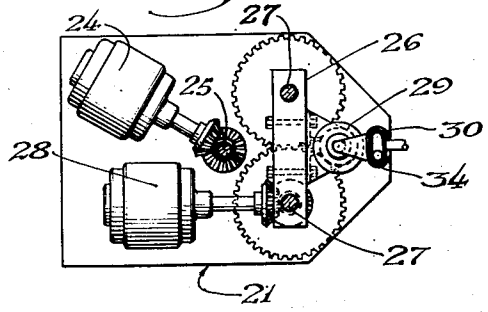


Fig. 4.



Inventors:
Vanderveer Voorhees
George W. Watts
By Pike H. Sullivan
Attorney.

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METHOD OF REMOVING COKE

Vanderveer Voorhees, Homewood, and George W. Watts, Flossmoor, Ill., assignors to Standard Oil Company, Chicago, Ill., a corporation of Indiana

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4 Claims. (Cl. 202—36)

This invention relates to the coking of carbonaceous materials such as coal, heavy hydrocarbon oils, etc. More particularly, it relates to a method for removing coke from coking drums where the coke has been deposited from petroleum residuums or other carbonaceous material at a high temperature. An object of the invention is to provide a method for decoking which will yield a higher proportion of lump coke than methods previously used. Another object of the invention is to provide a method for producing coke of higher physical strength and removing it from coking drums without the difficulties heretofore encountered with hard coke. Still another and more specific object of the invention is to remove coke from a drum without cooling delay and in a minimum period of time, thereby permitting use of the drum in process or on stream for a large proportion of the time. Still other objects of the invention will be apparent from the following description thereof.

The invention applies particularly to the coking of petroleum residuums by the delayed coking process as described, for example, in United States Patent 2,090,245 of Robert E. Wilson. According to this process hot residuum from the distillation of crude petroleum oil, generally a 15 to 40% residue, is rapidly heated in a flowing stream in a pipe heater and discharged into a stationary drum provided with heat insulation wherein the vaporized portions of the oil are evolved and the unvaporizable portions remain for a sufficient period of time to undergo a coking reaction. The temperature of this reaction is usually in the range of 800 to 1000° F. and a temperature of 900 to 925° F. is generally satisfactory. The higher the temperature employed and the longer the time permitted for the formation of coke, the harder and stronger will be the coke produced. The volatile products from the coking drum are ordinarily fractionated to separate coke still gasoline, gas oil and other products. The gas oil fraction may be employed as a charging stock for cracking processes or it may be recycled in part to the coking furnace.

When the drum becomes filled with coke, the general practice is to divert the stream of hot hydrocarbons to an adjoining empty drum, preferably preheated, while the coke is removed from the first drum. The time required for decoking a drum and putting it in readiness for further coking has usually been from 8 to 24 hours, and it has therefore been necessary to provide from 3 to 6 coking drums in a single coking unit in order to make the process a continuous one. Drums employed for this work usually have a height of 25 to 50 feet and a diameter of 12 to 20 feet.

Heretofore, coke has usually been removed by one of several methods such as mechanically boring it out from the bottom after removing the bottom header plate or breaking it out by the cable method wherein a steel cable embedded in the coke in a given arrangement is drawn out through the bottom manhole bringing the coke with it in lumps. Still another method is to cut the coke into sections by the cutting action of a high velocity water jet allowing it to fall from the drum in pieces.

Such methods have the disadvantage of producing a considerable amount of fine material which is of low market value and unsuitable for many fuel purposes. The automatic boring device produces substantially 100% of fines whereas the cable and hydraulic methods produce about 25 to 60% of fines. Another disadvantage of these methods, which applies particularly to the hydraulic and the cable methods, is that the coke must be of relatively soft structure to facilitate removal from the drum. Coke produced at high temperature or by the coking of certain selected stocks, has a higher physical strength, e. g., crushing strength, and as a result it is particularly valuable for certain purposes, for example, as a fuel in the metallurgy of iron, etc. However, because of the difficulty of removing hard coke from the drum, it has not generally been feasible to produce metallurgical coke by the delayed coking process.

In accordance with our invention, the coke is removed from the drum substantially in a single piece by an improved cutting method and may be broken up externally of the drum by any suitable means which will produce a minimum amount of disintegration to fine material.

Our invention is illustrated by a drawing in which

Figure 1 shows an elevational diagram of a coking drum and associated equipment for decoking; Figure 2 is a cross section of the cutting bar used in the apparatus of Figure 1; Figure 3 illustrates an alternative method of attaching the header plate to the bottom of the drum; and Figure 4 is a section taken on line 5—5 through the cutting mechanism of Figure 1.

Referring to Figure 1, the coking drum 10 is supported in an elevated position and supplied with hot oil vapors by hot residuum charge line 11. The residuum may be conventionally heated

in a suitable furnace or pipe still at a velocity sufficiently high to prevent deposition of coke in the still tubes. A suitable manifold not shown may be provided to divert the stream of hot oil at suitable intervals to an adjoining coking drum like the one shown, thus providing continuous operation of the furnace, etc. during the decoking operation. Means may be provided for preheating the drum before charging hot oil thereto. As the coking proceeds the vaporized products are withdrawn at the top of the drum by line 12 and conducted to a suitable fractionating and condensing system. When coke has accumulated in the drum in a bed, C, to the desired amount, for example, two-thirds to three-fourths of the height of the drum, the stream of oil introduced at 11 is discontinued and the drum is ready for decoking, either immediately or after standing for a period of hours to permit the coking reaction to go to completion.

Removal of coke is now carried out in the following manner: the top dome cover 13 is removed and hoisting apparatus 14 is lowered into the drum to engage the anchor rod 15. Rod 15 which is embedded in the coke passes axially through the center of the drum to the bottom cover plate 16. At its lower end the anchor rod is connected to anchor plate 17 by any suitable means, for example, by nut 17a. Plate 17 may be a disc of somewhat smaller diameter than the bottom opening of the coking drum. Plate 16 is then removed. Platform 18 is provided on which workmen may stand for carrying out this operation. A suitable crane, not shown, may be provided for swinging the cover 16 away from the opening of the coking drum.

The next operation is cutting the coke free from the wall of the drum which may be accomplished by introducing a rigid cutting tool from below along the wall of the drum through the space betwen the wall and the anchor plate 17. Various types of cutting tools may be used for this purpose. A number of vertical, successive cuts may be made or a bar carrying one or more serrated cutting wheels at the top may be caused to travel around the periphery of the drum somewhat in the manner of a boring tool. An accompanying water jet may be provided for washing cuttings from the path of the tool and for simultaneously cooling the cutting head.

The mechanism shown in Figure 1 for cutting the coke free from the wall of the drum resembles the foregoing in that it is a mechanical device operating from below the drum. It operates in the following manner. Circular tracks 19 and 20 are equipped with gear racks and maintain fixed positions outside of the line of the coking drum walls. Running on the tracks 19 and 20 is the carriage 21 provided with integrated gears 22 and 23 driven by a motor 24, connected to shaft 25. By this means the carriage 21 may be caused to travel in an upright position and at a controlled speed about the circular tracks 19 and 20.

The carriage 21 is provided with an elevator 26 which is independently movable from the top to the bottom of the carriage by jack screws 27 actuated by motor 28. Other means for raising and lowering the elevator 26 may be provided such as a rack and pinion.

Elevator 26 is equipped with steam or air cylinder 29 connected to cutting bar 30 through piston rod 31 imparting to the bar 30 a vertically reciprocating motion when desired. The bar 30 is equipped with cutting teeth along the upper length thereof for a distance at least equal to the thickness of the bed of coke, C, in drum 10. The bar is held in a vertical position against side thrust, by means of guides 33 and 34 which are affixed to carriage 21. The guides may be of roller construction and the upper guide 33 is arranged to allow the teeth in the cutting bar 30 to pass freely. Other means of reciprocating bar 30 may be employed, such as a motor driven crank. The cutting bar 30 is preferably flattened, with sufficient width in the direction tangential to the drum to provide the desired rigidity and resistance to cutting thrust.

Figure 2 shows a cross section of bar 30. The leading edge is provided with teeth 32 alternately swaged to produce the desired width of cut through the coke to permit free passage of the bar. A channel 36 is provided for the passage of liquid under pressure to assist in cutting the coke and washing away the cuttings. It is preferred to use water for this purpose, supplying the water under high pressure through a flexible connection 37 (Figure 1). The pressure may suitably be about 1500 to 4500 pounds per square inch where it is desired that the water exert a substantial cutting action. Lower pressures of the order of 50 to 100 pounds per square inch may be employed where water is required only to wash away the cuttings produced by the cutting bar 30.

The following is a description of a typical decoking operation: After the drum 10 has been unplated at 13 and 16 and sufficient lifting effort applied to anchor rod 15 by hoist 14 to support the weight of the coke, the cutting bar 30 is raised until the point of the bar engages the coke in the space between anchor plate 17 and the wall of the drum 10. A vertically directed jet of water from a nozzle positioned at the upper end of the bar 30 is started by directing water through three way valve 41 into channel 38, and the bar is forced into the coke, cutting a vertical channel along the wall by the combined mechanical and hydraulic action or either of them. During this penetrating operation the bar may be given a reciprocating motion through the action of cylinder 29 if desired. Water for the tip nozzle just mentioned is supplied through a separate channel within the bar indicated in Figure 2 by 38. Alternatively, the initial penetration of the coke along the wall of the drum may be effected by a drill which may be provided for that purpose, if desired.

In order to reduce the height of the construction as much as possible, it is preferred to mount track 20 at the ground level and the space between tracks 19 and 20 is provided to exceed the height of the coke, C, to be removed from drum 10. In a typical installation, this height may be about 15 to 20 feet, more or less. The cutting bar 30 having a length of more than double the thickness of the coke bed of drum 10 may be dropped into well 39 when not in use.

After the initial channel has been made in the coke at a point above well 39, the cutting bar is caused to travel in a circular path following tracks 19 and 20 completely around the periphery of the drum 10 and back to the starting position over well 39 into which the bar is then withdrawn. During the cutting operation bar 30 is reciprocated to effect a sawing action and simultaneously water is supplied through channel 36 to wash away the cuttings and prevent their retarding the action of the cutting bar. Channel 36 is connected to jets or nozzles made preferably by drilling holes between the

teeth of the bar and into channel 36 as indicated by the opening 40 in Figure 2. The control of the water supplied to the cutting bar 30 alternatively through channel 36 or 38 may be effected by the three way valve 41 (Figure 1).

It is desirable to remove a minimum amount of coke by the cutting action of bar 30 and accordingly the bar is designed with a minimum thickness commensurate with mechanical strength. The inside surface of the drum 10 is likewise made free from obstruction, rivet heads and the like, giving a smooth surface against which the cutting bar 30 is designed to operate. The reciprocating action of the bar coupled with the action of the water supplied thereto prevents jamming by any portions of the coke which may be incompletely carbonized.

After the coke has been cut free from the drum and the bar 30 has been returned to its original position, carriage 42 traveling on track 43 is placed in position beneath the drum 10 and the entire mass of coke is lowered by hoist 14 until it rests on the carriage 42, the anchor plate 17 resting securely on the bed plate 44 arranged to receive it. Locking nut 17*a* on the end of anchor rod 15 is then removed and the rod 15 is withdrawn from the mass of coke by lifting hoist 14. A parting compound coated on the rod previously will assist in this operation. If desired, however, the anchor rod may be allowed to remain in the bed of coke. The mass of coke is then hauled away to a suitable location for cooling and breaking or sawing into the desired size and shape.

In preparing for the next filling of drum 10 the anchor rod 15 is lowered to the ground level and another anchor plate 17 attached to it. It is then drawn again into the drum, the bottom plate 16 is replaced, the hoist 14 is released from the anchor and the top plate 13 is replaced. During the filling of the drum with coke the anchor rod 15 may be securely held in a central position by wires or other locking means temporarily fixed to the top of the rod. The bottom plate 16 may be coated with lime or other parting composition to prevent coke adhering and assist removal of the plate, or sheets of paper may be placed between the plates 16 and 17 for the same purpose.

Although we have described our invention by means of certain specific examples and embodiments thereof, we intend that it be limited only by the scope of the claims. Various modifications of our coke cutting device may be employed without departing from the spirit of the invention. Thus we may cut the coke free from the drum wall by the use of a single water jet of high velocity injected from a nozzle into the coke along the wall of drum 10, said jet being movable in a circle below the wall of the drum and being effective of itself for removing a channel of coke from along the wall of the drum without assistance of mechanical sawing action.

Instead of the hoisting device 14 various other devices may be employed for lowering the coke from the coking drum. Thus, we may employ an elevator operated from the outside of the drum. For example, we may employ a hydraulic elevator located below each drum in a battery, or the coke may be lowered from the drum by means of a platform, raised and lowered by suitable cables outside of the drum. When employing an elevator of this type, supporting the coke from below, it will be necessary to use a bottom cover plate construction similar to that shown in Figure 3.

The hoisting method described in Figure 1 employing hoist 14 for lowering the coke from the drum, is perhaps the simplest method for accomplishing this purpose. Various modifications of the anchoring arrangement shown may be employed. Thus anchor plate 17 may be attached to rod 15 after removal of head 16 and before cutting the coke free from the drum. Inasmuch as our invention reduces the time required for coke removal to such an extent that only two drums may be necessary to operate a continuous coking battery, the number of units of coke cutting and coke removing equipment required are few. A considerable reduction in the cost of construction is therefore obtainable.

We claim:

1. The method of removing coke from an elevated vertical drum which comprises supporting said coke as a body within said drum by an elevating device independent of said drum, exposing said coke at the bottom of said drum and adjacent the wall thereof piercing said coke body from bottom to top adjacent the wall of said drum, introducing a cutting tool through the resulting opening, vertically cutting the coke and removing it in a narrow, vertical channel adjacent substantially the entire vertical wall of said drum, simultaneously flushing the cuttings from the said channel in the vicinity of said cutting tool, lowering the body of coke substantially in a single piece to a point outside of said drum and closing said drum for further coking operations.

2. The method of claim 1 wherein the coke is removed from said channel adjacent the wall of said drum by the action of a mechanical saw vertically operating through said annular area from below said drum.

3. The method of claim 1 wherein the removal of coke from said channel adjacent the wall of said drum is facilitated by the action of a high velocity water jet directed through said annular area upward along the wall of said drum.

4. The method of claim 1 wherein coke cuttings are removed from said channel in the vicinity of said cutting tool by applying a stream of water to the vertical face of said channel subjected to the action of said cutting tool.

VANDERVEER VOORHEES.
GEORGE W. WATTS.