

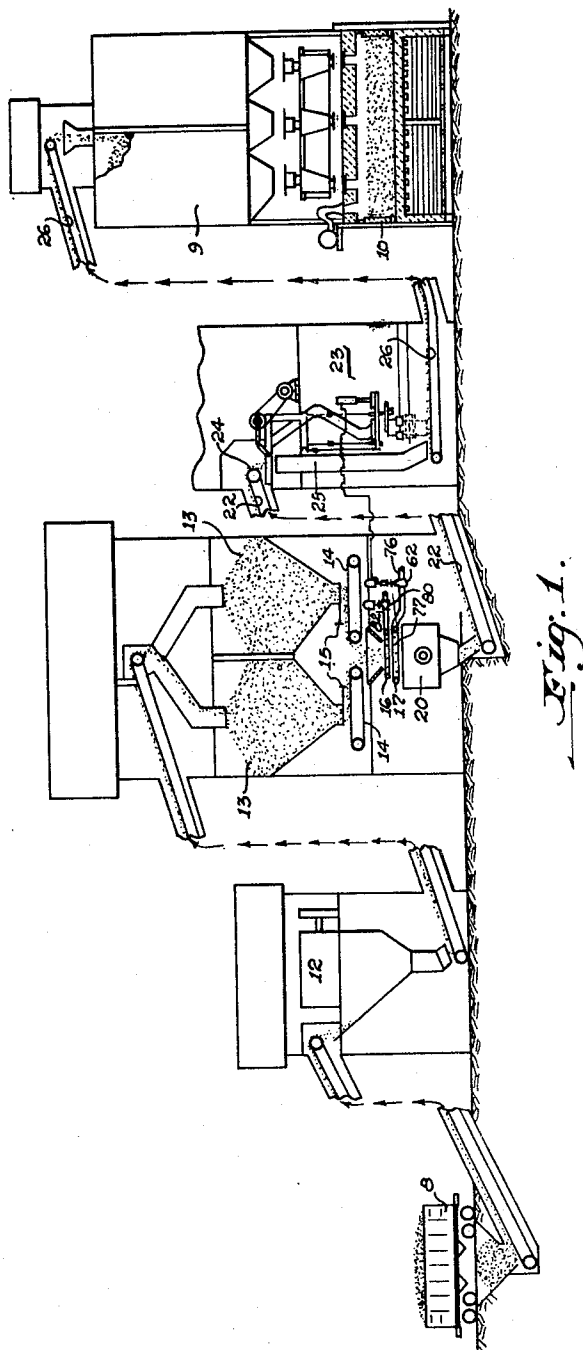
June 6, 1950

Filed Aug. 18, 1945

J. VAN ACKEREN
APPARATUS FOR ADDING LIQUID TO CONTROL
THE BULK DENSITY OF COKING COAL

2,510,158

4 Sheets-Sheet 1



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J. VAN ACKEREN
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2,510,158

4 Sheets-Sheet 2

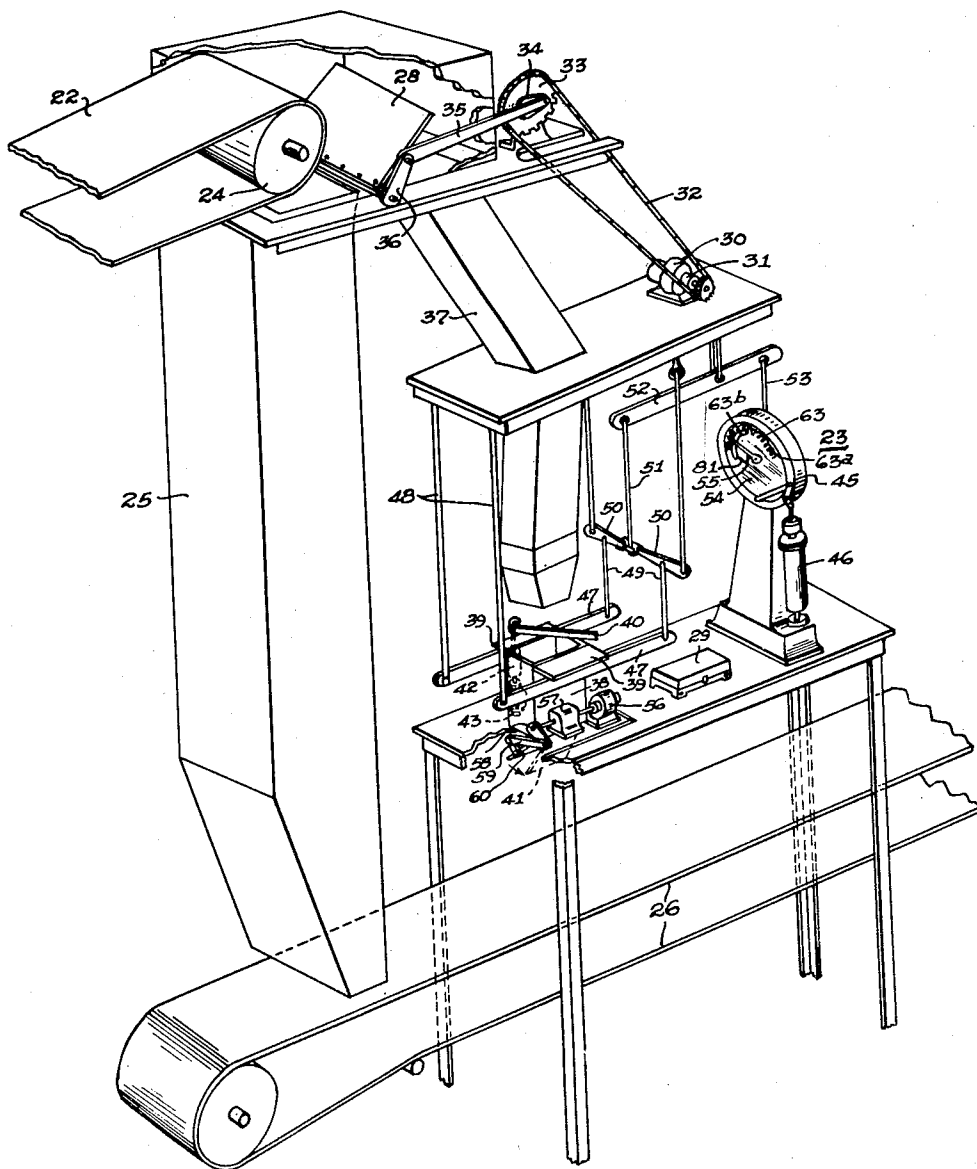


Fig. 2.

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4 Sheets-Sheet 3

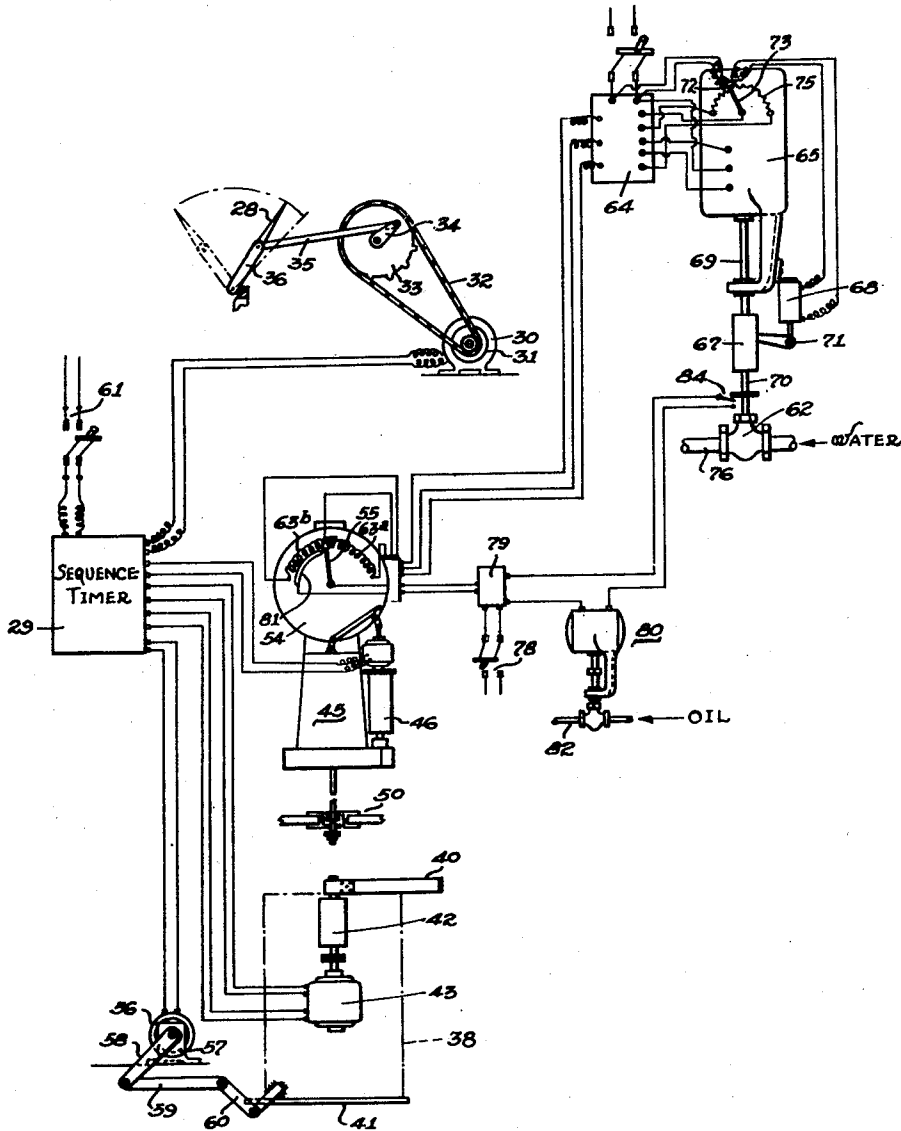


Fig. 3.

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4 Sheets-Sheet 4

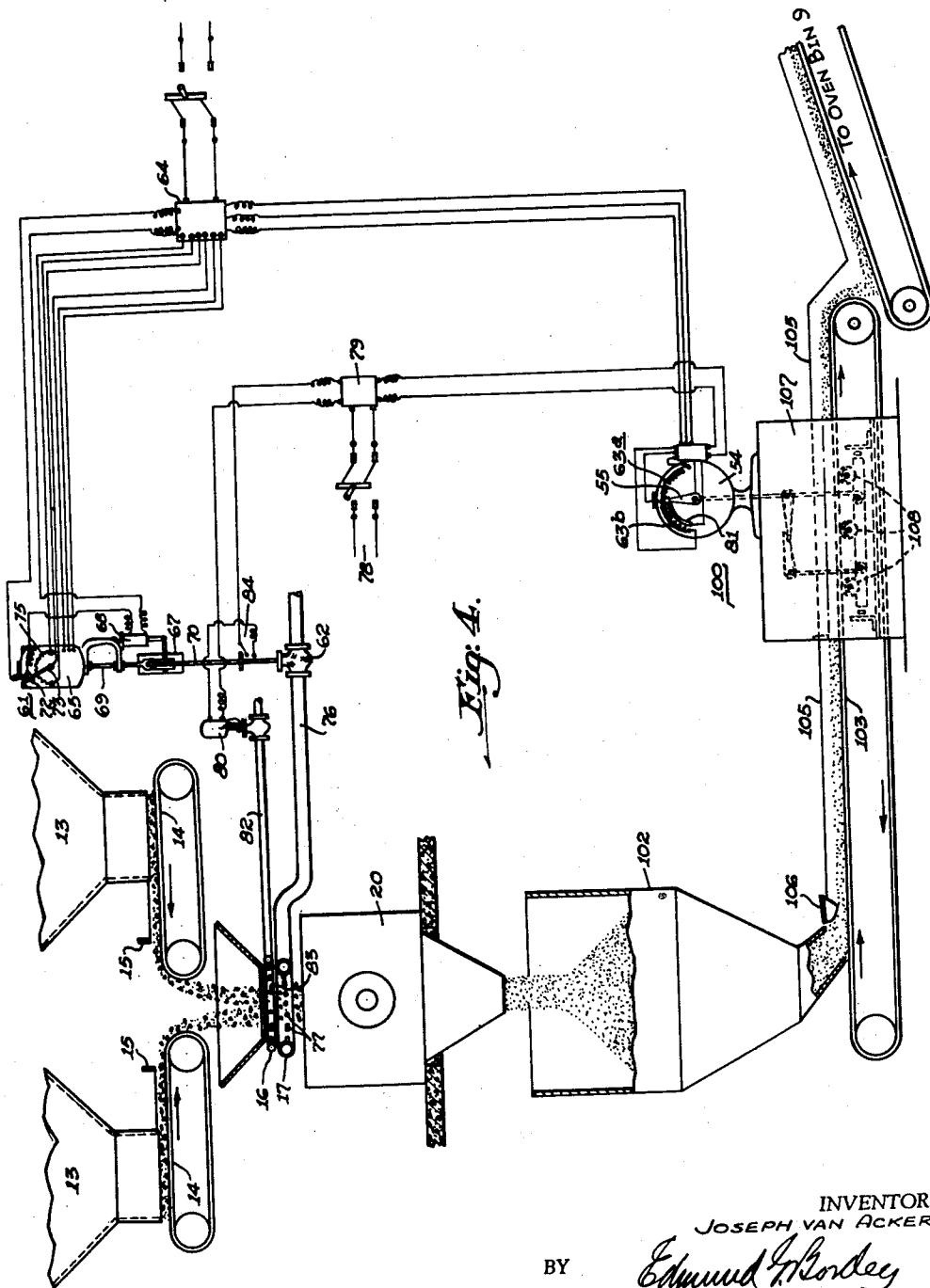


Fig. 4.

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UNITED STATES PATENT OFFICE

2,510,158

APPARATUS FOR ADDING LIQUID TO CONTROL THE BULK DENSITY OF COKING COAL

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Application August 18, 1945, Serial No. 611,395

3 Claims. (Cl. 241-41)

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The present invention relates to the preparation of coking coals for carbonization in by-product coke ovens and, more particularly, to the automatic control and adjustment of the bulk density of such coals while the same are in transit to the carbonizing apparatus.

It is well known in the art that variations in superficial moisture on particulate coal effect changes in the bulk density of the coal and that, when such coal moistures are within their usual range, the alteration in weight per volume is inversely relative to the amount of aqueous moisture thereon. There have, furthermore, been described and claimed in Lohr and McGurl U. S. Letters Patent 2,378,420 method and means whereby the bulk density of particulate coking coals can be made relatively uniform by well-distributed additions of liquids, for example, water, which decreases the bulk density, or oil, which in small quantities increases the bulk density of so-treated coal. This adjustment to a uniform bulk density and its resultant maintenance of uniform coking conditions in a carbonizing plant provide for carbonization of the coal under pressures within desired limits whereby the operating life of apparatus therefor is markedly extended; the said adjustment consistently maintains an optimum of carbonizing capacity in respect of the provided apparatus by regularly ensuring a uniform weight of coal in each coking chamber after leveling the charge; and, as a further result of such uniform charging, it provides relatively unvarying operating conditions in the by-product system of the said carbonizing plant.

It is amongst the objects of the present invention to provide automatically operative method and apparatus for adjusting to uniformity the bulk density of coal in transit to coke ovens whereby the above-described benefits of charging coal of a uniform, optimum bulk density are continuously and economically obtained automatically.

Another of the objects of the present invention is the provision, first, of means for automatically regulating to uniformity the bulk density of coal having the usual size of coal for coking, and, second, of automatic testing and controlling means whereby the so-adjusted coal can be tested for conformity to a standard optimum bulk density before its delivery to carbonizing means.

The invention has for further objects such other improvements and such other operative advantages or results as may be found to obtain in the processes or apparatus hereinafter described or claimed.

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Briefly stated, the method and apparatus of the present invention provide for the effective isolation from the whole coal stream of successive, uniform-volume portions of the fragmental coal during its travel on endless belts, or the like, from coal preparation means to carbonizing apparatus, such effective isolation in the coal stream being obtained automatically and without substantial interruption of the flow of the coal stream to said carbonizing apparatus; the method and apparatus encompass the automatic weighing of each such successively isolated uniform-volume portion of the coal stream and provide for the measuring and indicating of such weights in terms of bulk density; and they further provide for the regulably controlled operation, in automatic response to variations in the bulk density of the coal of the said weighed portions, of modulating control valve means whereby coal, preferably upstream from the coal-isolating and bulk-density-determining means, can be sprayed with liquid and thereafter extensively intermixed and can thus be adjusted automatically to a uniform and pre-selected bulk density. The present invention provides apparatus for automatically repetitive cycles of sampling and testing operation, the cycles recurring at any adjustable preferred rate.

As hereinbefore stated, the bulk-density-determining means is preferably situated downstream from the liquid spraying means. A primary reason for this rather unusual disposition is the factor that coals of different moisture or pulverization are differently affected by treatment with added liquid and thus, without a prior determination of such characteristics, it would not be possible to maintain a closely uniform bulk density by merely determining the bulk density of a coal and thereafter spraying it with a modifying liquid. Where however the apparatus is arranged in the preferred order, the bulk-density determining means will continue to effect changes in the liquid spraying until a bulk density is provided that will satisfy the said determining means. Especially where coals of greatly varying moistures and pulverizations are employed, it is thus highly preferable that the bulk density apparatus be located downstream of the spraying means so as to provide a check on the modified bulk density and to ensure a uniformity of the bulk density of coal being charged to coke ovens.

In the accompanying drawings forming a part of this specification and showing for purposes of exemplification a preferred apparatus and method in which the invention may be embodied and

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practiced but without limiting the claimed invention to such illustrative instance or instances:

Fig. 1 is a diagrammatic elevational view with parts broken away of a coke-oven battery and its supplying coal-handling means comprising one embodiment of the present invention, and disclosing its relationship to other elements of the said coal-handling system;

Fig. 2 is a diagrammatic perspective view with parts broken away illustrating the bulk density testing and controlling apparatus of the present invention;

Fig. 3 is a schematic electrical diagram showing in simplified form the electrical means for automatically operating the apparatus of Figs. 1 and 2 and the electrical controlling means with its interconnections for the communication of controlling effect of determined values to automatic control valves; and

Fig. 4 is a diagrammatic elevational view, parts being in section and parts broken away, of a second embodiment of the present invention, wherein there is shown complete apparatus including the also-diagrammatically-shown controlling electrical interconnections, for testing and controlling bulk density of conveyed coal.

The same characters of reference designate the same parts in each of the views of the drawings.

Referring now to the drawings and, more particularly, to Fig. 1, there is shown a coal-handling system that transports coal on endless belts from a source represented by hopper car 8 and, after preparation of the same by hereinafter described apparatus, to oven-supply bins 9 wherefrom the coal is charged to ovens of a coke-oven battery 10 for carbonization therein.

After being discharged from the said hopper car 8 the coal is fed to a preliminary breaker mill 12 which crushes the coal and reduces the larger lumps thereof and thereby establishes a preliminary relatively uniform size range of the coal. Thereafter, in the particular coal-handling system shown herewith, the so-crushed coal is fed to storage in mixing bins 13, 13, to one of which is delivered one coking coal, for example low-volatile coal, and to the other of which is delivered a second coal, for example, high-volatile coal. These coals are discharged from the said storage bins 13, 13, through measuring means, as upon endless mixer belts 14, 14, to supply measured volumes of coal, which measured volumes are regulated by means of adjustable knife gates 15, 15. The gates can be placed in vertical position above and across the mixer belts and serve to establish the maximum cross section and predetermined volumes of coal on the belts. The coals may equally well be mixed by weight in which case weight-controlling feeders, or the like, would be employed in place of the said adjustable knife gates.

The so-crushed coal falls, in admixture, from the said mixing belts past and down through a chute across the area of which concentric spray header pipes 16 and 17 deliver respectively oil and water. The rate of liquid coming into contact with the coal is controlled by automatic means to be hereinafter described. By this treatment the bulk density of the coal is adjusted substantially to uniformity. After having passed the said spraying means the treated coal falls into a final pulverizing means, such as a hammer-mill 20 which crushes the coal to the final pulverization preferred in the oven-charge, for example to about 80 to 85% through a one-eighth inch square opening screen, and which thoroughly mixes with

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the coal those liquids which are added by the hereinabove-mentioned sprays thereby to provide a uniform distribution of the superficial moisture on the so-sprayed coal and to obtain that adjustment in bulk density provided by the liquid spray before testing the so-sprayed coal.

The coal upon discharge from the hammermill 20 is transported by endless belt 22 to the bulk density determining apparatus 23 which is illustrated in Figs. 2 and 3.

Referring more particularly to Fig. 2, the major portion of the coal falls from a header pulley 24 of the belt 22 through a free-fall gravity-drop chute 25 upon an endless belt 26 and is finally delivered thereby after such free-fall to the oven-supply bins 9 and is thus undiverted from the general stream of coal undergoing conditioning in transit to the coke-ovens to prepare the coal for carbonization therein, while at relatively rapid intervals samples of the coal stream across the whole width of the belt at the said pulley are taken and are temporarily diverted therefrom to the said bulk density apparatus 23.

This intermittent diverting of representative samples from the coal stream being conditioned in transit for coking in the coke ovens is accomplished by sampling gate 28, which can be of any preferred and improved design but is here shown simply as a single-blade gate, and which is controlled, as are other devices of the testing apparatus by a sequence timer 29. The timer illustrated is a cam timer 2500 manufactured by the Automatic Temperature Control Company of Philadelphia and illustrated in their bulletin T36. Upon a signal communicated from the sequence timer 29 to a motor 30, the said motor begins operation and turns a gear reducer 31 which by communicating its motion through chain 32, turns sprocket wheel 33. The said sprocket wheel is communicably interconnected with the said gate 28 by means of connecting levers 34, 35, to a lever 36 which is rigidly attached to a shaft on which the sampling gate 28 is fixed. The movement of the sprocket wheel 33 is operative to begin moving the gate toward the face of the said head pulley and, upon a half turn of the sprocket 33, to cause the said gate to come into substantial contact with the face of the said head pulley. A continuing additional half turn of the sprocket 33 will cause the gate to return to its former position at which time the circuit is broken by the sequence timer 29.

The above-described sampling means is preferably rapidly operated, because the customarily high rate of flow of coal on a belt in the usual coal handling plant quickly provides a sufficiency of coal for test purposes, and more importantly, in order that as many samples as are practicable may be isolated from the main coal stream for a given flow of coal.

The coal sample which has been so-diverted from the main coal stream falls downwardly through chute 37, the angular sides of which cause the coal to change direction as it strikes against these sides, thereby to break the fall of said coal and deliver it, at a velocity equal to that of coal having fallen only a few feet, into a bulk density box 38. The bulk density box 38 is of known dimensions and is preferably of an even unit volume, such, for example, as an even one or two cubic feet; and it comprises supporting flanges 39, 39, which extend from opposite sides of the top of the box and are flush therewith, and an automatically operable false bottom 41 for the discharging of coal therefrom.

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The coal sample that flows into box 38 fills the box to overflowing and thereafter is leveled in a hereinafter described manner to just its known volume by a leveling bar 40 that is operatively attached to a gear reducer 42 and, connectively, to a reversing motor 43: the said gear reducer and motor are supported on flanges welded to one side of the said box 38. The said leveling bar 40 extends edgewise and horizontally across the top of the box, the lower edge of the bar being parallel to and almost touching the said top, and is so disposed that it swings in the arc of its rotation completely thereover.

After a short interval permitting the complete fall of the coal, the hereinabove-mentioned sequence timer 29 initiates the operation of the said motor 43 in rotating the leveling bar. After a swing of the leveling bar 40 completely across the top of the box, the circuit is broken and the sequence timer 29 then initiates operation of the motor in its reverse direction thereby to cause the bar to return to its starting position and complete a second leveling of the coal. Upon the said return to starting position the circuit is broken and the motor is stopped. That excess coal which is pushed from the surface of the box by the described operation of the leveling bar falls from the box down to the endless belt 26.

For the purpose of simplicity the leveling bar is shown with a single blade, but for ensuring a completely uniform leveling of the coal in the box 38, the bar 40 can be double-bladed, a second blade being also attached to the shaft of the gear reducer 42 and being disposed above the blade shown in Fig. 2 and slightly out of vertical alignment therewith so that it will push away the cone of coal above the top of the box and reduce the load on the lower blade.

Upon completion of the coal leveling step and the breaking of the circuit to the leveling motor 43, the so-isolated constant volume of coal in the bulk density box is automatically weighed. Communication of the coal weight to indicating and controlling scale means 45 is permitted by the unlocking of the scale mechanism upon the receiving of an impulse from the sequence timer 29 by an electrically operated scale thruster lock 46, of the type manufactured by the Toledo Scale Company of Toledo, Ohio. When in locked position, the thruster lock 46 that is mounted on the scale 45 prevents the operation of the scale while the density box is being charged and discharged, and avoids disturbing the scale mechanism, or affecting the controlling apparatus connected to said scale means. When in unlocked position, such release permits the weight of the coal and of the box and its appendages to be communicated through supporting bars 47, 47—upon which rest the said supporting flanges 39 and which themselves hang from depending rods 48, 48 at their one end and from rods 49, 49 at their other end—through scale splices 50, to which the said rods 49, 49 attach, and through supported scale-mechanism levers 51, 52, and 53 to the said scale 45. The indicating scale 45 is supplied with a dial 54, that is preferably graduated not only directly in pounds, but also in pounds per cubic feet. An indicator 55 in the scale is controllably connected to automatic valves in a manner and by means to be hereinafter described. The sequence timer 29 permits the scale thruster lock 46 to be released during only sufficient time for the indicator to attain the correct indicating position whereafter the indicator is again locked in the attained position.

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After the weighing operation is completed, and the scale mechanism is relocked in the attained position, the sequence timer then initiates operation of a motor 56 which, in operation, drives a gear reducer 57, Figs. 2 and 3, that in turn moves levers 58, 59, and 60 through a complete cycle of operation, thereby to move false bottom 41 to an open position to discharge the weighed coal, and thereafter to return the bottom to a closed position.

The so-discharged coal falls to endless belt 26 and is thence delivered, along with the undiverted coal, to oven-supply bins 9, Fig. 1. As soon as this temporarily isolated volume of coal is discharged from the above-described bulk-density determining apparatus, the sequence timer 29 at once returns to its starting position, the full sequence of testing operation is repeated, and any variation from the previously determined bulk density is accordingly ascertained and communicated to the hereinafter described automatically controlled valve means.

Particular reference now is made to Fig. 3 in which, for purposes of clarity, the said sequence timer 29 and its connections to the divers motors of the testing apparatus are shown without those relays, limit switches, and like devices or connections which are preferred or required therewith but which are ordinarily supplied by the timer manufacturer and are, in any case, well known in the art and therefore of no contribution or necessity of explanation here. The timer 29 is, therefore, simply shown as though it directly connected a power source 61 to the motors operating the successive steps of the testing sequence, namely, to the sampling-gate motor 30, the reversing motor 43 for both its directions of movement, to the scale thruster lock 46 and to the false-bottom-operating motor 56. The Fig. 3 also illustrates, in greater detail, the indicating scale 45 and its controlling connections to the automatic oil and water valves, which are shown herein out of place but are given their correct location in Fig. 4.

These said automatic valves are controlled by the movements of the indicator 55 in response to the varying weights of leveled coal in the constant volume bulk-density box 38. The indicator 55 is adapted to ride on a slide wire resistor 63, that is disposed around the perimeter of the dial 54 and that is divided into two segments 63a, 63b, by an insulated neutral point at approximately the center of the arc of the dial, which segments are so-connected to be the two actuating resistor elements in a balanced potentiometric circuit, such, for example, as the one manufactured by Brown Instrument Company and illustrated in their catalogue 77-1 on page 6 or the one manufactured by Automatic Temperature Control Company, and illustrated in their bulletin M-34 on page 2. The movements of the indicator 55 controllably operate, through a balancing relay 64 and the potentiometric connections, an automatic modulating control valve-operating mechanism 65 having a reversible motor which automatically turns a stem 70 of the water valve 62 in one way or the other, proportionately to, and in the direction taken by, the movements of the said indicator.

In order to provide for the particular requirements of the present invention, there is disposed between the driving elements of the automatic control valve-operating mechanism and the water valve 62, a reversing ratchet mechanism 67, that communicably interconnects a reduced-

speed shaft 69 of a gear reducer of the automatic valve-control mechanism to the water valve stem 70 of the valve 62.

The reversing ratchet mechanism 67 is shown in Fig. 4 in simplified form. The reversing ratchet has been specifically adapted to automatic operation, by the novel addition thereto of a self-retracting solenoid 68 that automatically operates a reversing lever 71 of the ratchet in a forward and retracted position thereby to place the ratchet in a position allowing either an opening operating rotation of the water valve 62 or the reverse thereof depending on the direction of the drive of the valve-control mechanism 65. The said solenoid 68 is actuated by a mercury switch 72 that can be mounted preferably on a lever 73 which is attached to a motor driven resistor element 75 of the balanced potentiometer circuit, in such manner that, when the fluctuating indicator 55 passes the said neutral point on the dial 54, the said switch 72 will either make or break contact, depending on the direction of movement of the said indicator 55.

When isolated and weighed coal is found by the present means to exceed a predetermined bulk density, that is, is found to have a bulk density greater or less than the preselected, optimum value, there will be a movement of the indicator 55, in either a clockwise or counterclockwise direction, to a position corresponding to the newly determined bulk density. When the new position taken by the indicator is at a value higher than the optimum weight, the indicator, through the potentiometer circuit, will cause the valve motor mechanism 65 to open the water valve 62 accordingly, i.e., to set it to deliver the quantity of water determined by the amount that the weight of coal in the sample exceeds the predetermined bulk density figure on the indicator and the resultant treatment with water spray will lower the bulk density of the so-treated coal which will thereafter be tested. However, should the value of bulk density as determined by this succeeding test show a reduction toward the optimum value but not lower than such optimum value, the motor mechanism 65 will not operate the valve 62, since indicator 55 having been held in advanced position by the thruster lock 46, indicator 55 merely slides backwardly somewhat on 63 to the lower point of weight in excess of optimum, and the motor mechanism 65 will slip at the ratchet mechanism, but will not reverse valve 62 through 67, since mercury switch 72 will not have been reversed, and hence solenoid 68 will not have been reversed, to operate reversing lever 71 for the reverse ratchet 67, for reverse rotation of water valve 62. As soon as the indicator 55 should pass from segment 63a on one side of the insulated zone that now marks the optimum value on the dial 54 to segment 63b on the other side, the motor driven resistor lever 73, turning in the same manner, will tip automatically the mercury switch 72 which will actuate the solenoid 68 and cause the lever 71 to be turned thereby establishing positive connection in the opposite rotation. Thus, when the weighed coal exhibits bulk densities below the set optimum value, the resultant movement from the neutral zone on the scale to lower values thereon of the indicator will procure a corresponding movement of the valve mechanism 65 and a proportionate closing of the valve 62, the ratchet mechanism being now set so that only a rotation of the shaft 69 in the direction which closes the valve will operate through the ratchet.

This alternately rotatable operation of the valve 62 is made necessary by the requirement that that particular valve opening, which is employed to lower a bulk density of a more dense coal to the said optimum valve, must be retained during the entire period that the said more dense coal is being delivered to the spraying means to discharge a uniform quantity of water continuously onto the coal at the remote point ahead of the sampler, as at ahead of the coal crusher 20; and this valve 62 setting should be so-retained even though coal treated by the certain measured spraying will, on its arrival at the preferably downstream testing means, obviously exhibit substantially that optimum bulk density to which by said spray the so-treated coal has been reduced. Eventually, of course, it can happen that the bulk density of untreated coal will change and thus the coal that is treated by the above-mentioned particular valve opening will again momentarily exhibit a bulk density exceeding, too high or too low, above or below optimum, even with the valve 62 in its previous setting. It is equally important, therefore, immediately upon the appearance at the testing means of this coal of altered density, that a proportionate change in the valve 62 setting automatically should occur and which takes place automatically when the indicator 55 moves along the segments (63a or 63b) which previously set the valve 62, or when the indicator 55 moves past the insulation from one side to the other of the two segments 63a, 63b.

By translating these aforementioned variations in bulk density to the movements of the indicator 55 which, as before described, is the indicator of such variations, it can be seen that no change in the setting of the valve 62 by the automatic valve control mechanism 65 can occur for any movement of the indicator from any point on either one of the two sides of the dial toward the (insulation) location thereon of the region for the optimum bulk density value, but that the only governing movements of the indicator 55 in respect of the operation of the automatic valve mechanism 65 and water valve 62 may be those movements away, in either direction, from that insulated neutral point, at the top of the axis of the dial 54, which insulation point encompasses the limits of the weight of the preferred (optimum) bulk density.

The motor-operated modulating control valve-operating mechanism 65 that is operatively controlled in the above-described manner can be, for example, the modulating control valve-operating mechanism V92-1 that is manufactured by Brown Instrument Company and illustrated in their catalogue 77-L, on page 12. The valve proper 62 controls the flow of water in pipe 76 that is supplied with water at constant head and that delivers the same to the hereinbefore-mentioned spray header pipe 17, (shown in Figs. 1 and 4) that is preferably equipped with a plurality of spray nozzles 77 for more efficiently admixing the water and the coal.

The apparatus illustrated for operation of the present invention is also adapted automatically to admix oil to the to-be-coked coal thereby increasing the bulk density of wet, low-density coals. For this purpose there is provided a contacting element 81 that is disposed on the left side of the dial 54 as shown in Figs. 2, 3, and 4 in the path of movement of indicator 55 which when making contact therewith, will close an opening 75 in a circuit, to open the circuit to the flow of elec-

trical current from a source 78 and a relay 79, through wired connections to motor-operated oil valve 80 such, for example, as the Brown Instrument Company's two-position valve V20 of catalogue 77-L. This valve, in the open position, permits the flow of oil through pipe 82 to spray header delivery pipe 16 having, preferably, a plurality of spray nozzles 83 to apply oil to the coal.

Inasmuch as oil and water ordinarily have opposite effects on the bulk density of coal, it is preferable that they be employed separately and therefore provision is made whereby, in order to conserve oil the oil valve can be opened only when the water valve is closed, such provision being the disposition in the power line from the actuating mechanism to the oil-valve motor 80 of a cut-off switch 84 that can be mounted on the aforementioned water-valve stem 70 and that can be closed only by movement of the water-valve stem to the closed position.

In accordance with the present invention, the bulk-density determining apparatus may be so constituted as to achieve a continuous testing of the entire coal stream by providing, as shown in Fig. 4, an alternate apparatus and means employing a directly analogous but simplified method for the automatic adjustment of coal bulk density. The water and the oil-spraying means and the automatic valve-control mechanisms 65 and 80 that regulate the flow of liquid to the former, respectively, are identical to those hereinbefore described and illustrated in Figs. 1 and 3 and can be located in identically the same positions in the coal-handling system.

Located downstream of the said valve and spraying means 16 and 17 and controllably connected therewith is an alternate bulk density determining means 100 that is preferably so disposed that as short a distance as possible exists between it and the spraying means and still permit the hammermill 20 to be situated therebetween.

Such disposition of mixing and crushing apparatus which is common to both embodiments provides for the thorough admixture of added liquid and for the final pulverization of the coal immediately prior to its testing in the bulk-density apparatus therefor, and before the charging of said treated coal to the coke-ovens.

There is further provided as a part of the said alternate apparatus a small lag bin 102 wherein coal having been discharged from the said hammermill 20 is momentarily detained in order that there may always be provided an even-flowing source of coal to fall upon an endless belt 103. This evenly provided flow of coal on the belt is regulated to a constant volume for any segment of the belt by guiding flanges, or "skirt boards" 105, 105 disposed longitudinally along both sides of the belt for its entire length, and especially by an adjustable radial knife gate 106 whereby coal of strictly regulated cross section on the belt is measuredly permitted to pass the gate and be delivered to the said testing means 100.

The basic unit of this alternate testing means consists of a belt conveyor scale 107 which can be of any ordinary commercial make or design, and which is arranged continuously to weigh each part of the entire coal stream as it flows over the suspended pulleys 108 of the said scale. Since the said conveyor scale is inherently adapted to weigh the coal lying upon a certain and fixed length of belt and since it has been herewith provided that the coal being delivered to said conveyor scale be of uniform cross section and thus

of uniform volume per length of belt, it will become apparent that the weight of coal as determined by the scale conveyor and as indicated by its indicator 55 and dial 54 will be a weight of a known volume which weight per volume, with the volume reduced to unity, is by definition the bulk density. Thus, the bulk density of each effectively isolated segment of the entire coal stream will, without even temporary diversion therefrom, be determined before being delivered to the oven bins 9.

The actuating mechanism and the controlling mechanism for transmitting the requirements for opening or closing movements through the automatic modulating valve-control mechanism 65, to the water and oil valves in response to variations in bulk density of the coal as determined by the alternate determining apparatus, is substantially the same as that hereinabove described embodiment for use with the first-described determining-apparatus, and comprises the indicator 55, the balancing relay 64, the ratchet mechanism 67, and the potentiometrically connecting wires that controllably operate modulating control valve operating-mechanism 65. Here again the said ratchet mechanism 67 operates to provide changes in valve 62 setting only when the bulk density of the tested coal begins to diverge from the optimum bulk density under the previous set position of valve 62, and here again is provided an on-off controlling mechanism operated by contact of indicator 55 with contacting segment 81 on dial 54 whereby oil can be sprayed from spray means 16 upon the coal when the said determining apparatus indicates the same to be below the optimum bulk density and to be at the same time untreated with water or like aqueous liquid.

It is to be noted that a sequence timer such as the timer 29 which controls the steps of testing with the apparatus of the first-described embodiment of the invention, is not needed nor employed with the alternative apparatus embodiment, here described, for the sample testing operation of the latter is continuous and consists of but one continuously performed step.

Although it is ordinarily preferable to employ the hereinabove-described alternate embodiment of testing means in a form whereby each part of the total coal stream can be tested, the said alternate apparatus embodiment could also be employed to determine the bulk density of a diverted portion of the main coal stream simply by continuously diverting a portion of the coal and allowing it to fall to a small lag bin which can be even smaller than lag bin 102 and then to flow through volume-regulating means to the described alternate apparatus embodiment.

The apparatus of either of the above-described embodiments can be simply provided with a switch to cut off operation of the entire mechanism when no coal is running on the belt, simply by providing a resiliently-supported pulley to ride under the coal conveying belt upstream of the testing apparatus and which pulley is connected to a switch which will be closed only when the belt is loaded and the pulley is down.

The automatic coal testing and bulk density adjustment of the present invention is also intended to include such other apparent variations as, for example, having in the system an additional water spray that is downstream of the bulk-density testing means and that is automatically operated by whatever deviations from optimum bulk density still exist in treated coal at

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the testing means and which could thus be communicated by a potentiometric circuit to an automatic, modulating control valve-operating mechanism.

The invention as hereinabove set forth is embodied in particular form and manner but may be variously embodied within the scope of the claims hereinafter made.

I claim:

1. Apparatus for the automatic adjustment and control of the bulk density of coking coal charges during preparation for carbonization in transit to by-product coke ovens, comprising: the combination with a coal handling system comprising oven supply-bin means for supplying the finally prepared coal to the ovens, storage hopper means for receiving the coal from a source of supply and storing it for delivery to the oven supply-bins, conveyor means for conveying the coal in measured quantities from the storage means to the oven supply-bin means, measuring means for measuring the quantity of coal delivered by the storage means to the conveyor means, and final coal crusher means for pulverizing the coal in advance of delivery thereof by the conveyor means to the oven supply-bin means; liquid supply means arranged to deliver measured quantities of liquid onto the coal after it passes the measuring means but before it is discharged by the conveyor means to the oven supply-bin means, and valve means for regulating the volume of liquid discharged on the coal by the liquid supply means; of bulk weighing means having a weight indicating movable member, arranged for weighing representative samples of the coal stream and disposed downstream of the region thereof where the liquid is discharged onto the coal by the liquid supply means; and automatically operable valve-control operating means for regularly opening and closing the valve means for the liquid supply means, and automatically operable actuating means operatively controlled by the degree of movement of the weight indicating member, for actuating the valve-control operating means in the direction of, and in proportion to the degree of, movement of the weight indicating movable member, to correspondingly regularly operate the valve for the liquid supply means; and in which the actuating means is of the type arranged to be operated by the weight indicating movable member only when the weight indicating member indicates a weight which is different from a predetermined weight setting on the weighing means for the bulk density of the representative sample in the weighing means, and in which the valve-control operating means for operating the valve for the liquid supply means includes a device movable into, and out of, driving engagement, accordingly as the weight indicating member moves away from, and towards, the predetermined weight setting on the weighing means, to discharge a uniform quantity of liquid continuously onto the coal ahead of the sampling, with the quantity of liquid determined by the amount that the weight of the representative sample is different from the predetermined bulk density figure set for regularly ensuring the supply of a uniform weight of coal in each coking chamber from the coal handling system.

2. Apparatus for the automatic adjustment and control of the bulk density of coking coal charges during preparation for carbonization in transit to by-product coke ovens, comprising: the combination with a coal handling system comprising oven supply-bin means for supplying the finally

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prepared coal to the ovens, storage hopper means for receiving the coal from a source of supply and storing it for delivery to the oven-storage bins, conveyor means for conveying the coal in measured quantities from the storage means to the oven supply-bin means, measuring means for measuring the quantity of coal delivered by the storage means to the conveyor means, and final coal crusher means for finally pulverizing the coal in advance for delivery thereof by the conveyor means to the oven supply-bin means; liquid supply means arranged to deliver measured quantities of liquid onto the coal after it passes the measuring means but before it is discharged by the conveyor means to the oven supply-bin means, and valve means for regulating the volume of liquid discharged on the coal by the liquid supply means; of bulk weighing means having a weight indicating movable member, arranged for weighing representative samples of the coal stream and disposed downstream of the region thereof where the liquid is discharged onto the coal by the liquid supply means; and automatically operable valve-control operating means for regularly opening and closing the valve means for the liquid supply-means, and automatically operable actuating means operatively controlled by the degree of movement of the weight indicating member, for actuating the valve-control operating means in the direction of, and in proportion to the degree of, movement of the weight indicating movable member, to correspondingly regularly operate the valve for the liquid supply means; and in which the actuating means is of the type arranged to be operated by the weight indicating movable member only when the weight indicating member indicates a weight which exceeds, above or below, a predetermined weight set for the bulk density of the representative sample in the weighing means, and in which the valve-control operating means for operating the valve for the liquid supply means is of the type which retains the valve in its pre-set position until actuated again only by a movement of the weight-indicating member that exceeds, above or below, the setting for the predetermined bulk density weight of the weighing means, to discharge a uniform quantity of liquid continuously onto the coal ahead of the sampling, with the quantity of liquid determined by the amount that the weight of the representative sample exceeds a predetermined bulk density figure set for regularly ensuring the supply of a uniform weight of coal in each coking chamber from the coal handling system, and which includes supplemental automatically operable actuating means operable by the weight indicating movable member for actuating a supplemental valve operating means, a supplemental valve operating means operable thereby, supplemental liquid supply means for separate discharge of a different liquid onto the coal after the measuring means and in advance of the oven supply-bin means, valve means for the supplemental liquid supply means, said valve means being regularly controlled by the supplemental valve-operating means, and said supplemental actuating means being operable by the weight-indicating movable member, when it exceeds below the setting for the predetermined weight for the bulk density of the weighing means sample, to actuate the operating means for the valve in the supplemental liquid supply means.

3. Apparatus as claimed in claim 2, and which includes auxiliary control means operable to render the actuating means for the supplemental

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valve means effective and ineffective; said auxiliary control means being arranged to be operated by the closing and opening movements of the valve for the first aforesaid liquid supply means, to render the supplemental actuating means effective when the valve for said first mentioned liquid supply means is closed, and ineffective when open.

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