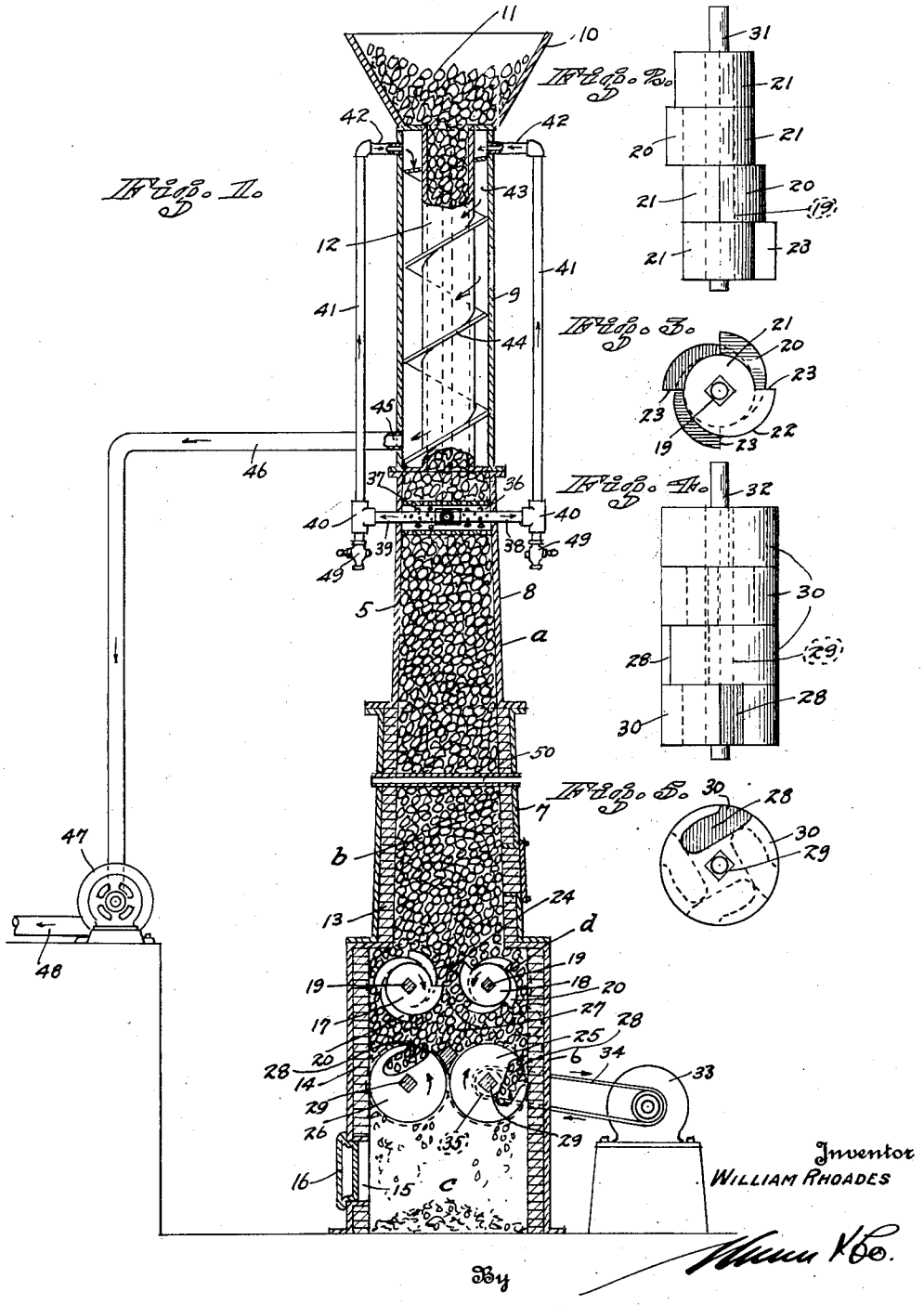
Jan. 14, 1930. W. RHOADES 1,743,394

APPARATUS FOR TREATING CARBONACEOUS MATERIAL

Filed March 24, 1926



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Patented Jan. 14, 1930 1,743,394

UNITED STATES PATENT OFFICE

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APPARATUS FOR TREATING CARBONACEOUS MATERIAL

Application filed March 24, 1926. Serial No. 97,074.

The present invention relates to apparatus for treating carbonaceous material, commonly known as oil shale, for the recovery of hydrocarbon oil therefrom.

The invention has to do specifically with retort apparatus adapted for use in the operation of separating oil from shale by the action of heat, and constitutes an improvement over the inventions described in my copending applications, Serial No. 678,230 on a process of extracting oil from shale, and Serial No. 678,231 on an apparatus for extracting oils from shale, both of which applications were filed on December 3, 1923.

In adapting a retort for use in the operation of removing oil from shale, it is common practise to construct the retort so that the same will hold a charge of material to be treated and to dispose the retort so that the material will feed downwardly to the heat by the action of gravity. In this connection the material to be treated is usually fed into the upper end of the retort and the combustion chamber is located in the lower or opposite end portion of the retort. The heat for combustion purposes is usually supplied by a fuel burner located in the combustion chamber, and the column of material within the retort is supported by a grate located in the lower end of the combustion chamber. The material to be treated is ignited upon entering the combustion chamber, and as a result gives off vapors which pass upwardly through the interstices between the components of the column of material and are taken off from the retort and conducted to the usual air or liquid condenser or to a condenser combining the air and liquid features. The heated vapors in moving upwardly quite naturally influence the temperature of the shale material interposed in their path of movement so that in instances where the temperature of these vapors is relatively high, the heat operates to liberate some of the higher volatile substances contained in the shale before the shale enters the combustion chamber. The heat of the vapors rising from the combustion chamber operates not only to liberate the more volatile substances in the shale material, but to soften the material itself. In softening, considerable of the substances in the shale which vaporize only by intense heat, spread over the surfaces of the pieces of shale so that the shale immediately over the combustion chamber is frequently found to have the consistency of a sticky mass. This mass, however, when entering into the combustion chamber is more or less readily reduced by the heat, but there, nevertheless, remain in the shale certain substances which the heat in the combustion chamber is insufficient to vaporize. These substances are found to be tar-like and sticky and operate to combine the pieces of spent shale in the combustion chamber into an agglomerate mass or clinker, the presence of which in the combustion chamber seriously interferes with the up-draft through the retort.

In the operation of treating oil shale within any retort for the recovery of oil, commercial practicability is based upon the time required for treating a given quantity of shale. Where the retort is arranged in operative relation to a large storage for the shale, the operation of a continuous feeding of the shale to the upper end of the retort can be easily accomplished. But it is not practicable to provide for feeding the shale into the retort more rapidly than the spent shale can be removed therefrom, consequently the feeding in of the shale must be timed with the rate of discharge of the spent shale. The rate at which the spent shale is discharged is dependent wholly upon the rate of combustion, and the rate of combustion aside from the different characteristics found in shale depends entirely upon the up-draft through the combustion chamber. Where grate bars are employed in the combustion chamber for supporting the column of shale, it is difficult if not impossible to provide for a free up-draft in the presence of clinkers within the combustion chamber. Various structures have been proposed for agitating the material in the combustion chamber with a view to disintegrating clinkers. The most efficient of these structures so far as known resolve themselves in various types of slides arranged to move back and forth over the grate bars and in some instances the grate itself is constructed

of a stationary section and a slidable section. In the use of slides which are operated periodically to move back and forth over the grate bars, there can be no up-draft in the interval when the slide is disposed over the spaces between the stationary grate bars. The absence of an up-draft even for an interval increases the time period for treating the shale within the combustion chamber, and also operates to effect a tighter binding between the pieces of spent shale going to make up a clinker, for the reason that the temperature in the combustion chamber is momentarily reduced, so that the sticky, tar-like material becomes a trifle harder through cooling. The presence of relatively hard clinkers negatives the action of slides and the like with the result that ideal up-draft through the retort cannot be had unless these hard clinkers are removed. To remove the clinkers frequently requires the shutting down of the retort and the loss of time incident thereto.

Coming now to the present invention the same proposes a structure in retorts for use in the treatment of oil shale, which is adapted to prevent the formation of clinkers in the lower and cooler portion of the combustion chamber and at the same time provide means which operates to effectively remove from the combustion chamber all of the spent shale as the same accrues, the said means being so constructed as to operate continuously upon the spent shale and to effect the reduction of this progressively to a substantially fine ash for delivery into the ash pit. The present invention further proposes to provide for maintaining a continuous up-draft through the combustion chamber and further to provide for a continuous feeding in of the shale into the upper end of the retort. In other words, the purpose of the present invention is to provide for recovering a maximum amount of oil from a given quantity of oil shale in a minimum of time, and to provide for recovering uniform amounts of oil in successive corresponding periods of time throughout the period in which the retort is in use.

The above and other objects are accomplished by instrumentalities pointed out in the following specification.

The invention is clearly defined in the claim.

A satisfactory embodiment of the invention is illustrated in the accompanying drawings forming part of the specification and in which

Figure 1 is a view of the device partly in side elevation and vertical section, certain of the parts being broken away to disclose the construction and relation of other parts.

Figure 2 is a detail plan view of one of the upper combined supports and breakers.

Figure 3 is an end elevation of Figure 2.

Figure 4 is a view similar to Figure 2 of one of the lower combined supports and breakers, and

Figure 5 is an end elevation of Figure 4.

The retort *a* of the present invention is constructed so as to extend vertically upward, the outer shell 5 is preferably of metal and tapers outwardly and downwardly between points adjacent to the upper and lower ends of the retort, this tapering of the shell providing for efficient distribution and downward feeding of the oil shale and also provides for such expansion as the shale undergoes under the influence of heat. For purposes of illustration I have shown the outer shell 5 as being formed of a lower section 6 of greater cross-sectional area than the section 7 superimposed thereon, the section 7 being flared and larger than the section 8 immediately thereabove. Section 9 which is superimposed upon section 8 may be substantially cylindrical. The hopper 10 forming the upper end of the retort *a* receives the shale to be treated from the usual bin, or place of storage for the shale, disposed above the retort and arranged so as to discharge into the hopper 10. Since the storage for the shale and the feeding thereof into the hopper forms no part of the present invention, the same is not illustrated. The shale to be treated, which is indicated generally by 11, is disposed in the form of a column within the retort *a*. It will be noted that the hopper directs the shale into a relatively narrow chute or passage provided by a tube 12 within the upper section 9. From the said passage the material moves downwardly by gravity and into section 8 and then downwardly and into section 7. Section 7 may be regarded as providing the combustion chamber of the retort and, as shown in Figure 1, a lining 13 of firebrick or other refractory material is provided for section 7. In like manner a lining 14 is provided for the lower or base section 6. The upper portion of section 6 constitutes the lower end of the combustion chamber, which is designated generally by *b*, and the lower end portion of section 6 provides an ash pit *c* from which the residue is removable through a door opening 15 provided with the usual door or closure 16.

A combined support and breaker, designated generally by *d* is located in the lower end portion of combustion chamber *b* for supporting the column of shale within the retort as shown in Figure 1. This support and breaker also operates to control the rate at which the spent shale is deposited in the pit *c*. In the embodiment shown, the column of shale 11 bears upon two horizontally disposed rolls 17 and 18 which are arranged in spaced relation and wholly disposed within the lower portion of combustion chamber *b*. The axes of these rolls are in a common

horizontal plane and the rolls are supported in any suitable manner such as by shafts 19 which are journaled in suitable bearings, not shown, in opposite portions of the shell 5.

Each roll is provided with a series of curved teeth 20 each of which extends over a portion of the surface of the roll and the several teeth are arranged in staggered relation around the periphery of the roll. In arranging the rolls within the chamber *b*, the same are disposed so that the ends opposite teeth of the rolls are in oblique alinement. For convenience in constructing the rolls 17 and 18, I have shown each as consisting of a plurality of rounded blocks 21 having central, non-cylindrical openings for the non-cylindrical intermediate portions of the shaft 19. Each of the blocks is provided with one of the teeth 20 which is preferably formed integral therewith and constructed so that its curved surface is eccentric with the central opening of the block. The curved surface 22 of each tooth merges at one end into the periphery of the block 21, and the opposite or outer end of the tooth is abrupt as indicated by 23, and extends radially of the block. The rolls, together with their teeth, are so proportioned in transverse dimension as to provide an intervening gap 24 therebetween and also passages between their peripheries and the adjacent surface of the wall of the combustion chamber. Thus it is to be seen that the stack of material within the retort is supported directly by the rolls and as these rotate in the direction of the arrows in Figure 1, the teeth operate on the material which disposes itself at the upper portion of the space 24 and also upon material that disposes itself between the rolls and the adjacent surface of the combustion chamber, with the result that the teeth move through this material, opposite teeth of the rolls passing through the material successively, thereby agitating the same constantly. In this way the pieces of shale are prevented from combining to form clinkers and such af the pieces that may combine for the moment are moved downwardly between the rolls and are crushed between the teeth thereof.

As the spent shale passes downwardly between the rolls, it is prevented from directly falling into the ash pit *c* by a pair of horizontally disposed rotatable drums 25 and 26 which are disposed with their axes in a common horizontal plane. These drums are spaced downwardly from the rolls 17 and 18 to provide a chamber 27 for the spent material, and each drum is provided with a plurality of pockets 28 which open through the periphery of the drum and are disposed in staggered spaced relation around the drum as shown in Figure 5. The drums are wholly disposed within the lower end of the combustion chamber and are carried by shafts 29 having non-cylindrical portions passing through centrally disposed non-cylindrical openings of the drums as shown in Figure 1. The drums are further disposed so that opposite pockets thereof move successively through the space 27. The openings of the pockets are such as to freely admit the spent material from the space 27 in the rotation of the drums. For convenience in manufacture, I have shown each of the drums as being formed of a series of circular blocks 30. These blocks are of metal and the pockets 28 are cast or otherwise suitably formed therein. As will be noted by reference to Figures 2 and 4, the shafts 19 and 29 are respectively extended at one end, as indicated by 31 and 32, and suitable trains of gearing are provided and connected to the extended end portions 31 and 32 for the purpose of causing the rolls 17 and 18 and drums 25 and 26 to rotate in the direction indicated by the arrows.

Motion is imparted to the drums and rolls through the gearing by a motor 33 which is connected as by a belt 34 to a pulley 35 secured to one of the shafts 29.

Referring now to Figure 1, a take-off device is provided for the vapor as the same is formed by the heat and rises through section 8. This section 8 may be regarded as a distillation chamber in that the heat from the combustion chamber operates to distill off the volatile material from the shale. 36 is an outlet for the vapors and is herein shown as a horizontally disposed tubular cross located adjacent to the upper end of section 8. The body portion of this outlet is provided with a number of perforations 37 through which the vapors pass into the outlet 36. Located within the outlet is a similarly shaped but relatively smaller outlet 38 which is perforated as at 39. The limbs of outlet 38 extend through the side wall of section 8 and are connected by suitable fittings 40 or the like to the vapor pipe lines 41 which extend vertically upward to points adjacent to the hopper 10. 42 are tubular connections between the upper ends of the vapor lines 41 and the upper end portion of section 9. The space between the tube 12 and the upper section 9 is a preheating chamber indicated by 43, and in this chamber is disposed a spiral 44, the presence of which causes the vapors to follow a relatively long path in moving to the outlet opening 45 in the lower end of the preheating chamber 43. 46 is a pipe line connecting an outlet opening 45 to a motor operated blower 47 which operates to draw-off the vapors from the preheating chamber 43 and to direct the vapors through a line 48 which is connected to a condensing apparatus, not shown. 49 are suitable drain cocks at the lower ends of the vapor pipe lines and provided for the purpose of drawing off condensed fluid which may form in the vapor line.

A characteristic of the present retort is the absence of an outside source of heat for reducing the material to be operated upon. In this connection the retort is arranged for operation by introducing thereinto through the hopper 10 a quantity of shale that will fill the retort. The lower end of the column of shale may be initially ignited by a fire arranged in ash pit *c*. When the base of the column of shale is ignited, the same burns readily and is maintained ignited by the updraft entering through door opening 15. When the shale composing the lower end portion of the column and in and around rolls 17 and 18 and drums 25 and 26 is well ignited, the combined support and breaker is set in operation. The draft can be so regulated that the zone of burning or ignited shale may extend to the upper end of section 7. In this connection a sight tube 50 is disposed transversely of the combustion chamber, this tube being formed of metal and its interior readily observable, so that when the tube is rendered incandescent by the heat in the combustion chamber, the operator can readily determine when the required degree of heat is had within the combustion chamber by observing the appearance of the tube. The up-draft through the retort is, of course, induced by the action of blower 47, and since the blower is operable at different speeds, the up-draft may be varied at will.

The heated vapors in passing into the preheating chamber 43 operate to preheat the shale within chute 12 so that when the shale feeds into the distillation chamber, the temperature of the shale is relatively high and its presence will not operate to reduce the temperature of the shale within the said chamber. In this way all likelihood of pre-condensation of vapor in the distillation chamber is avoided. As the material is consumed within the combustion chamber and feeds downwardly and is operated upon by the toothed rolls and the drums, the movement of the latter can be so regulated with respect to the time required for treating a given quantity of shale in the combustion chamber, that the drums will remove in a corresponding time from the space 27 an amount of spent material equal to the amount treated in the combustion chamber. When the feed to the hopper 10 is adjusted so as to deliver material at a rate corresponding to the rate at which material is consumed in the combustion chamber and discharged into the ash pit, it is evident that the action of this device can be regarded as being continuous. It is to be further noted that the construction of the combined support and breaker prevents an intermittent up-draft through the retort and the consequent momentary chilling and formation of clinkers in the lower end of the combustion chamber. With the construction described, it is obvious that the device of the present invention is positive in action and economically operable.

Although I have shown and described one embodiment of my invention, it is to be understood that the same is susceptible of various changes; and I reserve the right to employ such as may come within the scope of the appended clair..

I claim:

In combination, a retort and discharge means therefor comprising a revolvable drum mounted for supporting the contents of the retort and having an undercut pocket extending into the drum from its opening in the direction of rotation of the drum so as to fill gradually while sweeping through an extended area, the drum being longitudinally divided into a plurality of sections and the pockets of the different sections being disaligned from one another.

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