May 5, 1925. 1,536,831

G. A. EKSTEDT ET AL

SHALE OIL EDUCTION RETORT

Filed July 28, 1923 3 Sheets-Sheet 1

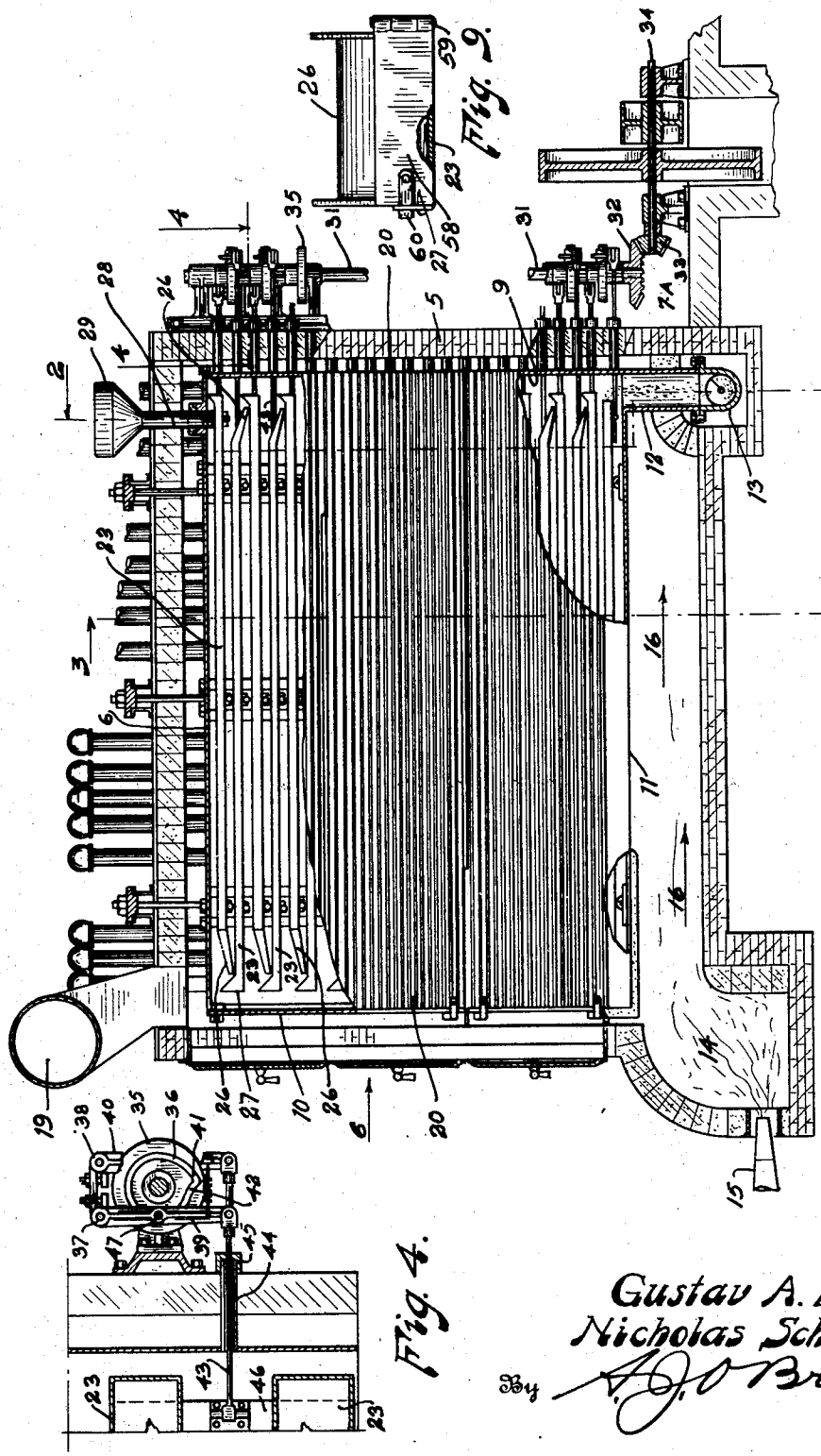


Fig. 1.

Fig. 4.

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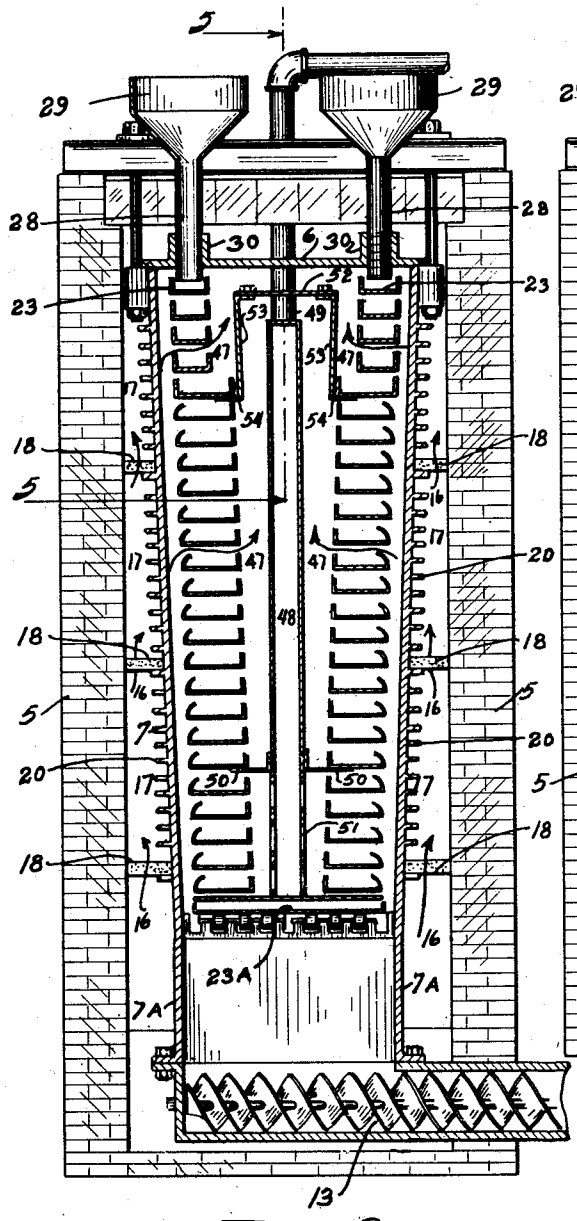


Fig. 2

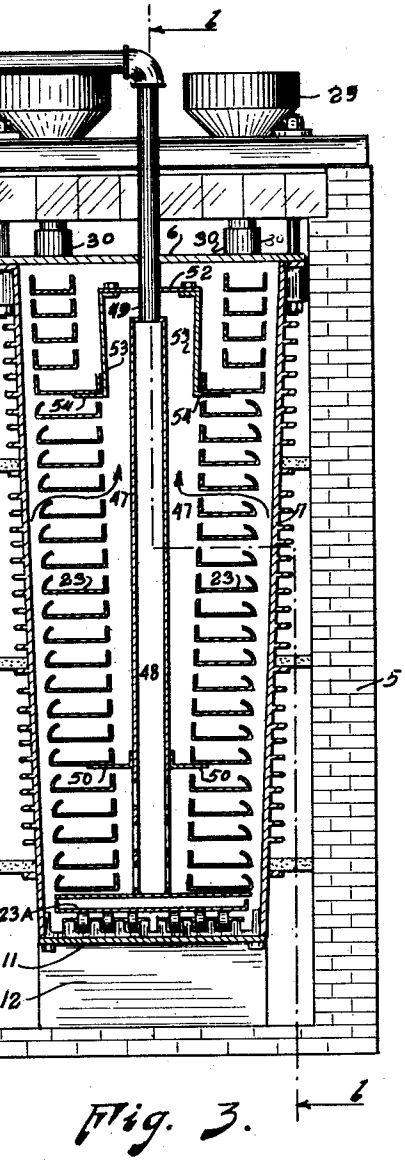


Fig. 3.

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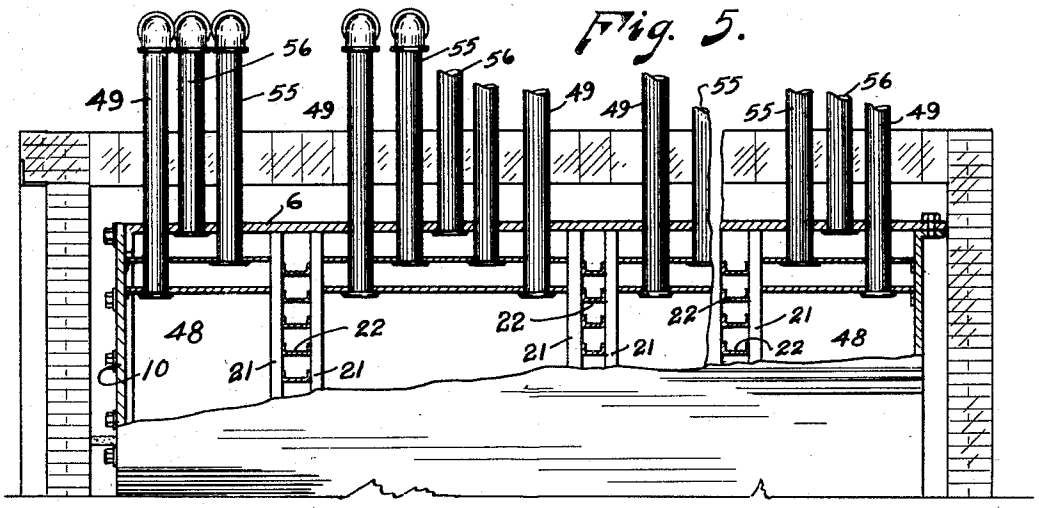
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Filed July 28, 1923 3 Sheets-Sheet 3

Fig. 5.



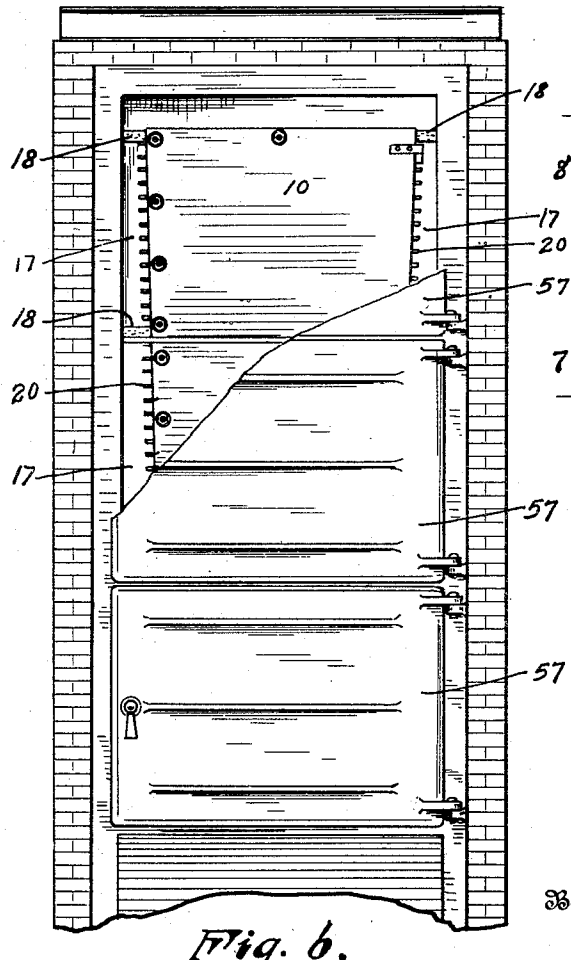


Fig. 6.

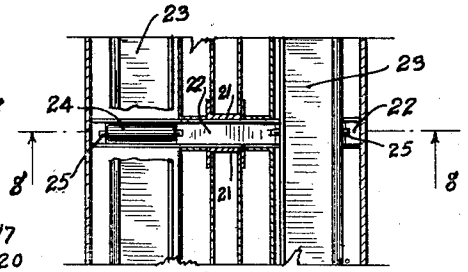


Fig. 7.

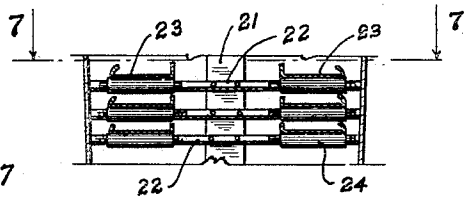


Fig. 8.

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UNITED STATES PATENT OFFICE.

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SHALE-OIL EDUCTION RETORT.

Application filed July 28, 1923. Serial No. 654,321.

To all whom it may concern:

Be it known that we, GUSTAV A. EKSTEDT and NICHOLAS SCHMUESER, citizens of the United States, residing at De Beque, county of Garfield, and State of Colorado, have invented certain new and useful Improvements in Shale-Oil Eduction Retorts; and we do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the characters of reference marked thereon, which form a part of this specification.

This invention relates to an improved eduction retort for uses in obtaining hydrocarbon oils from oil shale.

In many parts of the world there are immense deposits of oil shale which is very rich in hydrocarbons and from which oils can be obtained by proper treatment.

We are aware that many different methods have been resorted to for the purpose of removing the hydrocarbons from oil shale and that a large variety of retorts and stills have been invented for this purpose. Some of these methods and various of the different types of apparatus have been employed with more or less success. Thus, for example, it is old to place the shale in a retort which is heated to a high temperature and to move the shale therealong by means of a screw conveyor, removing the gases and condensing them in suitable condensers.

After an extensive experience with and observation of various types of oil shale eduction retorts, we have found them deficient in various important particulars, among which we may mention the fact that in most of the retorts with which we are familiar, the gases are all delivered to a common duct, whereas the gases given off along different sections of the retort are specifically different and should be kept separate and condensed in separate condensers and then the retorts permit the gases to come into contact with the heated portions of the retort, whereby they become overheated to such an extent that the product becomes discolored.

It is the object of this invention, among other things, to produce a retort that shall be so constructed that the oil shale shall travel at a high rate of speed through an intense heat and in which the gases shall be removed through the central or the least heated portion of the retort so that they will not come into contact with the heated sides of the retort. The above and other objects, which will become apparent as the description proceeds, are attained by means of a construction which we will now describe in detail, reference, for this purpose, being had to the accompanying drawings in which the invention is shown in its present preferred form, and in which:

Fig. 1 is a longitudinal vertical section, of our improved eduction retort, taken on line 1—1, Fig. 3.

Fig. 2 is a transverse section taken on line 2—2, Fig. 1.

Fig. 3 is a transverse section taken on line 3—3, Fig. 1.

Fig. 4 is a section taken on line 4—4, Fig. 1.

Fig. 5 is a central longitudinal vertical section taken on line 5—5, Fig. 2, but with parts omitted for the purpose of better showing the construction.

Fig. 6 is an end elevation of the retort looking in the direction of the arrow 6 in Fig. 1 with portions of the doors broken away.

Fig. 7 is a sectional view looking in the direction of the arrows 7—7, in Fig. 8.

Fig. 8 is a vertical section taken on line 8—8, Fig. 7 and shows the manner in which the shelves are supported.

Fig. 9 is an end view of the receiving end of the shelves and shows the door which is hingedly connected thereon for cleaning purposes.

The same reference numerals will be used to designate the same parts throughout the several views.

Our retort consists of a rectangular chamber whose walls 5 are formed from fire brick or which have a lining of fire brick. Within the chamber we have provided a retort chamber formed from steel plates. This retort chamber has a top 6, sides 7, a front end 9, a removable rear end 10 and a bottom 11. The bottom 11 terminates a short distance from the rear of the front plate 9 which extends downwardly below the level of the bottom 11. A plate 12 extends downwardly to the same extent as the front

plate 9 so as to form a pair of spaced walls which form the front and rear of a chamber whose ends are formed by downwardly projecting portions 7A of the sides 7. To the lower end of the last-mentioned chamber we secure a screw conveyor which we designate as a whole by the numeral 13, whose function and purpose will be hereinafter described. In the end of the rectangular brick chamber opposite from that occupied by the conveyor, we provide a furnace chamber 14 into which gaseous or liquid fuel is directed by means of a nozzle 15. The hot products of combustion passes from the furnace chamber in the direction of the arrows 16 and passes back and forth along the sides 7 of the retort where separate passages 17 are provided by means of fire brick spacers 18. The flue gases finally pass upwardly into and through the flue 19. It will be seen from the above that the heat generated in the furnace will travel in a zigzag course along the sides of the retort where it will heat the sides 7 to a very high temperature. The heat will be most intense near the bottom and gradually lessen towards the top which is an important consideration in a retort of this type. Secured to the outside of the retort walls 7 are a number of parallel flanges 20 which assist in abstracting heat from the heated gases.

Within the retort we provide a plurality of pairs of channels 21. The members of each pair are placed back to back and have secured thereto a plurality of transverse channels 27 which serve to support a number of shelves 23 which will now be described.

Supported on each end of the transverse channels 22 are rollers 24 which project through a suitable opening in the channel and are supported by the central projections 25 in the manner shown in Figs. 7 and 8. The shelves 23 rest upon these rollers and can be readily moved in a longitudinal direction. The shelves 23 are arranged in two substantially vertical tiers, one along each side 7 in the manner shown in Figs. 2 and 3. The delivery end of each shelf is bent downwardly slightly in the manner indicated by numeral 26 in Fig. 1 so as to deliver the shale onto the receiving end 27 of the shelf directly below without making it necessary for the shale to drop any considerable distance, thereby preventing the production of an unnecessary amount of dust. Shale is fed onto the upper shelf through a tube 28 which is provided at the top with a hopper 29. The lower end of the tube 28 has a threaded connection with the upwardly projecting flanges 30 so that the distance between the lower end of the tube 28 and the bottom of the upper shelf 23 can be adjusted to any desired height. It is obvious, when the tube 28 and hopper 29 are full of crushed shale, that the thickness of the shale layer on the shelf 23 will be determined by the distance from the shelf to the bottom of the tube 28.

In order to cause the shale to move along the shelves, we provide means for moving the same slowly in one direction and then quickly in the other direction so that the inertia of the shale will cause it to move relative to the shelf. The means for reciprocating the shelves consists of a rotatable shaft 31 which is rotated through the medium of a bevel gear 32 and a pinion 33 from a drive-shaft 34. Secured to shaft 31 are a number of cam members 35, each of which is provided on its upper side with a cam groove 36 (Fig. 4). Pivoted at points 37 and 38 to a suitable supporting member located to one side of the cam, are two levers 39 and 40, each of which has secured to the underside thereof a roller which cooperates with the groove 36. The cam member rotates in a counter-clockwise direction (Fig. 4) and as the groove 36 is in the form of a spiral, it will gradually move the levers away from the cam center until the roller reaches the apex 41, which is the point of the groove that is farthest from the center. A portion of the groove, indicated by the numeral 42, joins the apex 41 with the end of the groove nearest to the center so that a small angular movement of the cam will move the levers 39 and 40 from one extreme position to the other in a short space of time. The ends of the levers 39 and 40 are connected to the ends of the shelves 23 by means of rods 43 which pass through tubular guides 44 provided at their ends with caps 45 which serve to form glands for the purpose of preventing the escape of gases at the point. Let us now consider the manner in which the cams produce a movement of the shale relative to the shelves:

From Fig. 1 it is seen that each cam operates two levers (39 and 40). Lever 39 is located between the shaft 31 and the end of the shelves and has its inner end connected to a transverse bar 46 which joins the two top shelves 23 so that when the lever 39 moves about its pivot 37, it imparts a corresponding movement to the shelves 23. As the cam rotates in a counter-clockwise direction, lever 39 will move in a clockwise direction about its pivot 37 and the shelves will be moved slowly towards the left (Figs. 1 and 4). When the apex 41 reaches the roller which is pivoted on the pin 47, the lever 39 and the shelves 23 will be moved to the right with a quick motion. The inertia of the shale will prevent it from following the shelves to the right and will therefore slide on the shelves toward the ends 26. Lever 40 is pivoted at 38 and lies on the opposite side of the shaft 31 from that occupied by

the lever 39 and therefore the action of the cam groove is to move the same counter-clockwise about its pivot until the apex 41 reaches the roller when the lever will be quickly moved in a clockwise direction, which will cause the shelves 23 (the lower shelves of each pair) to move quickly to the left which results in the shale moving towards the right or discharge end of the shelves. A helical tension spring 142 connects the ends of the levers 39 and 40 and assists in imparting the fast movement to the shelves after the roller has passed the apex. As each pair of shelves is operated as described from a single cam, there will be a steady movement of the shale from one end of the retort to the other such movement amounting to about three inches every second. The comparatively rapid movement of the shale along the shelves prevents any coking or sticking of the shale to the shelves. Where twenty-six shelves are employed, as shown in the drawing, and where each shelf is fifteen (15) feet long, the total distance that the shale travels in its zigzag course is three hundred and ninety (390) feet and this course is covered in about twenty-six minutes. The distance that the shale travels and the time that it is within the retort may be varied to suit the particular conditions prevailing, as these are not always the same, but depend to some extent on the specific character of the shale and other conditions.

The four upper shelves are preferably made somewhat narrower than the remaining shelves, as it is preferable to have the shale in a thicker layer near the top. The bottom shelf, which we have designated as 23^A, is wide and shallow and receives the shale from both tiers of shelves and conducts the same to the passage leading to the screw conveyor. The shale receives its final coking on the shelf 23^A.

From the above, it will be apparent that when the shaft 31 and the cams carried thereby are rotated by suitable power and when crushed shale is fed through the pipes 28 onto the upper shelves, that there will ensue a steady movement of the shale along the shelves, first in one direction and then in the other, until the shale is finally delivered onto the lowermost pan 23^A which transfers it to the screw conveyor by means of which it is moved out and deposited on a suitable dump. An intense fire from oil or gas is maintained in the furnace 14 and the products of combustion passes back and forth along the outside of the walls 7 of the retort and heats the same to a very high temperature, finally escaping through the flue 19. The heat radiations from the inner surfaces of the walls 7 pass inwardly between the shelves 23 in the manner indicated by the arrows 47 in Figs. 2 and 3 and the liberated gases will also travel in this direction to the center of the retort and away from the hot sides.

It is desirable to keep the gases that are driven off at various stages separate, as they are specifically different. This is accomplished in our retort by the following described, simple expedient: A chamber 48 extends centrally of the retort from one end to the other and has connected to the upper end thereof pipes 49. Secured to the outside of the vertical sides of this chamber are outwardly extending flanges 50 which project between the shelves. Below the flanges 50 the sides of the chamber 48 are provided with a number of openings 51. The gas that is driven off from the coke on the shelves below the flanges 50 will pass inwardly through the openings 51 into the chamber 48 and will be conducted through pipes 49 to a condenser (not shown). Above the top of the chamber 48, we provide a plate 52 having attached thereto downwardly projecting sides 53 to the lower edges of which outwardly extending flanges 54 are secured. The gases driven off from the shelves between flanges 50 and 54 will pass upwardly between the side plates 53 and be carried off by pipes 55. The gases given off by the coke on the shelves above the flanges 54 will collect in the top of the retort and be carried away by pipes 56. It will be seen from the explanation just given that the liberated gases can be collected separately from separate sections of the retort so that only the most analogous gas products will be condensed in the same condenser. We have shown the gases removed in three separate parts, but by an extension of the same idea the gases may be separated into as many parts as may be desired.

The end plate 10 of the retort is removable so as to permit access to be had to the shelves for cleaning. The brick chamber is provided at its rear with a plurality of doors 57 which may be opened so as to permit the plate 10 to be removed when the shelves are to be cleaned.

The receiving ends, of the shelves, nearest the plate 10 are provided with doors 58 which are hinged at 59 and provided with a latch 60, all as shown in Fig. 9.

From the foregoing description, it will be apparent that we have produced a retort that is well adapted to be used in removing hydrocarbons from shale. The retort is made in the form of a rectangular chamber, whose sides are in contact with the hot products of combustion and which provide a large heat area, whose heat absorptive power is further augmented by the outwardly extending ribs 20. By the arrangement of the shelves along the walls 7, heat passes from the side walls under and between the shelves and together with the

gases liberated, passes into the central portion of the retort and away from the heated walls. The walls 7 can therefore be heated to a very high temperature without any danger of burning the gases and cracking them, which so frequently happens in other types of retorts.

The arrangement of a series of shelves, one above the other, permits a long travel of the shale in a comparatively short retort, as pointed out above, there being a travel of 390 feet with shelves 15 feet long. This permits the shale to be moved very fast and at the same time allows it to remain in the retort as long as necessary.

The shelves are supported on horizontal supports by means of rollers which roll on the supports and on the bottoms of the shelves so that no lubrication is required.

The thickness of the layer of shale on the upper shelves is easily determined and adjusted by adjusting the distance from the shelves to the lower end of the tube 28 and this determines the thickness of the shale on each of the shelves. By having the upper shelves narrower than the remaining shelves, the shale will rest more heavily on the shelves and this will prevent the shale from sticking to the same during the early portion of its passage through the retort.

Since the shale is passed from one shelf to the other and is reversed in its direction of travel, the layer of shale will be virtually reversed at the end of each shelf. The delivery end of each shelf is bent downwardly, as indicated at 26, so that the shale as it passes from a shelf to the one directly below will have only a short distance to fall. This will prevent dust from being formed.

By means of several compartments, to which the different sections of the shelves are connected, the gases of different specific gravity may be separately collected and condensed.

The two tiers of shelves empty into the wide shallow pan at the bottom where the final coking takes place.

Since the retort is so constructed that the shale moves downwardly while the gases move in an upward direction, there is therefore no tendency for the gases to leak out at the bottom and this makes it possible to dispense with a seal.

We want to call particular attention to the arrangement by means of which the shelves are reciprocated. This has been described in detail above, but the advantages have not been fully pointed out. By having the shelves operated by cams located at the same end of the retort, the other end becomes entirely free and can be opened up for cleaning. It will be noted that one cam controls two shelves. This is accomplished by having one lever on each side of the shaft 31 in the manner explained. The arrangement illustrated and described produces the proper motion of the shelves to cause the shale to travel in one direction in one shelf and in the opposite direction on the other shelf.

The above and other advantages not mentioned are attained by means of the improved retort construction which has been described above, and which will be hereinafter claimed.

Having now described our invention, what we claim as new is:

1. A shale oil eduction retort comprising an elongated retort chamber of substantially rectangular transverse section, a plurality of relatively movable shelves arranged vertically above each other along the inner surfaces of the retort sides, means comprising grooved cams for positively reciprocating said shelves, said reciprocating means moving the shelves slowly in one direction and quickly in the opposite direction, said movements being in reverse order in any two adjacent shelves, means for feeding shale onto the receiving end of the upper shelves, means for removing the shale from the retort after it has passed over the shelves, means for heating the walls of said retort chamber, whereby hydrocarbon gases will be liberated from the shale, and means for removing the gases from the retort.

2. A shale oil eduction retort comprising an elongated retort chamber of substantially rectangular transverse section, a plurality of relatively movable shelves arranged vertically above each other along the inner surfaces of the retort sides, means comprising grooved cams for positively reciprocating said shelves, said reciprocating means moving the shelves slowly in one direction and quickly in the opposite direction, said movements being in reverse order in any two adjacent shelves, means for feeding shale onto the receiving end of the upper shelves, means for removing the shale from the retort after it has passed over the shelves, means for heating the walls of said retort chamber, whereby hydrocarbon gases will be liberated from the shale, means for separating the gases delivered by the shale at certain portions of its line of travel from the gases delivered at other portions, and means for conducting said gases away to a suitable condenser.

3. A shale oil eduction retort comprising an elongated retort chamber having a substantially rectangular cross-section, transverse supporting bars within said retort, a shelf supported from each end of said bars, said shelves forming vertical tiers, roller bearings between the supporting bars and the bottom of the shelves, a vertical shaft rotatably mounted near one end of said retort, a cam secured to the shaft and adapted to positively operate two adjacent layers

of shelves, said cam having means cooperating with intermediate connecting means for moving the shelves alternately, slowly and then quickly in opposite directions.

4. A shale oil eduction retort comprising an elongated retort chamber of substantially rectangular cross-section, a furnace chamber enclosing said retort, a plurality of shelves arranged in two spaced tiers within said retort, means for admitting shale to the upper shelf in each tier, means for causing the shale to move intermittently along the shelves and from one shelf to the next below it, said means comprising a number of cams rotatably mounted on the outside of the furnace chamber, means connecting the shelves to the cams, means at the bottom of the retort for removing the spent shale, means located intermediate the tiers of shelves for removing the liberated gases, said last-named means comprising a plurality of separate chambers, each of which is connected with a portion only of said shelves, and separate means for removing the gases from each chamber.

5. A shale oil eduction retort having an elongated retort chamber of substantially rectangular cross-section, a furnace chamber enclosing said retort, a plurality of superimposed shelves on each side of the retort, said shelves being located near to the sides of the retort and spaced apart at the center, means for introducing shale to the receiving end of the upper shelves, said means comprising a tube terminating above the upper shelf, and means for adjusting the distance from the lower end of the tube to the shelf, whereby the thickness of the layer of shale deposited on the shelf may be regulated.

6. A shale oil eduction retort having an elongated retort chamber of substantially rectangular cross-section, a furnace chamber enclosing said retort, a plurality of superimposed shelves on each side of the retort, said shelves being located near to the sides of the retort and spaced apart at the center, means for introducing shale to the receiving end of the upper shelves, said means comprising a tube terminating above the upper shelf, means for adjusting the distance from the lower end of the tube to the shelf, whereby the thickness of the layer of shale deposited on the shelf may be regulated, and means for reciprocating said shelves at different rates of speed in opposite directions, whereby the shale will be caused to travel along the shelves.

7. A shale oil eduction retort having an elongated retort chamber of substantially rectangular cross-section, a furnace chamber enclosing said retort, a plurality of superimposed shelves on each side of the retort, said shelves being located near to the sides of the retort and spaced apart at the center, means for introducing shale to the receiving end of the upper shelves, said means comprising a tube terminating above the upper shelf, means for adjusting the distance from the lower end of the tube to the shelf, whereby the thickness of the layer of shale deposited on the shelf may be regulated, means for reciprocating said shelves at different rates of speed in opposite directions, whereby the shale will be caused to travel along the shelves, and means for removing the liberated gases from the central portion of the retort.

In testimony whereof we affix our signatures

GUSTAV A. EKSTEDT.
NICHOLAS SCHMUESER.