May 13, 1924. 1,493,880

J. B. JENSON

OIL SHALE RETORT

Filed July 18, 1921 2 Sheets-Sheet 1

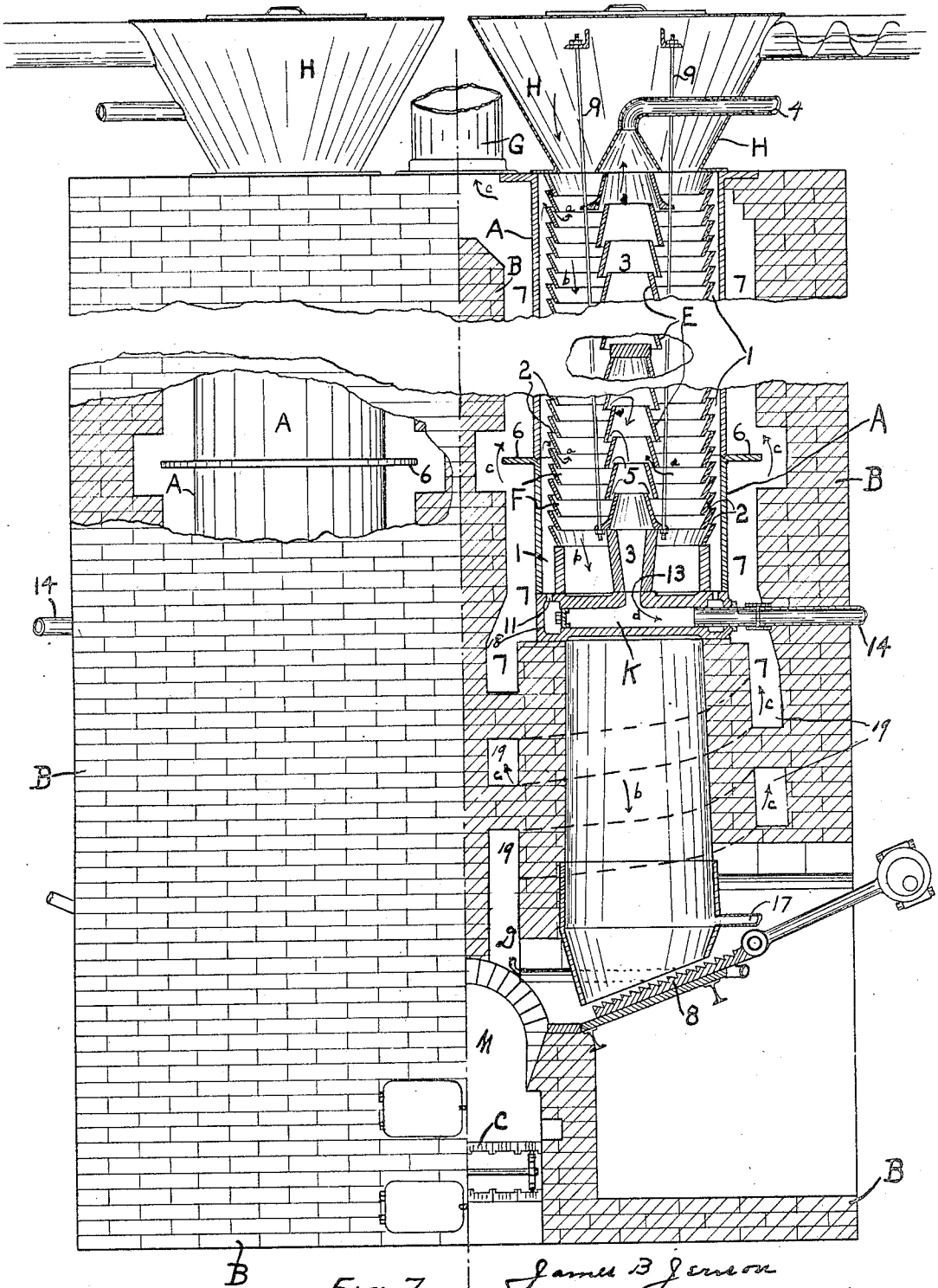

Fig. 7.

James B Jenson
INVENTOR

BY J M Thomas

ATTORNEY

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2 Sheets-Sheet 2

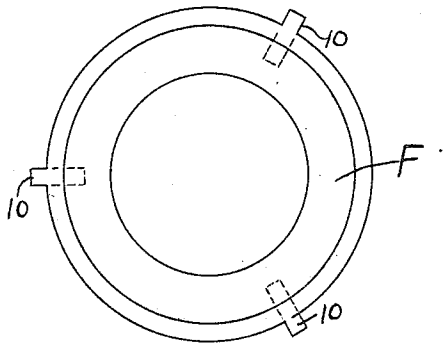

Fig. 1

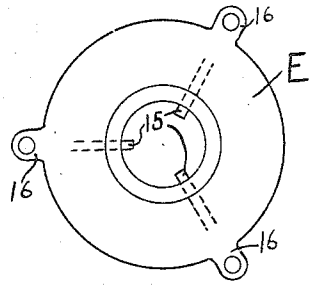

Fig. 3

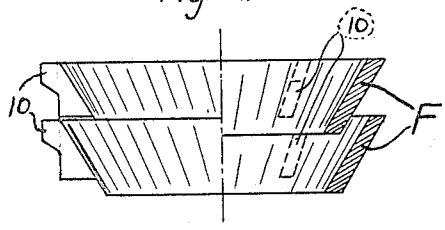

Fig. 2

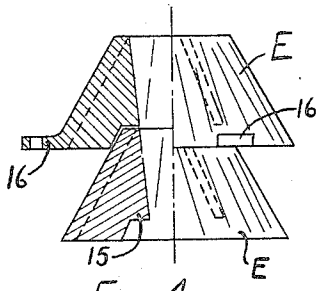

Fig. 4

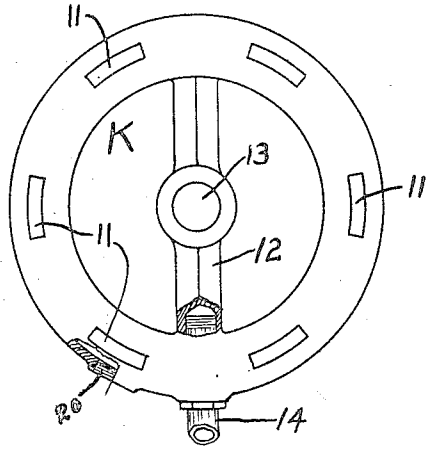

Fig. 5

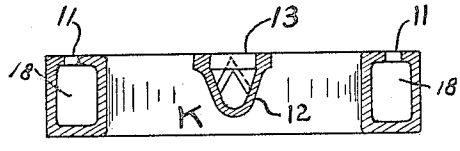

Fig 6

James B Jenson

INVENTOR,

BY J M Thomas

ATTORNEY

Patented May 13, 1924. 1,493,880

UNITED STATES PATENT OFFICE.

JAMES B. JENSON, OF SALT LAKE CITY, UTAH.

OIL-SHALE RETORT.

Application filed July 18, 1921. Serial No. 485,689.

To all whom it may concern:

Be it known that I, JAMES B. JENSON, a citizen of the United States, residing at Salt Lake City, in the county of Salt Lake and State of Utah, have invented certain new and useful Improvements in Oil-Shale Retorts, of which the following is a specification.

My invention relates to retorts for extracting the oil from oil-bearing shale and has for its object to provide two contiguous retorts which may be operated together or singly, having one discharge flue, and otherwise economically constructed as a unit. Also as many units may be adjacently constructed as desired.

These objects and others which are set out hereafter I accomplish with the apparatus illustrated in the accompanying drawings in which similar letters and numerals of reference indicate like parts throughout the several views, and as described in the specification forming a part of this application and pointed out in the appended claim.

In the drawings in which I have shown a substantial embodiment of my invention Figure 1 is a plan view of one of the outer rings. Figure 2 is an elevation with parts shown in section of two of said rings. Figure 3 is a plan view of one of the inner rings. Figure 4 is an elevation with parts shown in section of two of said inner rings. Figure 5 is a plan view of the base or supporting ring for both sets of rings, while Figure 6 is a diametric section of said base ring. Figure 7 is a view showing one retort in elevation and the contiguous one in vertical section, parts cut away.

In the production of oil from oil-shales, particularly the high grade shales of the American Continent, one of the chief troubles in the column or Scotch type retort is the "fluxing" of the shale in the lower portion of the retort. This is caused by the volatilization of the heavy constituents or hydrocarbons in the lower portion of the retort; where the highest temperature exists, these heavy volatiles passing upward through the column of shale and condensing, as they come into contact with the cooler shales which are passing downward from the upper or cooler end of the retort, form on each particle of shale a thick coating of the heavy oil and tar products. When these shales, now covered with the heavy oil, reaches the high temperature zone, these heavy carbons are again volatilized together with the heavy hydrocarbons contained within the shale and again pass upward thus passing through a cycle of volatilization, condensation, re-volatilization, re-condensation, etc., and inasmuch as each time the hydrocarbons are thus volatilized at high temperature, it leaves a deposit of solids, fixed carbon or coke upon the shale, it eventually forms a solid mass which chokes up the retort and compels discontinuance of operations until the solid charge of shale can be removed from the retort. This may be prevented by treating only leaner shales or by mixing leaner shales with the higher grade shales until a proper charge is had to prevent the excessive deposits of the heavier hydrocarbons through the above mentioned cycle. Inasmuch as many of our American ledges contain deposits of high grade shale, the treatment of these afford a greater profit than when operation is confined to the leaner shales and it is important that fluxing be avoided so that these can be treated.

Another difficulty with the Scotch type or column retort is that in order to heat the central portion of the shale column which is usually between 2 and 2½ feet in diameter and as much as 40 to 60 feet in height, it becomes necessary to overheat a large portion of the shale column or that portion which is in contact with the retort, in order to obtain a sufficiently high temperature to volatilize the hydrocarbon in the central portion of the column. This reduces the oil yield by converting a large portion of the condensable oil gases into non-condensable gases, thereby reducing the profit greatly in the operation of the plant. It is important, therefore, not only that the shales and gases be not overheated but that also they be withdrawn from the retort as quickly as possible after volatilization.

In the column retort as operated in Scottish practice it is necessary also to charge the shale into the retort in a coarse condition and free from all fines, in order that the gases may percolate freely upward through the long column of shale. From the fact that the coarser pieces thus charged are several inches in diameter, these require longer time for treatment with heat than the smaller pieces which are probably not to exceed one inch in diameter. This action not only demands high temperature but makes the passage of the charge through the retort

necessarily slow in order to volatilize the entire hydrocarbon content of the coarser pieces.

Aside from these serious objections to the use of the Scotch type retort in the retorting of our high grade American shales, the column retort contains most excellent features for the production of ammonium sulphate and it is doubtful if any device can be developed which will excel, on a whole, the principles utilized in the lower portion or ammonia sulphate portion of the column retort and, therefore, that if the above-mentioned undesirable features are removed, the column retort can be made to supply useful purposes in the development and production of oil from our American shales.

I have constructed a retort which overcomes these difficulties and which at the same time retains all the desirable features in the production of ammonia by the column retort. I find that if I can economically heat the non-condensable gas, or any other suitable medium for conducting or conveying heat to the shale and cause it to envelop each particle of shale without permitting the shale to come into contact with the hot metal surfaces, that I overcome the difficulty of overheating certain portions of the shale while other portions are underheated and that I am enabled to heat the entire surface of each particle of shale, regardless of the size or fineness to the same degree of temperature. Also that I am able to sweep the gases volatilized from the hydrocarbon portion of the shale, immediately out of the retort, thereby preventing the burning or secondary decomposition of the gases. The fact that I am causing hot gases to circulate through the shale and to come into contact with all the sides and surfaces of the shale produces more efficient heating and prevents undue waste or loss of heat. To do this I aim to keep my column of shale thin, say from four to twelve inches, which also permits me to crush to a smaller and more uniform size without preventing the percolating or travel of the gases through the shale, thereby effecting a more complete volatilization of the hydrocarbon with less heat and in less time than where the large diameter column of shale containing a large proportion of coarse pieces must be penetrated and volatilized.

I propose to use the non-condensable fixed gases from a previous operation of the retort, after condensation and scrubbing, by passing them through the retort which is so designed that they shall form a gaseous wall between the portion of the retort which is in contact with the exterior heat and the portion of the retort which is in contact with the shale, thereby preventing the shale from coming into contact with the heated portion of the retort. The non-condensable gases, therefore, as they are passed into this portion of the retort, absorb the heat directly from the heated portion of the retort and pass in a heated condition through the shale, thereby heating the shale and carrying away with them the vapors and gases of volatilization. To provide for their immediate withdrawal I form a column of smaller diameter than the retort to pass through the central portion of the retort and to form a wall of shale within the retort so arranged that I may withdraw the gases of volatilization and the fixed gases, which are there as a heating medium, quickly through the shale from the retorting zones and convey them to the condenser system, either through one or more exhaust pipes or conduits. I may thereby make one or more fractions or grades of oil by one operation. While I am showing a retort of circular cross section I do not confine myself to this form and the retort may be built circular, oblong, square or of any desired shape.

The fixed gases which are thus charged into the walls of the retort in addition to supplying the purpose of a heating medium for the shales, are made to serve the additional purpose of yielding hydrogen to combine with that portion of the carbon that is being volatilized from the shale, coal, peat or other hydrocarbon material being treated, which is unable to secure the necessary hydrogen from the shale to form a saturated oil product, I am thus able to effect an increased degree of saturation in the oil products and also to increase the oil yield by the addition of hydrogen to the carbon molecule which has not been able to secure enough hydrogen from the shale itself.

My retort consists of a vertical cast iron shell A set in and supported by masonry B provided with suitable traveling grates C, oil or gas burner D for heating and a fire box M for using coal or coke, and two sets or series of cast iron frusto-conical rings E and F.

Each of the said rings F has radially extended lugs 10 on which is supported the other respective rings making up the column, and by giving said rings a tapered or conical shape, the spaces 2 are provided for the ingress of heat gases and to prevent the egress of the shale which is passing downwardly within the column formed by all of said rings F. A base ring K is set on the masonry and supports each column of rings and is hollow or annularly recessed, as at 18, and with gas ports 11 opening from said hollowed interior 18 to said space 1 between said shell A and said rings F. A diametrically disposed conduit 12 is formed in said base ring K with an upwardly discharging axial port 13, and in one end of said conduit 12 is screwed the suction pipe 14, to withdraw the volatilized oil contents of the shale

from the hotter zones. Each of said rings E has radially and inwardly extended lugs or bosses 15 which rest on the next lower of said rings E. Some of said rings E have outwardly extending lugs 16, with holes therethrough and in which the rods 9 are passed to take out said rings E for repairs as desired. The pipe 4 is provided and connected with the upper end of the inner column 3 by which the volatilized oil of the cooler heat zones is withdrawn. The line of travel of the shale through the retort is shown by the arrows *b*, the line of travel of the condensable gases, or volatilized oil from the shale is shown by the arrows *a*, while the line of travel of the heat units is shown by the arrows *c*. Heat from the oil or gas burners D is conducted through the spiral heat chambers 19 to the volatilizing heat space 7 which surrounds the said shell A, and in which the said heat currents or units are shown by the arrows *c*.

The series of said rings F is set inside and in contact with the shell A by radial lugs 10, allowing a space 1 between, of an inch or two, and being for the ingress of non-condensable heating gases; the other series of rings E of smaller diameter is set centrally and concentrically within the shell for the egress of condensable and non-condensable gases.

As stated above, each time the heavy condensed oil is volatilized it leaves a solid carbon product and at the same time makes a light oil. This free or solid carbon attaches itself to the inner metal portion of the retort and it becomes necessary occasionally to remove it from and to clean the metal portion. To facilitate this I use two sets or series of rings E and F having different diameters at their top and bottom and forming rings with sloping walls of frusto-conical shape and with a space 2 between each ring to enable the gases to pass between the rings of each series and through the shale and at the same time to prevent the shale from passing between the rings on its downward course within the retort, and to confine the shale within the space formed between the two series of rings.

Also in order to prevent the shale from lodging or hanging within this space, between the two series of rings and thereby clogging or choking up the retort, I increase the space between the two walls or series of rings by gradually reducing the diameter of each ring in the inner series from the top of the retort downward, allowing the outer series of rings to be uniform; as shown in drawing, or I may gradually increase the diameter of the outer series of rings from the top downward in the retort and make the inner series of rings uniform. This increases the thickness of the wall or column of shale downward and permits it to spread, thereby preventing its clogging or choking in the retort.

The outer rings F forming the ingress column are cast with their outer diameter somewhat less, say an inch or two than the inside diameter of the shell of the retort. This is to provide the free space 1 in which the non-condensable gases may travel and during which time they are brought into contact with the outer or hot wall A of the retort which is externally heated and from which the gases absorb the heat before passing between the ingress rings F, transversely through the wall of shale and then between the egress rings E into and through the exhaust conduit or space 3, from which they are withdrawn to the condensers. The inner or egress conduit 3 may be connected with a single exhaust pipe 4 or it may be divided into any number of compartments, two, three or more from which the volatilized gases of the shale are produced at different temperatures in the retort may be withdrawn separately to produce oils or fractions of different gravities or boiling points. The non-condensable or heating gases may be driven through the retort under pressure or be drawn through the retort by means of vacuum. The heating gases are made to enter at the lower or hottest portion of the retort through opening 20 and ports 11 and to find their way upward to the top of the retort, portions of this gas after heating passing between all the ingress rings through the spaces 2; transversely through the shale and then outward between the egress rings, through the spaces 5. The natural tendency for the greater portion of the gas to pass out of the heating space through spaces between the lowermost ingress rings is offset by the more compressed condition of the shale as the bottom is approached. The shale is thus uniformly heated in the zones of varying temperatures from the cooler at the top, to the hotter at the bottom, without possibility of any condensation taking place on the shale, thereby preventing fluxing.

The outer shell A of the retort is shown cast in section with a projecting rib 6 at one end on each section, whose purpose it is to arrest the gases of combustion on their upper course of travel and to deflect them against the sides of the retort, thereby forming zones of varying heat and also utilizing as fully as possible the heat from the fuel which is applied under the retort or in any suitable manner from the side. The outer shell A is set in and supported by masonry B, permitting a space as shown at 7, around the retort and between it and said mason work B and is connected at the upper portion of the retort with a suitable flue or chimney G to conduct away the gases of combustion. The crushed shale is charged

into a hopper H at the upper end of the retort, with sloping sides and a closed cover. The shale may be dumped directly into the hopper from dump bottom or hopper cars or it may be carried to the hopper by a helical or other desirable form of conveyor. That portion of the retort below the cast iron shell A and metal rings E and F is constructed of brick, fire clay or any suitable material which is adaptable for use when high temperatures are desired. It has a gradually increasing diameter downward to facilitate the free travel of the shale in its downward course and is provided at the bottom with a movable gate 8 which carries or supports the shale column and to which is given a forward and backward movement by an excentric or other oscillating device for the purpose of gradually removing a portion of the spent shale and to provide a continuous downward travel of the shale column. Within this chamber or portion of the retort I introduce steam through the pipes 17 in a similar manner to that employed in Scotland for the purpose of producing ammonia and additional combustible gases from the fixed carbon or coke attached to and contained within the spent shale. In the fire brick portion of the retort, therefore, the usual high temperature, say up to and including 1300° F. is employed while in the upper or metal portion of the retort the temperature ranges between 200 and 1000° F.

It will be noted that the series of rings E are fastened together by the rods 9 and are removable for cleaning or repairs, it being necessary only to withdraw the series or column through the upper portion of the retort by means of a chain block or other convenient method. Although the shell of the retort is here shown in sections, the same may be cast integral or in one piece when so desired. The purpose of casting in sections being to facilitate and economize in repairs and for convenience in transportation. It is proposed to use the non-condensable gases for fuel although coal, gas, oil or any other kind of fuel may be used. The shale should be crushed at least to a size to pass a 1½ inch ring and such fines as will pass through a ¼ inch screen should be screened out for best results although in the high grade shales particularly, where a small proportion of fines is produced, the product may be treated as it comes directly from the crusher plant.

The operation of my retort is as follows:—

With crushed shale supplied within the hopper H it is allowed to pass downward through the retort by confining it within the rings F and allowing it to fall onto, and be discharged from the retort by, the reciprocating gate 8. Heat of non-condensable gases is supplied at the lower end of the retort to the shell A and radiating therefrom to heat the space or chamber between the said shell A and the column F, and pass through the spaces 2 between the different rings F and after volatilizing the oil contents of the shale to pass as condensable gases between the said rings E and into the egress column 3. This column or egress opening may be divided into two or more compartments as desired and the said condensable gases withdrawn through the pipes 4 and 14 to produce different fractions.

I thus provide a new and novel retort having new means for conducting the non-condensable gases to and surrounding a new and novel shell within which shell the moving shale is subjected to volatilization from said heat, while it is passing by gravity and spaced from the interior of said heat shell but is passing through a new and novel column with openings through which the heat units may pass and through and surround the individual shale particles. Also a new and novel exit or egress column within and surrounded by the shale under treatment, with new means for withdrawing the condensable gases from heated zones of different temperatures to produce different fractions and to provide a continuous method of extracting and producing oil from shale.

Having described my invention and its operation I desire to secure by Letters Patent and claim:—

A retort for treating oil shale comprising a vertical cast iron shell having outwardly projecting flanges and surrounded with a heat chamber; a vertical column made up of a plurality of spaced apart inverted frusto-conical rings concentrically mounted within and spaced from said shell; a downwardly tapering egress column made up of a plurality of spaced apart frusto-conically shaped rings; a base ring having an annular recess therein with ports leading therefrom without said first mentioned column and with the interior of said base ring opening to the interior of said column; an axial portion of said ring opening to the interior of said egress column by means of which gas may be withdrawn from said egress column.

In testimony whereof I have affixed my signature.

JAMES B. JENSON.