Jan. 7, 1930. L. G. NILSON 1,742,273

RETORT

Filed Jan. 15, 1926

Fig. 1.

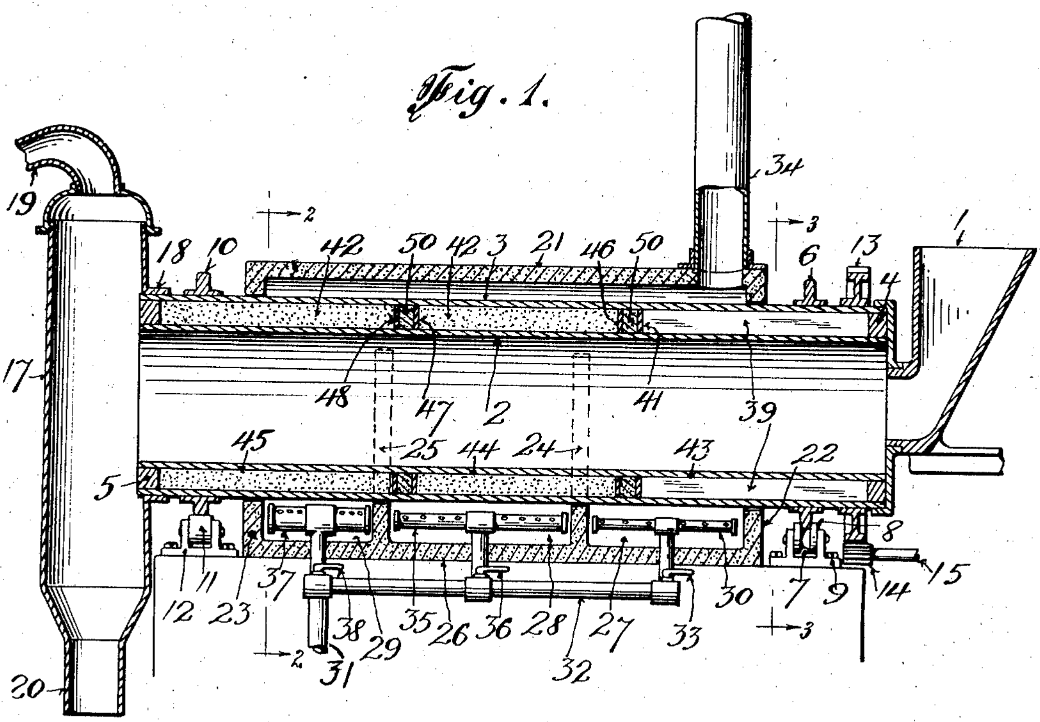


Fig. 2.

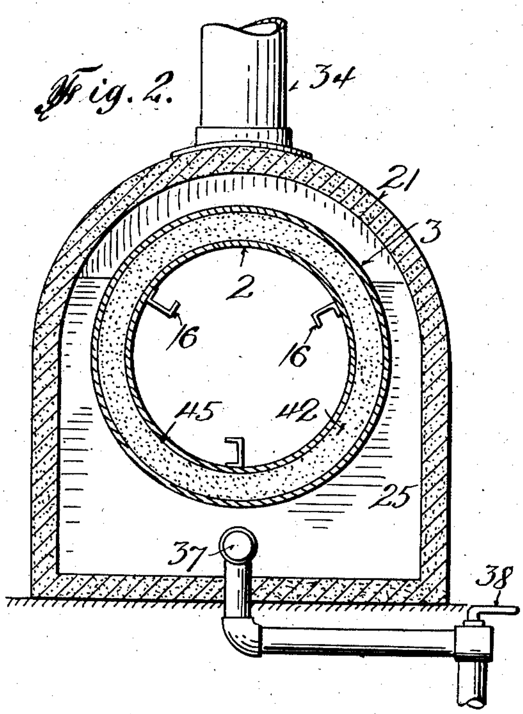
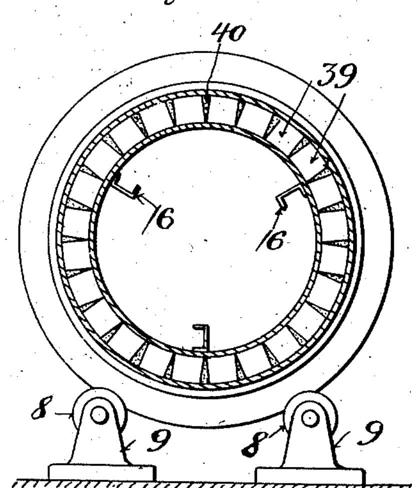


Fig. 3.



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RETORT

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My invention relates to retorts, and while it is adapted to be used in the treatment of various carbonaceous materials, its principal usefulness is in the treatment of shale for the purpose of extracting hydro-carbon oils therefrom. The present retort belongs to that type wherein the carbonaceous material is conducted through an inclined, revolving cylindrical retort chamber wherein the material is subjected to heat for the purpose of extracting the hydro-carbon oil and fixed gases from the shale. One of the principal objects of the present invention is to obtain in a retort of the revolving cylinder type, a zoning of the heat in order that the carbonaceous material will be gradually increased in temperature as it progresses through the revolving cylinder, in order to avoid flash spots and in order to obtain volatilization of the hydro-carbons at or adjacent the point where the carbonaceous material discharges from the revolving cylinder. In retorts in which substantially uniform heat is applied to all portions of the revolving cylinder, there is a tendency for the volatiles to separate from the shale along the retort so that the volatiles which are evolved near the feeding-in end of the cylinder have to pass through the cylinder to the discharge end, and during this extended travel of these first evolved vapors, the latter are often raised to such a temperature as to cause partial decomposition of the vapors and this portion of the product is reduced in quality. By obtaining a zoning action or gradual stepping up of the temperature of the carbonaceous material as it travels through the retort, I have been able to gradually increase the heat of the material up to the point of maximum heat, so that the volatiles are suddenly evolved at the discharge end of the retort and immediately pass off to the condenser before these volatiles can be injured by excessive temperature or partial burning after they are separated from the shale.

Another object is to utilize solid material either in finely divided or bar or plate form, as a heat equalizing medium between the inner and outer walls of the revolving cylinder. With these and other objects in view, as will be more fully described hereinafter, my invention is constructed and operated as follows:

In the drawing forming part of this application,

Figure 1 is a longitudinal sectional view of a retort embodying my invention,

Figure 2 is a cross sectional view taken on the line 2—2 of Figure 1, and

Figure 3 is a sectional view taken on the line 3—3 of Figure 1.

In the drawing I have shown a hopper 1 which will be stationarily mounted and this is adapted to receive the carbonaceous material or shale which is to be treated. There is a long cylinder which receives the shale from the hopper 1 and this cylinder is preferably constructed as follows: The cylinder comprises an inner cylindrical shell 2 preferably of steel or iron, and surrounding and enclosing this cylinder is an outer wall or cylinder 3 which is spaced from the inner one to provide an annular space extending the length of the cylinder, the space being closed at opposite ends by suitable rings 4, 5 fitting tightly between the inner and outer walls. The cylinder as a whole is inclined horizontally so that the end nearest the receiving hopper 1 is elevated in relation to the left hand or discharge end as shown in Figure 1. The outer cylinder 3 has surrounding and attached to it a circular flange 6 which is adapted to rest in the grooves 7 of the grooved supporting rollers 8 which are mounted to revolve in the supports 9. By arranging this flange to rest in the grooved rollers, the cylinder is prevented from shifting longitudinally, and at the same time the cylinder is permitted to revolve, the rollers 8 forming the bearing at or near one end of the cylinder.

Near the left hand end of the cylinder in Figure 1 I have shown another flange 10 attached to and surrounding the cylinder, and this rests upon the flat face rollers 11 which are arranged to revolve in suitable supports 12. I prefer this arrangement as the flange 11 may shift slightly on the faces of the rollers 11 as the cylinder expands and contracts under change of temperature. In other words, the flange 6 engaging in the grooved rollers 8, maintains the cylinder in its longitudinal position and the flat flange 10 engaging the flat rollers 11 allows the cylinder to expand and contract longitudinally. I also show an annular gear 13 surrounding and attached to the cylinder adjacent one end, and there is a pinion 14 mounted on the shaft 15 and operated by any suitable source of power, the purpose of the same being to operate upon the annular gear 13 to revolve the cylinder.

Within the inner cylindrical wall 2 are attached suitable lifters, here shown as channel bars 16 attached to the inner surface of the wall 2 and extending lengthwise thereof. These lifters serve to carry the material from the bottom of the cylinder upwardly and thence drop it so that the shale is properly agitated and broken up to cause all portions to be subjected to equal heat treatment while it is passing through the retort. At the discharge end of the revolving cylinder, or at the left hand end in Figure 1, I have shown a cylindrical chamber 17 substantially vertically disposed and provided with a lateral flange 18 encircling the discharge end of the cylinder. To the upper portion of this chamber there is connected a pipe 19 which serves to lead off the volatiles and to conduct them to a condenser (not shown) or to a fractionating still. The spent shale is discharged through the lower end 20 of this chamber into a suitable receptacle or bin (not shown). It will be understood that suitable check valves may be used at the point where the shale enters from the hopper 1 and at the discharge end of the chamber 17 for preventing the escape of the volatiles through these openings, but as such devices are well known in the art they are omitted from the drawings.

The revolving cylinder is enclosed by walls 21 preferably formed of fire brick and of sufficient thickness to prevent loss of heat which is applied to the cylinder. In the form of the invention shown herein, this enclosure includes an end wall 22 adjacent the intake end of the cylinder, and a similar end wall 23 adjacent the discharge end of the cylinder. Intermediate of these two end walls I have provided dividing walls 24, 25 which divide the furnace spaces between the bottom wall 26 and the cylinder in order to separate these spaces into separate furnace compartments 27, 28, 29. These dividing walls also extend upwardly and partially around the cylinder dividing the annular space between it and the fire wall. In the first furnace compartment I have shown a burner 30 disposed under the revolving cylinder and liquid or gaseous fuel may be fed to this burner from a supply pipe 31 and through the common feed pipe 32 which leads to all of the burners. There is a valve 33 for controlling the feed of the fuel to the burner 30 and this burner is designed and operated to heat the intake end of the revolving cylinder to a lesser degree than the subsequent burners. The products of combustion from this first burner pass upwardly in the annular space between the cylinder and the furnace wall and in this passage it is confined between the end wall 22 and the first dividing wall 24 and these products of combustion lead off through the stack 34. In the second furnace compartment 28 I have shown another burner 35 which is also controlled by means of a valve 36 and if desired this burner may be somewhat larger in size than the first burner, and provided with a greater number of flame outlets in order that this burner may, at its particular location, create a higher temperature in the second section of the revolving cylinder, than that which is maintained by the first burner in relation to its portion of the cylinder. The products of combustion from this second burner pass upwardly in the annular space around the cylinder and it is confined to the space between the first and second dividing walls 24, 25 and these products of combustion pass from the upper portion of the annular space through the common stack 34. In the third furnace compartment 29 I have shown a third burner 37 which may be larger than those previously described, and provided with a still larger number of flame openings. This burner is also controlled by means of a valve 38. The products of combustion from this burner pass upwardly and around the cylinder in the annular space and they are confined to the compartment between the second dividing wall 25 and the end wall 23.

The annular space between the inner and outer walls of the revolving cylinder is filled with a substance or substances which will equalize the temperature circumferentially of the cylinder and in the preferred form of my invention this annular space is divided off in order that the different sections may be heated to different degrees by the several burners and thus maintain different local degrees of heat in so far as the length of the cylinder is concerned, but circumferentially uniform. In Figure 3 I have shown one form of filler or equalizing agency corresponding to the showing in the first section at the right hand of Figure 1. In this section I have shown a number of bars 39 of metal extending lengthwise of the annular space between the inner and outer walls 2, 3. These bars, which may be copper, are shown disposed in close relation around the annular space and I prefer to pack asbestos or sand between the edges of these bars as shown at 40. This latter material is more or less compressible and permits the bars 39 to expand and contract without injury to the walls of the cylinder, and at the same time fills the spaces sufficiently to distribute the heat. These bars 39 are shown extending only part way of the length of the revolving cylinder or between the head and a lateral dividing wall 41 which corresponds to some extent with the location of the first burner compartment. All of the compartments of the cylinder may be filled with the same equalizing material as that just described or some or all of them may be filled with other solid material as follows: In the second and third compartments I have shown what may be considered as metal filings or sand 42. In the compartment 44 defined by the dividing walls 46, 47 I have shown in the annular space a body of this equalizing material, preferably sufficient to practically fill this space. In the third compartment shown at 45 and defined by dividing wall 48 and by the end wall 5 I have shown another and separate body of equalizing material which may also be metal filings, sand or other solid material. The spaces between the several dividing walls 41, 46, and 47, 48 may also be filled with heat insulating material such as asbestos but preferably with air as to assist in segregating the several compartments and to prevent the direct conduction of heat from one compartment to another.

In the operation of the device, the shale or other carbonaceous material is introduced into the hopper 1 and the cylinder is revolved continuously so that the material is carried upwardly by the several buckets 16 and thus turned and agitated, and due to the inclination of the cylinder, the shale travels by gravity from the intake or hopper end to the discharge chamber 17 from which the spent shale is discharged. As the shale first enters the revolving cylinder it is subjected to the heat created by the first burner 30 and as stated above, this burner is so designed and operated as to produce a heated zone in the revolving cylinder, sufficient to raise the temperature of the shale to a point somewhat below that at which the hydro-carbons will be released from the shale. For instance, in this section of the cylinder the temperature may be maintained at approximately 550 degrees Fahrenheit, although this is merely stated as an example for illustrating the operation of the device. As this temperature is below the volatilizing temperature of the shale, the latter in this section or zone is merely prepared for the subsequent heating operation, and no appreciable amount of volatile is given off. As the shale progresses from right to left in Figure 1, within the cylinder, it next comes into the heating zone defined by the dividing walls 24, 25 and it is subjected to the heating action of the second burner 35. As this burner is operated to produce a higher temperature than that produced by the first burner, this second zone will be maintained at a higher temperature and therefore the shale will be progressively raised in temperature as it passes from the first zone into the second zone. Preferably this second zone, while heated to a higher degree than the first zone, is maintained, nevertheless at a temperature slightly below that at which the volatiles are evolved from the shale. Continuing its passage through the cylinder, the shale enters the third zone, defined by the dividing wall 25 and the end wall 23 and here the shale is subjected to the heating action of the burner 36 which, in the particular device here illustrated, will produce the final and maximum temperature in the shale. The temperature to which the shale is raised in the third heating zone will be sufficient to cause the immediate volatilization of the hydro-carbon content of the shale and these volatiles will pass into the chamber 17 and will be discharged through the pipe 19 to a condenser (not shown). It will be apparent that by causing the volatiles to be given off only or principally in the last heating zone, that these volatiles will pass immediately into the discharge pipe, whereas if the entire retort chamber were subjected to a uniform heat, sufficient to evolve the hydrocarbons, a considerable part of these volatiles would have to travel the length of the retort cylinder and in doing so they would be partially consumed or otherwise rendered less valuable. The rings 41, 46, 47 and 48 as well as the equalizing materials, maintain the inner and outer walls of the cylinder in concentric relation, thereby maintaining alignment of the cylinder.

The heat equalizing material in the annular space between the inner and outer walls of the cylinder causes equalization of heat circumferentially of the retort so that while the shale is in a particular heat zone, it is all subjected to uniform heat treatment. By segregating the several bodies of equalizing materials, the heat is not materially conducted from one zone to another, so that I am enabled to gradually step up or increase the temperature of the shale as it progresses from one zone into another. The dividing walls 24, 25 assist in this function by separating the annular space between the cylinder and fire wall into separate annular compartments; and by regulating the several burners, or by their construction, I am enabled to maintain separate heat zones lengthwise of the revolving cylinder, and to attain the progressive heating action referred to. I have shown the burner compartments slightly staggered in relation to the several equalizing compartments as is shown in Figure 1 in order to more gradually increase the temperature of the shale as it travels through the cylinder. It will be understood that any form of fuel may be used for heating, but I prefer to use a fuel which will be subject to regulation. In practice, it will generally be found convenient either to force hydro-carbon fuel into the burners under air pressure, or to use gas mixed with a suitable proportion of oxygen.

As far as I am aware, this is the first instance in which a revolving type of retort has been provided with means for creating and controlling differential heat zones in order to more gradually raise the temperature of the shale to the point where volatilization of the hydro-carbons takes place, and to evolve these hydro-carbons at or adjacent the discharge end of the retort. While I prefer to combine all of the features herein shown in the same structure, it will be apparent that the means for dividing the heating spaces into separate compartments may be used independently of the heat equalizing means and vice versa. So far as I am aware, this is also the first instance where solid heat equalizing material as distinguished from a material which becomes fluid when heated, has been used between the inner and outer walls of a revolving retort cylinder. While I have shown and described three heat zones it will be apparent that the device may be designed for a greater or a lesser number of such zones.

Having described my invention, what I claim is:

1. A retort for the purpose set forth, including a revolvable cylinder and means for heating the same, said cylinder comprising concentric inner and outer walls arranged to provide an annular space between them, heat equalizing material arranged in said annular space, and rings of low-heat-conducting material in said annular space for separating different portions of said equalizing material into separate sections.

2. A retort for the purpose set forth, including a revolvable cylinder through which the material to be treated may pass, said cylinder comprising spaced concentric walls providing an annular space between said walls, a non-fluid heat equalizing and heat conducting filler in said annular space, and a ring of low-heat-conducting material arranged in said annular space to divide said heat equalizing material into separate sections and means for applying heat to the exterior of said cylinder.

3. A retort for the purpose set forth, including a revolvable inclined cylinder through which the material to be treated is passed, said cylinder including spaced, concentric walls forming an annular space between said walls, a filler of heat equalizing and heat conducting material arranged in said annular space throughout the greater portion of the length of said cylinder, a plurality of rings arranged adjacent each other in said annular space to form an air space around said cylinder between said rings for the purpose of dividing said equalizing material into separate sections, and means for applying heat to the exterior of said cylinder.

4. A retort for the purpose set forth, comprising a revolvable cylinder through which the material to be treated is passed, said cylinder comprising spaced concentric walls forming an intermediate annular space, non-fluid heat equalizing material arranged in said annular space, means forming an enclosure for said cylinder, and providing a combustion chamber around the latter, means dividing said combustion chamber laterally into separate heating sections, and heating devices in the several sections for progressively heating said cylinder.

5. A retort for the purpose set forth comprising a revolvable cylinder through which the material to be treated is passed, said cylinder comprising concentric inner and outer walls spaced to provide an annular space between them, a heat equalizing filler in said annular space, means in said space for dividing said heat equalizing material into separate sections, means forming an enclosure for said cylinder and spaced therefrom to provide a combustion chamber, means for dividing said chamber laterally into separate heating compartments, and heating devices in the separate compartments of said combustion chamber for heating said cylinder.

Signed at New York city, county of New York, State of New York, this 12th day of January, 1926.

LARS G. NILSON.