March 7, 1933. I. H. DERBY 1,900,047

METHOD OF DISTILLING FLUENT MATERIALS AND PRODUCING COKE

Filed March 6, 1929 2 Sheets-Sheet 1

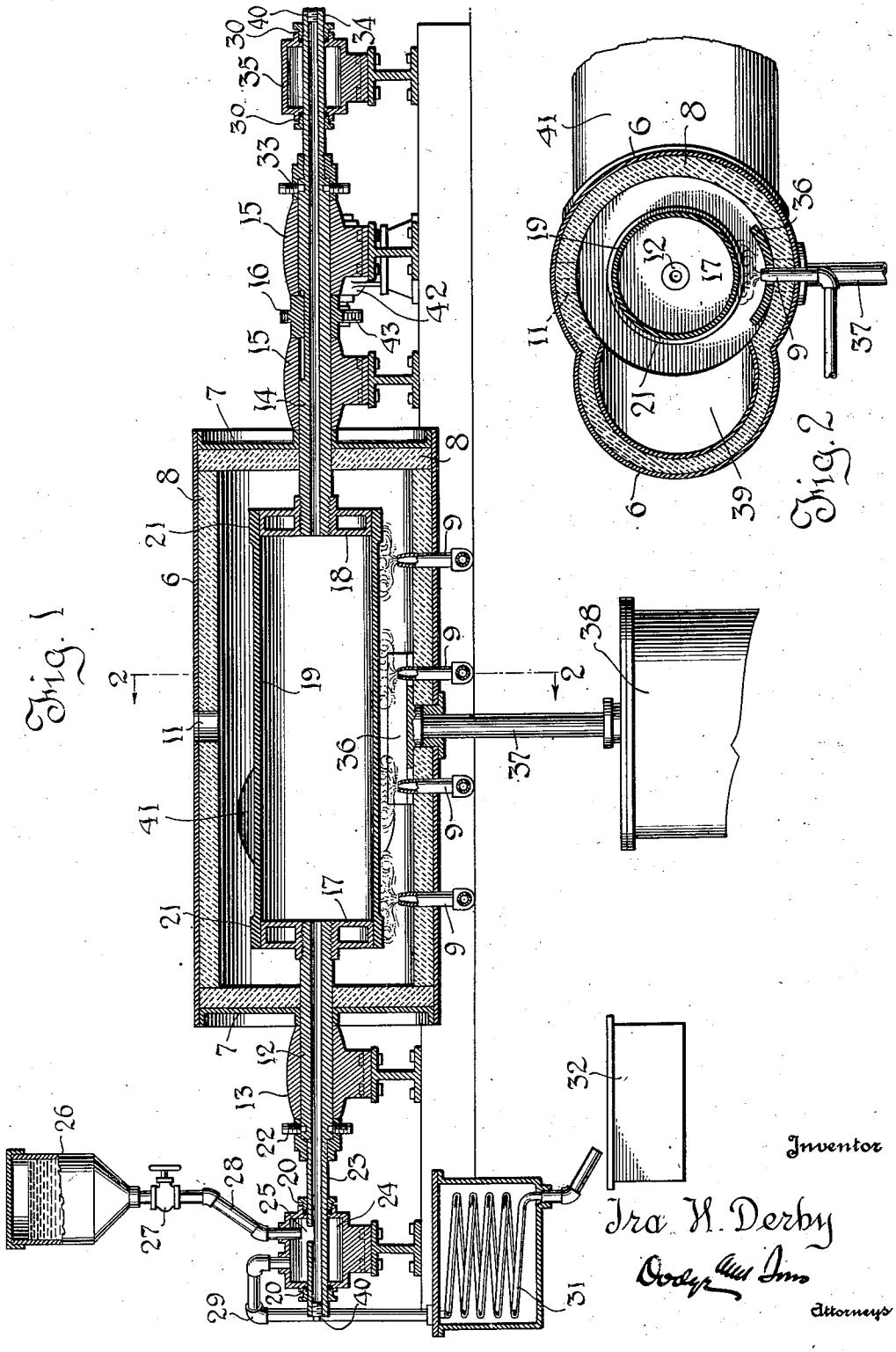


Fig. 1

Fig. 2

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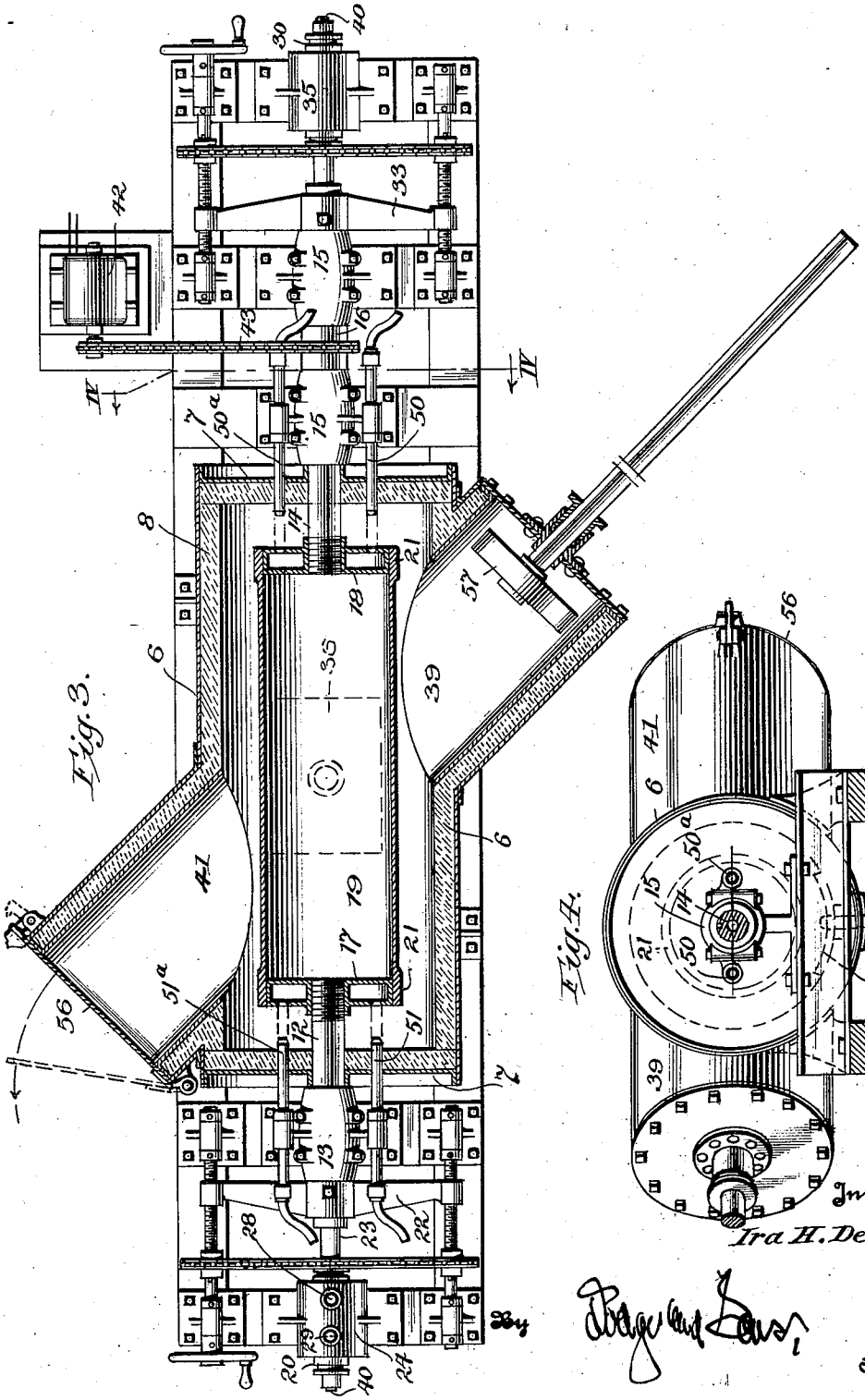


Fig. 3.

Fig. 4.

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UNITED STATES PATENT OFFICE

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METHOD OF DISTILLING FLUENT MATERIALS AND PRODUCING COKE

Application filed March 6, 1929. Serial No. 344,796.

This invention relates to a method for accelerating the transfer of heat from hot gases, such as those existing in a furnace or muffle, to the interior of a still or retort containing fluent materials such as liquids and granular solids. The method further suppresses foaming in the case of liquids and the discharge of dust in the case of coals, etc.

The invention is of particular utility in connection with a method of distilling coal, tars, pitches and other hydrocarbons, and mixtures of the same, and will be described in this connection. The distillation may be carried on at atmospheric and other pressures, and in the presence of gases or vapors if desired in particular cases, so far as the method here claimed is concerned.

The apparatus illustrated in the accompanying drawings and discussed in this specification, is not herein claimed, but forms the subject matter of a separate application for patent filed March 6, 1929, and patented August 9th, 1932, No. 1,870,901.

Generally stated, the method contemplates the rotation of the still or retort on an axis, preferably a horizontal axis, at such speed that the fluent material contained in the still will be distributed and maintained over the wall of the still in a substantially uniform layer of relatively shallow depth. The result is to increase the effective heating surface of the still, reduce the thickness of the layer of treated material through which heat must be transmitted, and accelerate the transfer of heat because of the rapid movement of the retort shell in the heated gases and because of a relatively active flow of the treated material in contact with the internal surface of the retort. Centrifugal force also effectively suppresses foam and dust (either or both) which tend to interfere with or delay prior coking or distilling processes.

The invention will be described in connection with the accompanying drawings, in which,—

Fig. 1 is a longitudinal axial section with nonessential parts of the apparatus omitted.

Fig. 2 is a section on the line 2—2 of Fig. 1.

Fig. 3 is a plan view with the furnace and retort being shown in section, and Fig. 4 a transverse vertical sectional view taken on the line IV—IV of Fig. 3.

In the drawings, 6 represents the cylindrical shell of a furnace or muffle having circular heads 7, the furnace being lined with refractory material 8. The furnace, heated by a plurality of gas jets 9 of suitable type, or by any other suitable means, discharges the products of combustion through the port 11. Journaled coaxially with the furnace, and projecting through one head 7 thereof, is a hollow shaft 12 mounted in bearing 13. Extending through the other head of the furnace is a similar but longer shaft 14, which turns in bearings 15.

Splined on the shaft 14 and confined between the bearings 15 is a sprocket 16 through which the shaft 14 may be rotated. The shaft 12 carries a hollow disk-like head 17 and the shaft 14 carries a similar head 18. These heads make a shrink fit with a cylindrical shell 19, which is the retort or still proper.

The ends of the cylindrical shell 19 are thickened or reinforced, as indicated at 21, and the heads 17 and 18 are rendered removable from the cylindrical shell 19 by the introduction of a cooling fluid which causes them to shrink away from the shell 19. The introduction of the cooling liquid may be readily effected by longitudinally movable pipes 50 and 50^a at one end of the retort which cooperate with the head 18 and 51 and 51^a at the opposite end of the retort which cooperate with the hollow head 17. Introduction of a cooling liquid, such as steam, into these pipes when they pass into the openings formed in the heads 17 and 18 will cause a contraction thereof and permit their removal. Prior to the full retraction of the heads the cradle 36 is raised and brought into contact with the under face of the still 19. The still may then be moved in a horizontal plane by imparting motion to the shaft 37 through any suitable means. Rotary motion of the shaft 37 will be stopped when the retort or still 19 is brought into alignment with the pockets 39 and 41. A gate 56 at the outer end of the pocket 41 is then opened and a ram 57 is forced through the still, clearing it of all coke. This opera-

tion is a quick one and does not necessitate the lowering of the temperature of the furnace surrounding the still. The still is brought to normal operative position by a mere reversal of the motions above specified. This, however, is not a feature of the present invention, and is described in further detail in the companion application above mentioned. The heads 17 and 18 may be withdrawn when shrunk by withdrawing the shafts 12 and 14.

The shaft 12 has a reduced tubular extension 23 which passes through a box or chamber 24 and has an opening 25 leading to the interior of the box 24. Stuffing boxes 20 prevent leakage. Liquid, such as coal tar, to be treated in the shell 19 may be fed from a reservoir 26 through a valve 27 and pipe 28 to the passage 25. A swiveled yoke 22 is provided to permit the longitudinal shifting of shaft 12 to withdraw head 17 from shell 19.

When distillation is going on gas and vapors may pass out through the hollow shaft 12 and the pipe 23 to the box 24 and thence by way of pipe 29 to a condensing coil 31 in which any oils or waxes are condensed and from which said materials will drain to a collecting tank 32. The tubular shaft 14 has a reduced tubular extension 34 which passes through a box 35 which may be given functions similar to those of the box 24, but which is here shown as devoid of either the supply or condenser connection. Packing glands 30 similar to glands 20 are used, and a swiveled yoke 33 affords means for retracting shaft 14 and head 18.

Before withdrawing the heads 17 and 18 the shell 19 is supported on a cradle 36 carried by the piston rod 37 of a fluid pressure lift 38, which is only diagrammatically illustrated. When so supported, and after the withdrawal of the heads, the platform 36 may be revolved by means, not illustrated, to swing the ends of the shell 19 into recesses formed in the side of the muffle, and indicated in Fig. 2 at 39 and 41.

When the shell is in such position the coke or other solid materials, produced as a result of the distilling operation, may be removed from the shell 19 by the use of a ram or other means.

The shell 19 and the heads 17 and 18 and the shafts 12 and 14 are made of heat resisting alloys, which at the high temperature contemplated, have sufficient mechanical strength to resist the centrifugal or other forces developed. The speed of rotation is quite high.

As a convenient means of driving the sprocket 16, a motor 42 and driving chain 43 are illustrated, but any equivalent means might be substituted.

Where the charge is in liquid form it may be introduced by way of the reservoir 26 and related apparatus, as described. Where granular solid materials or material solid at the temperature of introduction is to be used, it may be inserted in the shell 19 while the heads 17 and 18 are removed. For this purpose the charge may be made up as a cartridge, if necessary. Another way of charging, particularly granular materials, is by removing a plug 40 at the end of extension 23 or 34 and inserting a charging tube (not illustrated) through which the material is forced.

While the use of a shrink fit between the shell 19 and the heads 17 and 18 is preferred, because of its simplicity and ease of manipulation, this feature is not essential to the invention.

In the practice of the process, the minimum speed permissible is that at which the fluent material is distributed in a substantially uniform and relatively thin layer over the entire cylindrical surface of the shell 19. Under such conditions the transfer of heat is favored by the thin layer of material and the consequent minimizing of the heat insulating effect of the material itself. This is important under conditions encountered with granular material which flows sluggishly if at all during rotation, and with viscous liquids and after materials have commenced to set into coke. With liquids which flow readily the rapid rotation sets up convection currents which accelerate heat transfer and produce a very uniform heating effect. Consequently the product from different parts of the still is uniform.

In experiments which have been carried out with the process, it has been found that while 120 R. P. M. was an adequate speed, so far as centrifugal distribution of the charge was concerned, the heat transfer rate could be doubled by raising the speed to 600 R. P. M. Even higher rotative speeds have been used and the best speed to use depends on the material and the dimensions of the still.

There are other important advantages, inherent in the process, when distilling or coking various hydrocarbons. The tendency to foam, which is noted at certain stages of prior processes, and which then requires slow heating to prevent boiling over, is almost completely suppressed. In distilling coals the dust which forms is centrifugally separated from off-flowing gaseous material.

Furthermore where coal is the material undergoing treatment a large yield of oil is obtained, such oil having certain characteristics hereinafter specified.

The oil distillate resulting from the carrying out of the process above outlined will make it evident that the oil distillate has passed through a redistilling process following its formation and preceding its discharge from the apparatus through the conduit 12.

The coal adjacent the retort wall is first heated and coked before the temperature of

the interior of the coal has risen at all or to any appreciable extent. As a result, a considerable portion of the oil distilling from the coal is condensed and runs back to the outer or hot zone where it is again distilled.

Incident to this redistillation there is more or less decomposition of the less stable products. It is of course impossible to state how many times this process or action is repeated but it is obvious that it does take place.

The products of distillation are discharged or pass toward the axis of the retort through the uncoked body of coal; as a consequence the cracking effect is held to a minimum. In this it differs from other processes in which latter the coal distillate is discharged towards and through the most highly heated portion of the body of the coal thus giving rise to the maximum cracking effect. An extreme condition in this regard is present in the common coke oven operation.

A distillation conducted on Indiana coal, using the apparatus herein set forth gave a yield of oil of twenty-five gallons per ton of coal distilled and having a density on the whole distillate of approximately 1.04. This oil distills 60% to 70% up to 360° C., and the oil fraction up to 315° C. contained approximately 50% tar acids.

From one standpoint the oil product we obtain by our process is analogous to the oil obtained by the distillation of the low temperature tar, but on the other hand, due to the special conditions under which the oil is formed and distilled, it differs materially from the low temperature tar oil and is furthermore a primary product.

Where coke is formed, the product is finely grained and of greater mechanical strength than has been secured heretofore. The coke has a cellular structure but with much smaller cells than are found in coke from conventional processes. This gives a finer and more even texture, and the coke on examination clearly evidences the fact that the gas bubbles tending to produce foam were compressed or condensed by the centrifugal forces developed in the charge.

Another noticeable characteristic of the coke shell is that the volatile content is least at the outer and greatest at the inner portions of the shell (with reference to position in the rotary retort) the proportion of volatile content changing progressively between these two limits.

Finally, at the completion of the coking operation, there is a tendency of the annular coke shell to shrink away from the shell 19 of the retort, thus making the removal of the coke from the retort a relatively simple matter. The removal of the coke mass from a fixed still is a very troublesome process so that from a commercial standpoint the feature just mentioned is one of outstanding importance.

No limitation is implied to the use of the apparatus illustrated, as that is shown merely to assist in explaining the invention, and various different or equivalent mechanisms might be substituted.

What is claimed is:

1. The method of distilling and coking a fluent carbonizable material contained in a retort which is subjected externally to the heat of a furnace, and accelerating the transfer of heat from the furnace to the carbonizable material, which comprises continuously rotating the retort at a speed materially in excess of that necessary to distribute the fluent material by centrifugal force in a layer over the interior of the retort whereby foaming of the material is prevented and a dense, fine-grained coke is produced therefrom.

2. The method of coking fluent carbonizable materials contained in a retort, which comprises applying heat externally to the retort and, as a consequence, heating the material therein and at the same time rotating said retort without interruption and at a speed which develops centrifugal force sufficient to distribute the material in a layer over the interior surface of the retort and to a degree sufficient to suppress foaming of the material whereby a dense, fine-grained coke is produced.

In testimony whereof I have signed my name to this specification.

IRA H. DERBY.