

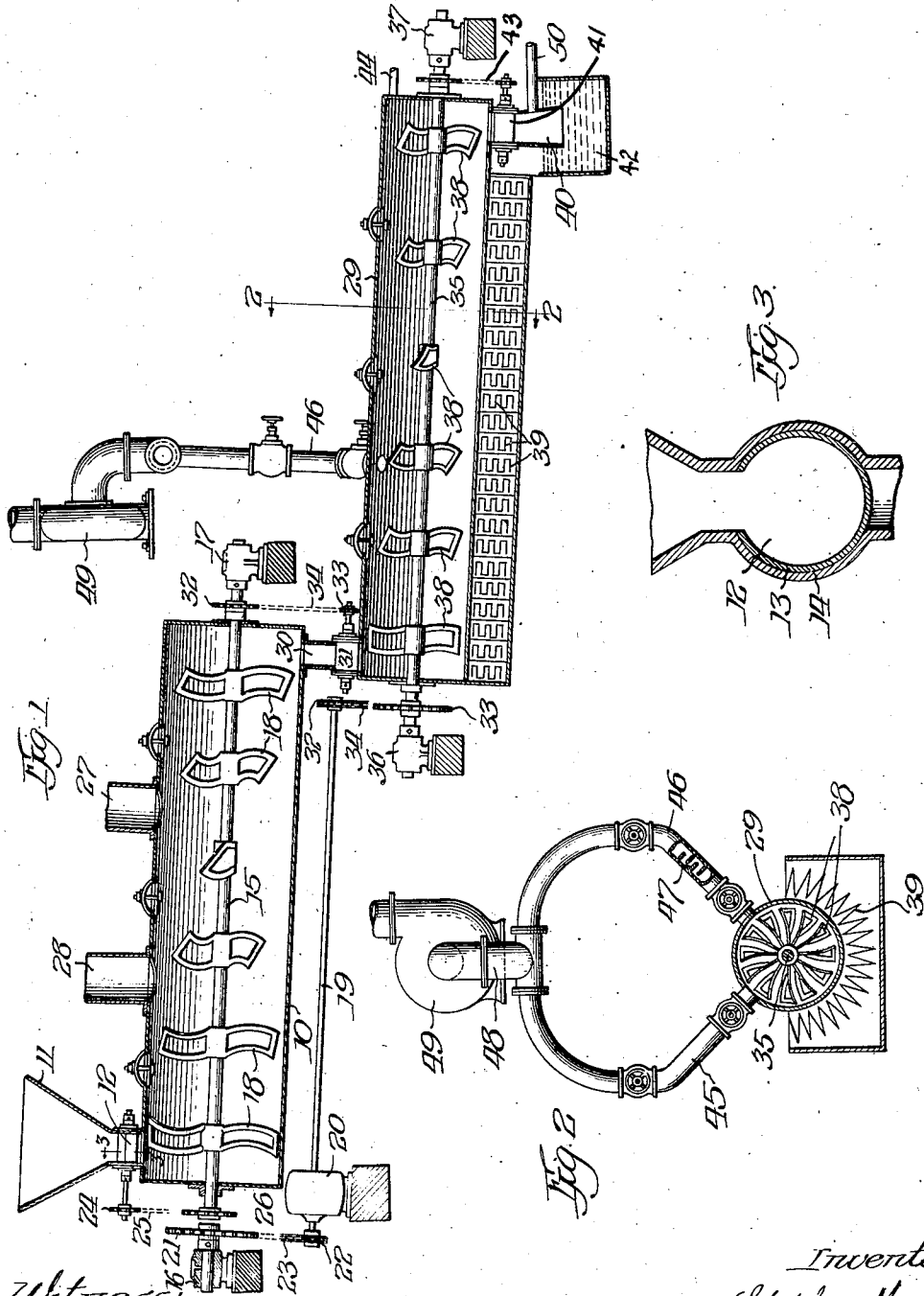
Apr. 10, 1923.

1,451,367

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PROCESS OF TREATING SHALE

Filed Oct. 10, 1921



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Patented Apr. 10, 1923.

1,451,367

UNITED STATES PATENT OFFICE.

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PROCESS OF TREATING SHALE.

Application filed October 10, 1921. Serial No. 506,757.

To all whom it may concern:

Be it known that I, STEPHAN MARKO, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Processes of Treating Shale, of which the following is a specification.

My invention pertains to the production of combustible or illuminating gas by the heat treatment of suitable material such as ground oil-bearing shale.

The main object is the development of such gas from a relatively common mineral and in such a way that the process may be practiced on a commercial scale in an economical and efficient manner.

The process consists of two main steps, first the treatment of the sub-divided shale with dry heat, and then during further heat treatment of the shale subjecting the expelled gas to the action of superheated steam, thereby rendering possible the production of the required gas in an inexpensive and effective way.

To the attainment of these and other desirable purposes, I have invented a novel and valuable process or method based upon the principle indicated above, whereby the combustible gas may be produced both cheaply and by the employment of simple apparatus comparatively easily operated.

In order that those skilled in this art may have a full and complete understanding of a suitable apparatus by which this method or process may be practiced, in the accompanying drawing forming a part of this specification I have illustrated such a structure, and in this drawing like reference characters have been applied to the same parts throughout the several views.

In this drawing:

Figure 1 is a more or less diagrammatical sectional view illustrating a suitable apparatus for the practice of the process;

Figure 2 is a vertical cross-section on line 2-2 of Figure 1; and

Figure 3 is a section illustrating one of the rotary valves.

Referring to this drawing for an understanding of such an appropriate apparatus which may be conveniently employed for the carrying on of the process, it will be observed that this includes a first, inclined, stationary, cylindrical retort or casing 10 heat-insulated by any suitable material, but

this feature of construction has not been shown since it is well understood in the art.

At its top near its upper end such retort is provided with a feed hopper 11 equipped with a rotary valve 12 of ordinary type by means of which charges of the ground oil-bearing shale are fed intermittently to the retort without an escape of gas therefrom.

This valve is shown more in detail in Figure 3 and comprises merely a round valve member 13 revoluble in an enclosing shell 14 having top and bottom openings or ports communicating respectively with the lower part of the hopper and the top of the retort.

Such member or element 13 is so formed or shaped that, during its rotation, while it is receiving a charge from the hopper, it closes the passage into the retort, and, conversely, when, during its rotary movement, it delivers its charge into the retort, it closes the passage or port into the hopper, thus at all times effectively preventing the escape of gas from the retort or shell.

Such cylindrical retort has a central or axial longitudinal shaft 15 extended there-through, being revoluble in external bearings 16 and 17, the shaft inside of the retort having a plurality of agitator or feeder arms or stirrers 18, 18 each of general open skeleton form, curved somewhat forwardly from the shaft, and twisted or canted slightly, whereby to produce an efficient, stirring, lifting and forward feeding action on the ground shale preferably of about one-quarter inch in size. To this end, also, these arms or agitators are arranged spirally or in angularly stepped relation around the axis of the shaft whereby to act in series relation on the material contained in the retort, the latter being about half filled with such ground shale.

Shaft 15 is rotated at the proper speed from a main drive shaft 19, revolved by an electric motor 20 or otherwise, by means of appropriate sprocket wheels 21 and 22 and an associated sprocket chain 23, and the valve 12 is rotated at the required speed by means of an external sprocket wheel 24 on its shaft, coacting with a sprocket chain 25, cooperating with another sprocket wheel 26 on shaft 15, all as is clearly illustrated.

At its top, retort 10 is connected to one or more pipes or flues, in the present instance two 27 and 28, through which the hot, exhaust, dry, combustion gases from a coal or oil or other fuel burning furnace are intro-

duced into the retort to heat the shale contained therein to a temperature of approximately 500 degrees Fahrenheit, any specific portion of the ground shale remaining in such retort and being subjected to the specified heat for a period of an hour, more or less.

The lower end of such inclined retort or casing is connected to the top or upper end of another similar sloping, heat-insulated retort 29 by means of a vertical pipe or connection 30 which may or may not contain a rotary valve 31 like the valve 12, rotated from shaft 15 by sprocket wheels 32 and 33 and a companion sprocket chain 34, all as will be readily understood from the illustration.

The shale continuously traversing the first retort by reason of the inclination of the latter and the feeding action of the revolving elements 18, when it reaches the lower end of such retort is delivered through pipe 30 into the second retort where it is subjected to the action of further heat and to the action of superheated steam.

Such second or lower cylindrical retort or chamber of suitable dimensions is similarly equipped with a central lengthwise shaft 35, revoluble in external bearings 36 and 37 and inside the retort it is equipped with agitators, stirrers, paddles, or feeders 38 like those in the complementary retort, whereby the shale is thoroughly stirred and slowly fed forwardly.

The lower half only of retort 29 is externally heated by a plurality of electrical heating units 39 which unitedly and conjointly encase or enclose the lower half of the cylindrical chamber or retort, such heating elements by any appropriate means being subject to regulation to govern and control their heat producing function and hence the temperature of the retort and its contents.

At its lower end retort 29 is fitted with a discharge pipe or chute 40 equipped with a rotary valve 41 like valve 12, which delivers the spent shale or shale residue into an underlying water chamber 42, the valve being rotated from shaft 35 by a suitable sprocket wheel and chain connection 43, as will be readily understood.

At the top of the lower end of such compartment 29 a pipe 44 delivers superheated steam at approximately two to three pounds pressure into the retort to supply the necessary hydrogen to the gas which by the heat treatment of the oil shale has been driven off or freed from the oil contained in the rock.

The temperature in such second or lower retort is maintained at temperatures in excess of 600 degrees Fahrenheit and the material treated occupies approximately one hour in traversing the chamber.

The illuminating or combustible gas de-

veloped or generated in retort 29, as well as that which enters such retort from the upper one, is discharged or delivered therefrom through two valved pipes 45, 46 provided internally with baffles or barriers 47 to remove dust and dirt from the gas, these pipes uniting in a single pipe 48 connected to a suction appliance, such as a fan 49, which causes the gas to pass through a condenser and scrubber into a gas holder or reservoir ready for consumption or combustion when needed, these latter members or pieces of apparatus being well known in the art and hence not illustrated.

Another pipe 50 is connected to pipe or chute 40 by means of which through a suitable suction device not shown gas may be drawn off for use as fuel for the boiler which produces the superheated steam referred to, or it may be employed for any other suitable purposes.

Thus it will be seen that the reduced or sub-divided oil containing shale is first or preliminarily subjected to dry heat by the introduction of the hot gaseous products of combustion into the first retort and that in the second retort the shale is still further raised in temperature by the heat applied externally to the lower part only of such chamber, the expelled or freed gas derived from the oil content of the shale being charged with hydrogen from the superheated steam.

By thus effecting a substantial heating of the material in an economical manner without the use of steam in direct contact therewith, the presence of an excess of moisture is avoided and the quantity of superheated steam used is substantially lessened.

The salient features of the invention lie in the heating of oil shale with dry combustion gases at temperatures sufficiently high to separate incondensable gas therefrom. These temperatures will vary according to the character of the shale which is treated. In the treatment of Colorado and Utah shale, temperatures from 600 to 900 degrees F. in the second retort are adequate to produce the gas desired. Kentucky shale necessitates temperatures from 1100 to 1300 degrees F., and Indiana shale, which is somewhat more of a slaty character, temperatures in the neighborhood of 1300 degrees F. The shale having been treated by the dry combustion gas in the primary stage of heating during continual agitation by the paddles or mechanical agitators is passed to the secondary retort, which is externally heated by electrical heaters, shown at 39. The shale in the initial zone or retort is raised to temperatures ranging from 400 degrees upwards by the dry combustion gases, while in the second retort or finisher the temperatures will be further increased to produce the desired reaction. The vaporous

oil constituents evolved in the second retort are separated after their removal therefrom into gas and oil distillates while certain by-products contained in the liquors removed with the condensed water vapors are also separated. Although an intermittently operating valve is shown between the retorts, results indicate that the elimination of this valve give as satisfactory results, due to the fact that the vapors can pass more readily where the retorts are in free communication, thus facilitating the reaction taking place in the separate stages.

Also, it is desirable to eliminate any obstruction between the two chambers in order that the vapor conditions in the two retorts may be maintained relatively constant. This secondary retort functions as the distilling chamber, the temperatures being increased relative to the temperatures in the initial stage, and controlled quantities of superheated steam added to supply the necessary hydrogen to the evolved gases. In the treatment of the shale a very limited quantity of steam is necessary to produce the desired effect.

The process is one which lends itself to practice with marked economy and to great commercial advantage for the reasons stated.

The invention is not limited and restricted to the precise and exact details specified because these may be modified within comparatively wide limits without departure from the heart and essence of the invention and without the sacrifice of any of its substantial benefits and advantages. The primary function of the process is to recover the gas, while the liquor and oil distillates occur only as by-products.

Particular reference has been made in

this application to the production of a combustible or illuminating gas, but it is to be borne in mind that the gas generated in passing through the condenser referred to is purified, resulting in the production not only of such gas but also of crude oil and water vapor, from the latter of which sulphate of ammonia may be recovered.

I claim:

1. A process of producing combustible gas from oil-bearing shale, consisting in agitating ground shale in the presence of dry heated gaseous products of combustion at temperatures in excess of 600 degrees F., passing the heated shale and gases to a secondary zone of treatment and there continuously agitating the shale and subjecting it to increased temperatures and adding sufficient quantities of superheated steam to the secondary stage of treatment to increase to a predetermined amount the hydrogen content of the evolved gases, separately withdrawing the gas and shale residue from the secondary stage of treatment.

2. A process of producing combustible gas from oil-bearing shale, consisting in passing ground shale through successive closed retorts connected in series, agitating the shale in the first retort and subjecting it to the treatment of heated, dry gaseous products of combustion, passing the heated shale and gases to a second retort and subjecting the shale to further agitation and increased temperatures to produce increased distillation, supplying sufficient superheated steam to produce a hydrogenating action of the gaseous constituents and withdrawing separately the gaseous products and shale residue from the system.

STEPHAN MARKO.