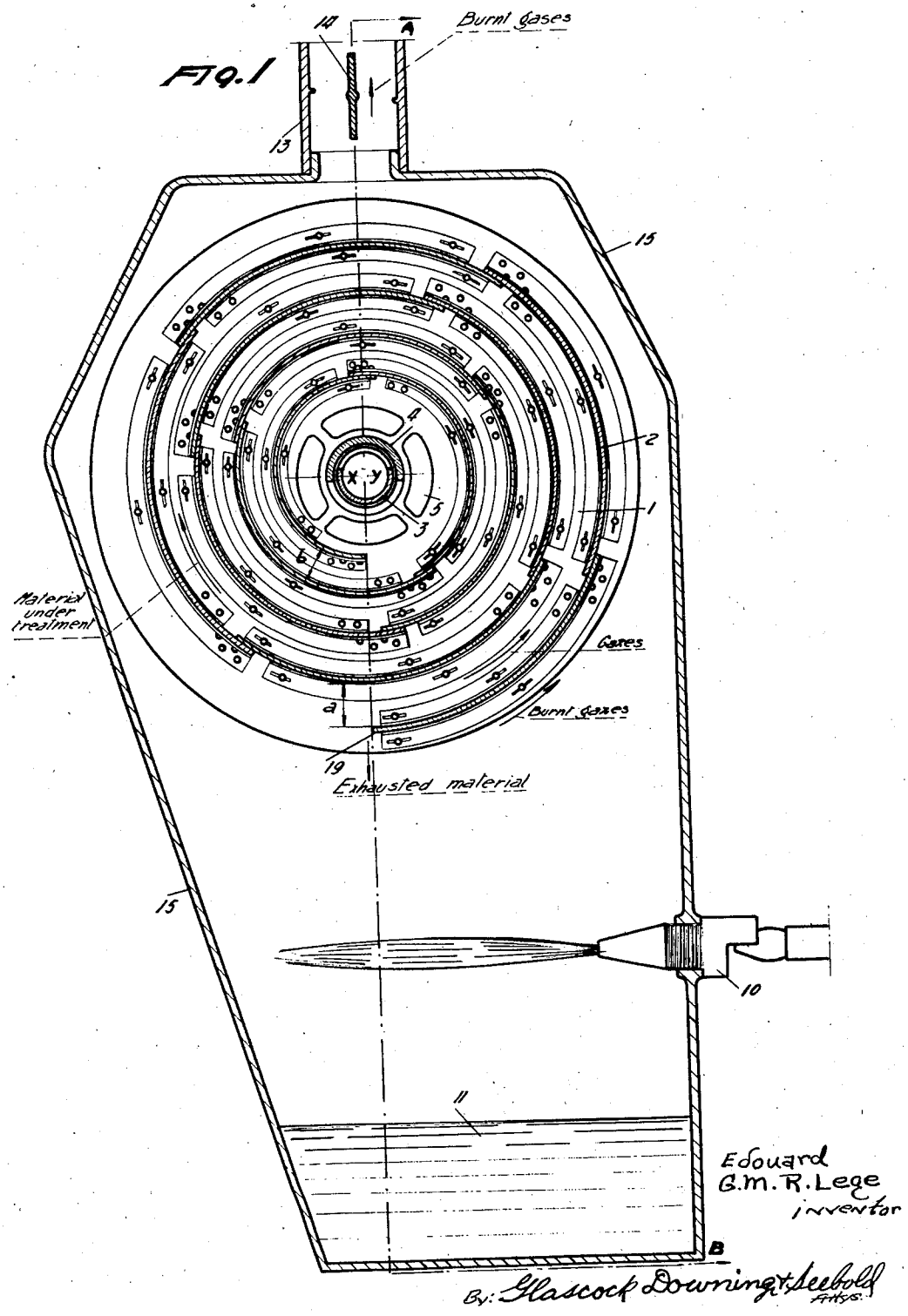
Dec. 6, 1938. E. G. M. R. LEGÉ 2,138,973

CONTINUOUS DISTILLATION FURNACE

Filed March 12, 1936 6 Sheets-Sheet 1

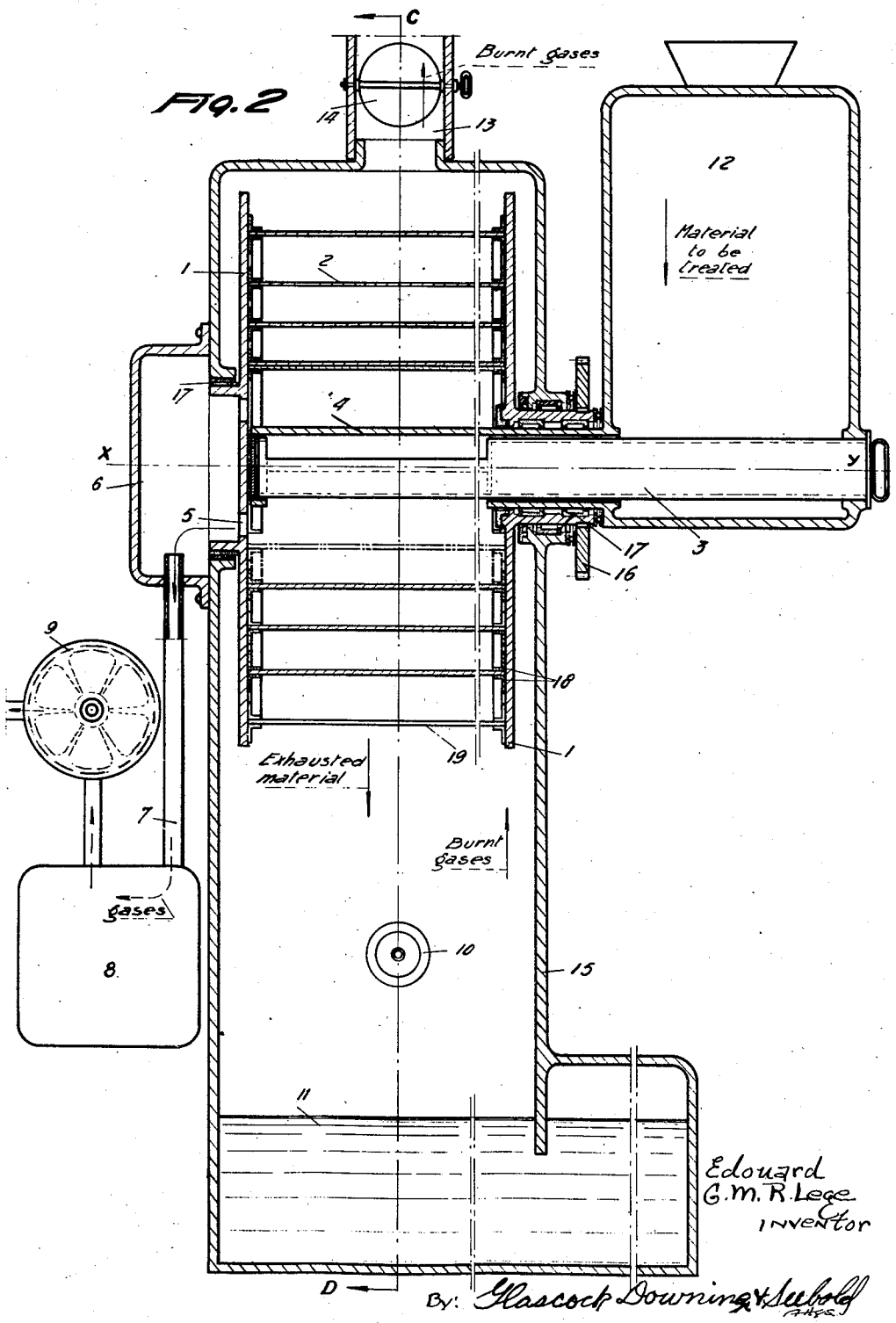


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CONTINUOUS DISTILLATION FURNACE

Filed March 12, 1936 6 Sheets-Sheet 2

FIG. 2



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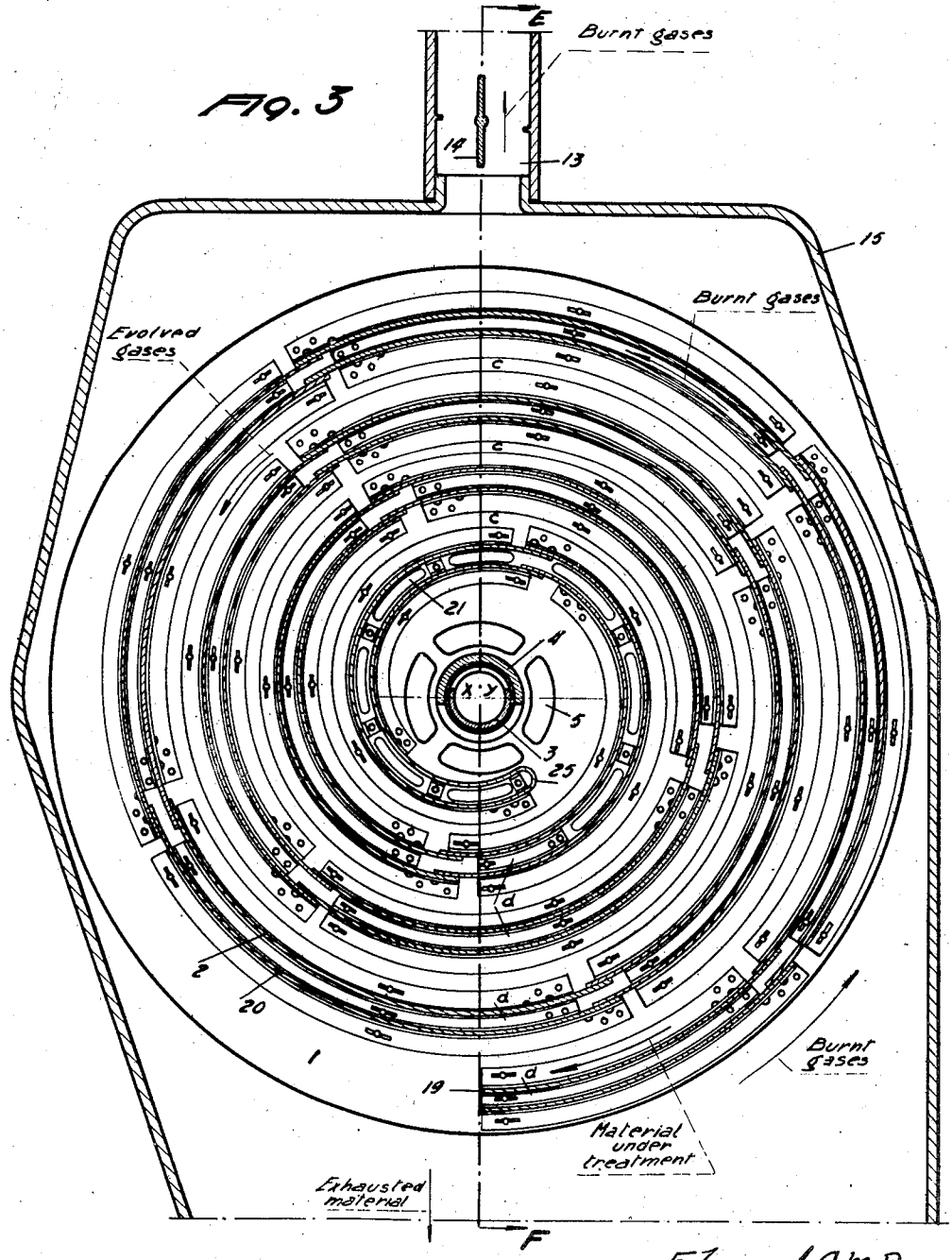
By: Glascock Downing & Seibold
ATTYS

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CONTINUOUS DISTILLATION FURNACE

Filed March 12, 1936 6 Sheets-Sheet 3

Fig. 3



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CONTINUOUS DISTILLATION FURNACE

Filed March 12, 1936 6 Sheets-Sheet 4

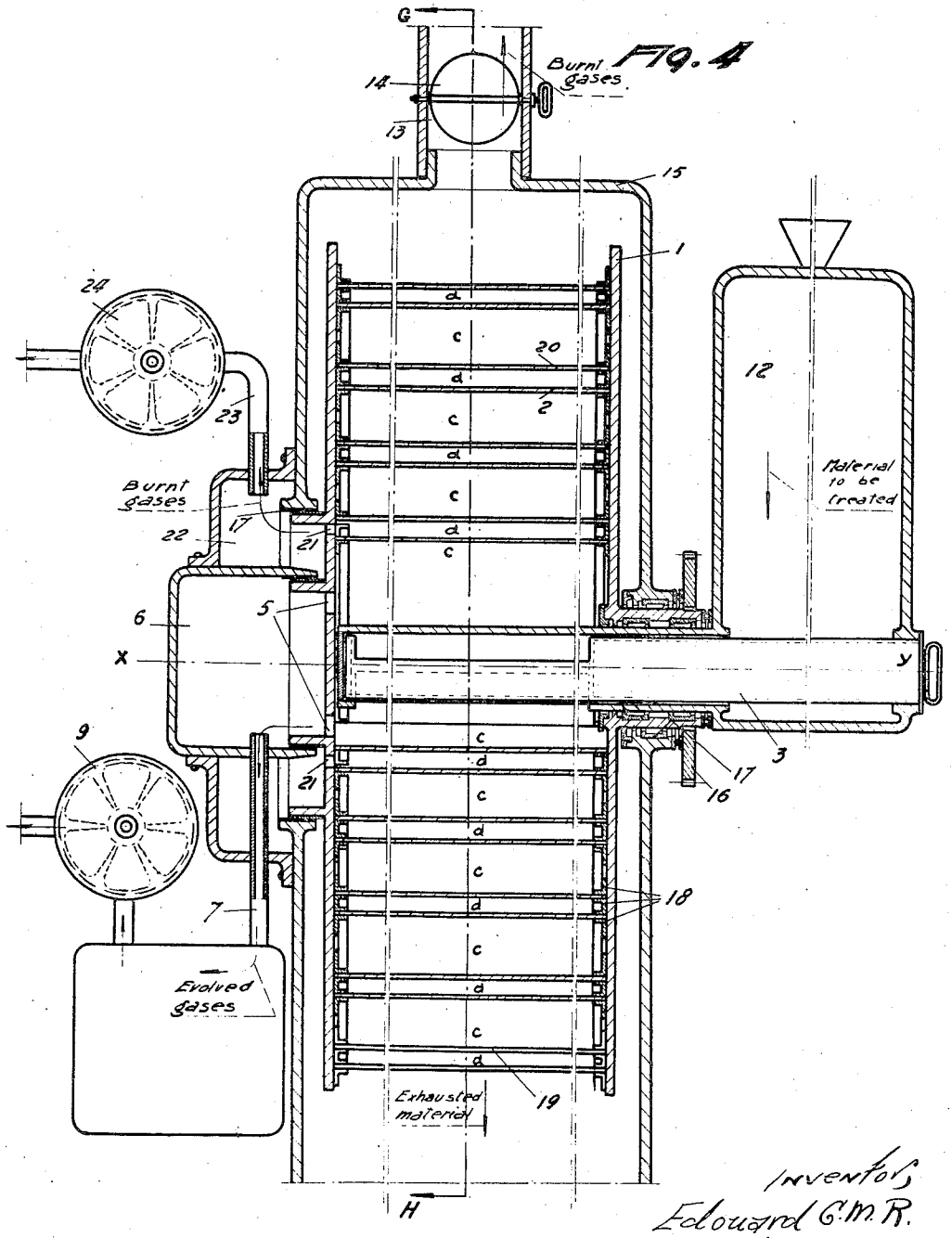


Fig. 4

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CONTINUOUS DISTILLATION FURNACE

Filed March 12, 1936 6 Sheets-Sheet 5

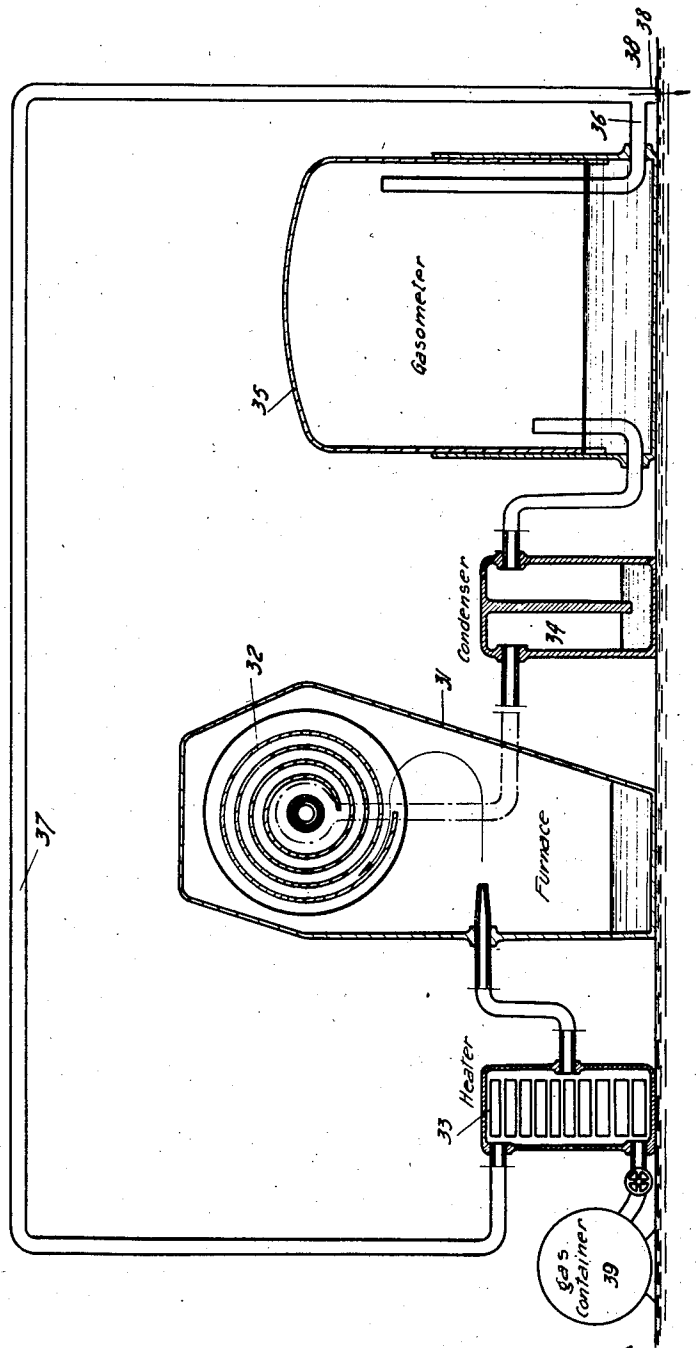


FIG. 5

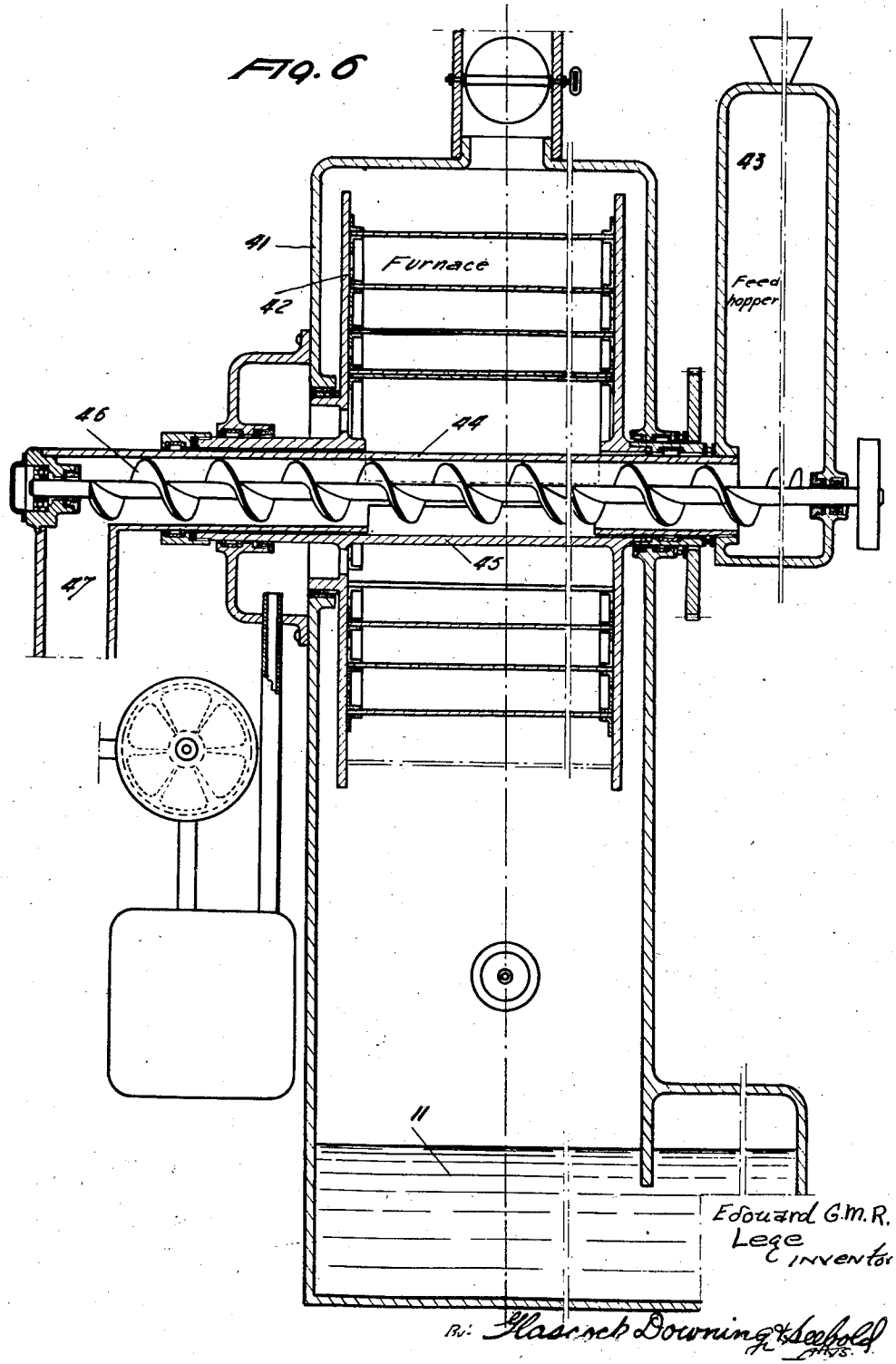
Inventor,
Edouard G.M.R. Lege
by Glascock Downing & Seebold
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Dec. 6, 1938. E. G. M. R. LEGÉ 2,138,973

CONTINUOUS DISTILLATION FURNACE

Filed March 12, 1936 6 Sheets-Sheet 6

FIG. 6



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UNITED STATES PATENT OFFICE

2,138,973

CONTINUOUS DISTILLATION FURNACE

Edouard Georges Marie Romain Legé, Paris, France

Application March 12, 1936, Serial No. 68,528
In France March 19, 1935

3 Claims. (Cl. 202—100)

My invention has for its object the execution of an industrial furnace adapted to perform the continuous distillation of various materials impregnated with liquids or adapted when heated to evolve vapours and gases. Such materials comprise solid raw material such as bitumen, schists, lignites, coal, turf, oleaginous grains and the like containing substances capable of evolving when heated distillable vapours and/or gases or else solid material impregnated with substances adapted when heated to be vaporized or gasified as in the case of sand impregnated with mineral oils, coke soaked with oil, etc.

My invention affords means in particular for producing the cracking or second distillation of certain liquids such as used lubricating oils, gas oils and fuel oils forming the residue of the distillation of petroleum oils etc., said liquids forming the impregnating material for suitable supports which after cracking remain loaded with the impurities and the cracking by-products which it is desired to eliminate.

The furnace according to my invention also provides means for continuously distilling raw petroleum and the like liquid materials.

It is well known that petroleum, schists, lignites, coal and the like when heated under certain conditions evolve vapours which it is possible to condense and combustible gases. The yield of oil and gases depends on the contents of organic matter in the material treated, on the temperature of treatment, on the manner of conducting the operations and on the nature of the walls of the still used. I have also found that for increasing the yield in the distillation of carbonaceous material, it is necessary to satisfy a system of cooperating conditions. My improved furnace is designed so as to afford a particularly high yield of desirable products through distillation.

This furnace is chiefly constituted by a part forming a spiral-shaped channel adapted to rotate inside a closed space round the axis of the channel passing through the centre of the spiral so as to ensure the progressive advance through the channel of the material to be treated, which material is submitted during its advance to the action of heat or of suitable gases.

I have illustrated in accompanying drawings two forms of execution of my furnace together with improved means for heating and for feeding same.

Figs. 1 and 2 are vertical diagrammatical cross-sectional views of a first form of execution.

Figs. 3 and 4 are similar views of a modification.

Figs. 5 and 6 are diagrammatical views of the improved heating and feeding means respectively for the furnace according to my invention.

Returning to Fig. 1, it is apparent that the furnace comprises a main part chiefly constituted by one or more metal sheets 2 spirally wound round the axis XY. The pitch of the spiral is chosen according to the intended use of the furnace which may be the distillation of any of the above mentioned materials, schists, lignites, coal, turf, oleaginous grains, etc. or the cracking of petroleum residues etc. The pitch is designed in a manner such as to provide at the different points of the flow of gases and vapours between *a* and *b* a gradually increasing speed due to the gradual restriction of the width of the channel.

The sheets of the spiral are rigidly or removably attached through their edges to two parallel metal walls 1 adapted to rotate inside the drums 17 carrying them.

The coils 2 constituted by smooth corrugated or suitable shaped metal sheets, are inserted between the angle bars 18 which follow the curvature of the spiral of the desired pitch. The sheets are secured at one edge only to the walls 1 so as to be capable of freely expanding both laterally and longitudinally. The bars 18 are rigidly secured to the walls 1.

The nature of the metal forming the coil sheets may vary from the centre to the periphery of the spiral in accordance with requirements. For instance at the outlet of the vapours and gases at *b* (at which the material to be treated enters the furnace) the sheets are preferably of aluminium, magnesium, nickel, copper or an alloy thereof. Further on in the direction of advance of the material under treatment, nickel sheets are preferable; at the outlet *a* for the treated and exhausted material, steel sheets are used. This sequence is given solely by way of example. The nature of the metal used depends on the material treated and the temperatures required.

A general casing 15 enclosing the spiral-shaped furnace ends at its lower part as a funnel 11 closed by an hydraulic joint which also serves for extinguishing the exhausted material.

A row of burners 10 fed with gas, gas oil, crude petroleum, distillate residue, pulverized coal or the like, heat the sheets or coils 2 either directly or indirectly through protecting means.

The burnt gases pass out partly through the channel forming the furnace where they pass over the material under treatment and carry along with them the vapours and gases evolved and partly through the space inside the drum 17 and out-

side the spiral furnace and thence into the stack 13 where they may preheat the material before it undergoes treatment or any device adapted to recover the heat carried away by the burnt gases.

Ventilating means 9 are provided in the passage 7 through which the vapours and gases are removed with part of the burnt gases. A similar device or a suitable output regulator 14 is provided in the outlet for the burnt gases. These two devices are adjusted in a manner such that their throughput may correspond to the distribution of the hot gases inside and outside the spiral furnace according the desired proportions.

The material to be treated is loaded either by means of a charging box shown diagrammatically at 3 or by a screw conveyor of which an improved form is shown in Fig. 6 and described hereinafter. The charging box engages a cylindrical casing 4 inside the furnace the underside of which is provided with a discharge aperture. A feed hopper 12 feeds the open end of the charging box in the usual manner when said box is in its outermost position after which the box is pushed back into the position shown and then revolved through 180° so as to empty its contents, through the discharge aperture in the casing 4, on to the coil underneath said aperture.

A driving sprocket wheel 16 provides means for rotating the furnace in the desired direction and at the desired speed around the axis XY.

A receiving box 6 collects the vapours and gases passing out of the inner end of the spiral furnace through the apertures 5 provided in one of the walls 1.

In the outlet passage 7 for the vapours and gases are inserted condensing, washing, dust-removing and the like means 8 behind the fan 9.

The oils, gases and raw material are stocked in suitable containers and the exhausted raw material is removed through the hydraulically closed funnel 11. Obviously the furnace is complete with all required auxiliary devices such as pyrometers, gates, gears, transmissions, motors, containers, boilers and the like.

The operation of the furnace is as follows: The previously crushed raw material, pulverized or not, impregnated as required with water, organic material, oil or solvents, is introduced in the feed hopper 12. It falls in the charging box which periodically or continuously enters it in the spiral furnace through the inner end thereof.

The raw material, when in the furnace, falls from one coil on to the next at each revolution of the furnace, while it rolls and slips over the metal sheets over which it forms a thin layer. This fall ends when the material is fully exhausted and passes eventually through the flames of the burner 10, out of the furnace at *a* into the hydraulic joint 11.

The spiral furnace is heated to the required temperature before the raw material is fed into it by the burner line 10 fed preferably with gas, gas oil or crude oil.

The burnt gases are directed as stated partly towards the exhaust stack 13 and partly towards the fan 9 through the furnace where it carries along with it the evolved vapours and gases and where it may react eventually on the material undergoing transformation. The burnt gases and the distilled vapours and gases pass out of the spiral furnace through the annular series of ports 5, the receiver 6 and the outlet passage 7—8.

The ratio between the gas inlet section *a* and the gas outlet section *b* is as stated equal to the ratio between the desired speeds of the aeriform fluids at these two points, account being made for the differences in temperature and for the amounts of gases and vapours evolved between these two points.

As the raw material passes down through the spiral furnace it may be submitted to the action of steam adapted to react on the carbonaceous material at the point considered so as to form producer gas by exhausting said carbonaceous material more or less completely.

The aeriform heating fluid passing through the spiral furnace and that evolved by the heated material introduced therein together with the steam fed to the furnace or produced by the hydraulic joint 11 under the action of the hot material falling into it, pass out through the ring-shaped series of ports 5 under the action of the fan 9 towards the described outlet 7—8 including refining and stocking means.

The gases issuing through the stack 13 through the regulator may if desired pass through steam or raw material preheaters as described.

The number of coils of the furnace is determined by the speed of fall required for the material in the furnace under treatment for a given speed of rotation of the furnace. This material as described progresses gradually from the centre to the periphery and falls out at the end 19 of the spiral into the hydraulic joint 11.

It should be noted that the raw material as it passes continuously through the spiral furnace becomes gradually hotter until it falls into the hydraulic joint. The raw material may be soaked with water, organic material, oils or solvents which may be recovered at the outlet. The shaped or corrugated sheets of metal of a nature varying from one end to the other of the furnace show an increased resistance to flexion and further provides an energetic stirring of the pulverulent material, as compared with smooth sheets. The raw material is constantly heated, on one hand by the metal sheets and on the other by the hot gases and the steam sucked out by the fan 9.

The speed of passage of the gases and vapours may be adjusted by suitably choosing the pitch of the spiral and the suction exerted by the fan 9 and the regulator 14. This speed may in particular be greatly accelerated at the moment of the evolving of the oil vapours in order to remove them as soon as they are formed from the action of cracking catalysts such as iron oxide and the like.

Steam introduced as stated directly or formed by the burning of the heating media or by the evaporation of the water of the hydraulic joint may react on the carbonaceous material resisting distillation and produce thus hydrogen adapted to hydrogenate the oils at the moment of their formation.

The heating may be adjusted so as to provide at all points of the spiral furnace the desired temperature with a view to adjusting the distillation process. The amount of gases burnt is adjusted by adjustment of the burners 10 and the proportion of gases passing through the stack 13 and the furnace itself is adjusted by means of the fan 9 and regulator 14.

It is thus possible to suitably adjust:

(*a*) The temperature at all points,

(*b*) The speed of feed of the raw material through the loading means 3,

(*c*) The speed of the gases and vapours at all points,

(*d*) The amount of material used for soaking the raw material,

(*e*) The amount of steam introduced into the furnace.

It may be noted that it is possible by providing a suitable number of coils and a suitable speed of rotation therefor to obtain the desired speed of fall for the raw material through the furnace.

This furnace, which is very compact, has all the advantages and none of the drawbacks of the horizontal rotary furnaces. It is applicable to all distillation and heating purposes provided the maximum temperature applied at any point is not high enough to be detrimental to the proper preservation of the metal sheets employed. As stated it may be used for the continuous cracking of oils previously admixed with suitable supporting material.

In case it is desired to prevent the material undergoing distillation and the distillates thereof from contacting with the burnt gases in the rotary part of the furnace, I may use the modification shown in Figs. 3 and 4 which differs as follows from the furnace first described.

The rotary part of the furnace comprises two spiral surfaces **2** and **20** wound concentrically round the axis XY and dividing the space between the two walls **1** into two separate compartments. The first compartment comprises spaces *c* through which the material to be treated moves as it falls from the centre to the periphery of the furnace. The second compartment comprises the spaces *d* through which the burnt gases are to flow, said gases used for heating moving from the periphery towards the centre.

The coils **2** serve as a sliding and rolling surface for the material under treatment and are constituted by smooth, corrugated or shaped sheets of suitably chosen metals. The coils **20** inserted between the coils **2** are preferably smooth and made of metals satisfying at each point the requirements of the desired distillation.

The spiral surfaces **2** and **20** are interconnected at their central extremity **25** so as to separate the succession of spaces *d* from the succession of spaces *c*.

At its centre one of the walls **1** is provided with apertures **21** which set in communication the central extremity of the spaces *d* considered as a whole with a receiver **22** for the burnt gases passing through said spaces *d*, said receiver communicating with the fan **24** through the pipe **23**.

On the other hand the spaces *c* communicate through the apertures **5** with the receiver **6** in which the distilled vapours and gases collect. The receiver **6** communicates in its turn with the fan **9** through the pipe **7** and the condensing, purifying and the like apparatuses at **8**.

The operation of this modified furnace is as follows: The raw material from the feed hopper **12** is sent into the furnace through the loading means **3** and moves through the spiral furnace in the direction of the arrow, falling from one coil **2** on to the next until it falls at **19** into the hydraulic joint **11**.

The burnt gases are directed partly towards the stack **13** where the throughput is adjusted by suitable means **14** and partly through the spaces *d* of the spiral furnace, the apertures **21**, the receiver **22**, the pipe **23** and the fan **24**.

Obviously it is possible by suitably adjusting the fans **9** and **24** and the regulator **14** to distribute as desired the burnt gases through the three exits provided, to wit: outside the spiral towards the stack **13**, inside the spiral towards the spaces *d* and inside the spiral towards the spaces *c*. It is possible in fact, to substantially prevent the burnt gases from passing through the spaces *c* in which the distillation of the material undergoing treatment is performed so that there may be no contact between the distillate and the burnt gases used for heating the furnace.

The heating of either type of furnace may be performed in a manner different from that described hereinabove. Fig. 5 shows how this may be executed by using gases produced by the distillation or other gases, said gases being brought to the desired temperature outside the furnace unit and being caused to circulate through the latter. All or part of these gases, freed if required of all condensable products of the distillation may be returned afterwards to the heating apparatus.

The arrangement shown in Fig. 5 comprises the furnace unit **31** which is hermetically closed and suitably heat insulated. It contains the rotary spiral sheet system **32** forming the furnace proper.

To the front of the furnace is the heating apparatus **33** of any suitable type; for instance as shown diagrammatically it may comprise a system of tubes heated in any suitable manner. It may comprise in particular refractory brick apparatuses which are in alternation heated through direct combustion and cooled by the gases to be heated.

At the outlet from the furnace unit are provided condensing apparatuses **34** provided with means for separating the non-condensable vapours and gases. These apparatuses are followed by a gasometer **35** adapted to collect the gases the exit of which is through the pipe **36**. The gaseous current is then subdivided. Part returns through the pipe **37** to the heating apparatus through the tubes of which it passes so as to reenter the cycle of operations; the other portion of the gaseous current from the gasometer passes into the pipe **38** and may be used for instance for heating the heating apparatus **33**.

The operation is as follows: At the beginning, the gases used are those provided by a container **39** and which may be producer gas or water gas. These gases are superheated in the heating apparatus **33** to the desired temperature. They then initiate the distillation of the material to be treated in the rotary spiral furnace **32**. Henceforward the gases produced by the distillation in the furnace serve in lieu of the gases from the container **39** for circulating heat inside the system **34—35—36—37—33—32**. The gases and vapours produced by distillation inside the furnace **31** pass out of it along the axis of rotation of the spiral furnace **32** and enter the condensing apparatuses **34** where the condensable vapours remaining in said apparatuses are separated from the gases which continue their way into the gasometer **35**. Part of these gases removed through pipe **38** may be used for heating purposes. The remaining gases passing through the pipe **37** return to the heating apparatus **33** and after being heated therein to the furnace unit **31**. The hot gases pass through the spiral furnace **32** in which they cause the distillation of the material contained in said furnace. Thus a closed circulation system is established for the gases.

This arrangement shows the advantage of returning into the cycle of operations the distillation gases which give a lighter character to the heavy fractions obtained through distillation. These circulating gases retain thus a substantial-

ly constant composition and it is thus no longer necessary to make a large amount of burnt gases pass through the furnace and considerably dilute the distilled vapours therein thus requiring the use of cumbersome and costly condensation apparatuses. Moreover, the burnt gases are liable to cause chemical or physical disturbances in the distilled vapours.

I will now describe the improved feed means shown in Fig. 6 for ensuring a perfectly regular and constant feed of material into the furnace. In this figure the feed hopper **43** is connected with a tube **44** passing throughout the furnace unit shown diagrammatically at **41**, along the axis of the rotary part **42** of said furnace. Inside the furnace unit, the tube **44** is provided on its underside with an aperture adapted to be periodically closed and uncovered by a movable shutter **45** adapted to be angularly or longitudinally shifted by any suitable known means which have not been shown for sake of clearness on the drawings. A conveyor screw **46** is arranged inside the tube **44** so as to pass throughout the breadth of the furnace.

The speed of rotation of the conveyor screw **46** is adjusted so as to ensure its complete filling with a slight excess during the intervals separating two periods of uncovering by the shutter **45** of the aperture in the tube **44**. Consequently at each uncovering of the slot, a perfectly constant amount of uniformly distributed material falls into the spiral furnace. The excess material passes out through **47** and may be returned to the feed hopper **43**. This arrangement is greatly superior to the usual conveyor screws adapted to feed through their extremity and which are thus almost incapable of providing a correct and regular feed, said feed being either adjusted too small and not providing the required efficiency or adjusted too large which leads to a clogging of the ducts.

What I claim is:

1. A furnace for the continuous distillation of solid distillable material comprising a casing, two vertical parallel metal walls supported in and by said casing and adapted to rotate round a horizontal axis, at least one metal sheet being spirally wound round said axis with the edges thereof attached to said walls to form with said walls a spiral shaped channel, means in the casing for producing hot gases heating said channel, means for feeding distillable material into the central extremity of said channel, and separate means for removing the distilled gases out of the central extremity of said channel.

2. A furnace for the continuous distillation of solid distillable material comprising a casing, two vertical parallel metal walls supported in and by said casing and adapted to rotate round a horizontal axis, two metal sheets spirally wound round said axis with the edges thereof attached to said walls to form with said walls two adjacent spiral channels, means in the casing for producing hot gases heating said channels, means for feeding distillable material into the central extremity of the first of said channels, separate means for removing the distillation gases out of the central extremity of said first channel, and separate means for removing the gases out of the central extremity of the second channel.

3. A furnace for the continuous distillation of solid distillable material comprising a casing, two vertical parallel metal walls supported in and by said casing and adapted to rotate round a horizontal axis, at least one metal sheet being spirally wound round said axis with the edges thereof attached to said walls to form with said walls a spiral shaped channel, a horizontal tube passing through the casing along the central axis of the channel and provided with a lower aperture in front of the inner end of the channel, a conveyor screw inside said tube passing over said aperture, means for periodically closing said aperture, and separate means for removing the distilled gases out of the central extremity of the channel.

EDOUARD GEORGES MARIE ROMAIN LEGÉ.