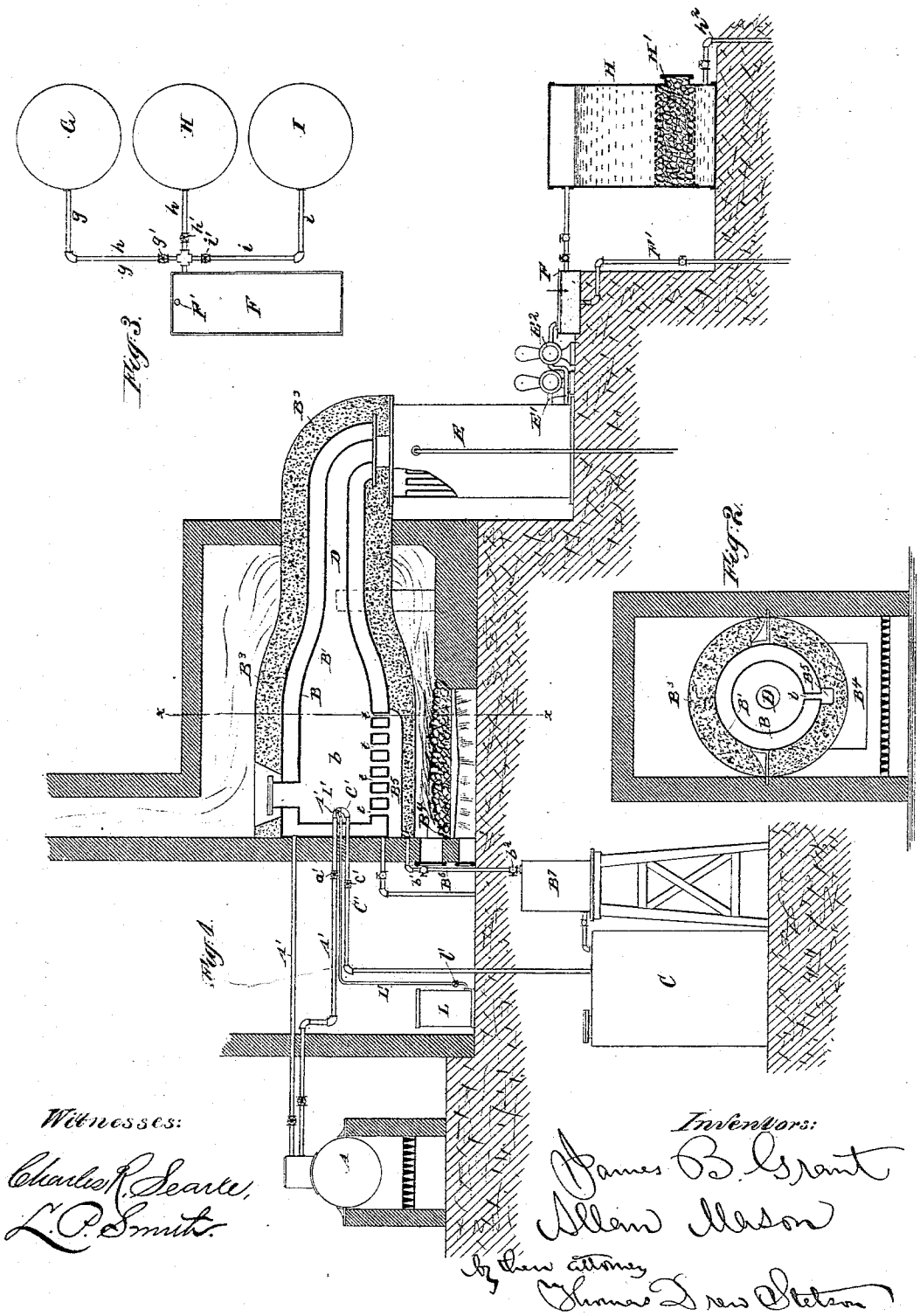
(No Model.)

J. B. GRANT & A. MASON.

APPARATUS FOR REFINING OIL.

No. 339,546. Patented Apr. 6, 1886.



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UNITED STATES PATENT OFFICE.

JAMES B. GRANT, OF NEW YORK, AND ALLAN MASON, OF BROOKLYN, N. Y.

APPARATUS FOR REFINING OIL.

SPECIFICATION forming part of Letters Patent No. 339,546, dated April 6, 1886.

Application filed August 13, 1885. Serial No. 174,270. (No model.)

To all whom it may concern:

Be it known that we, JAMES B. GRANT, of the city and county of New York, in the State of New York, and ALLAN MASON, of Brooklyn, Kings county, in the State of New York, have invented certain new and useful Improvements in Apparatus for Refining Oils, of which the following is a specification.

We have discovered that oils, whether mineral, vegetable, or animal, whether in their crude form or partially refined, or separated by other processes, may, by rapid and violent agitation in the presence of the vapor of water with alkali or acid in a diffused condition, with sufficient heat uniformly applied and subsequent rapid condensation, and filtering through acid or alkali, be refined or manufactured into one practically uniform grade of oil. In the case of oils commonly known as "hydrocarbon" it proves to be an oil of high fire-test, suitable for illuminating purposes. In the case of vegetable or animal oils it proves to be a refined oil of superior quality, suitable for all the purposes to which such oils are usually applied.

We will describe our invention as applied to that class of hydrocarbon oils commonly known as "petroleum." We receive the petroleum into a vacuum-retort and meet it upon its reception therein with a stream of live steam under sufficient pressure to thoroughly mix the vapor of water with the oil, and instantaneously force the whole mass into a vacuum-condenser arranged to receive it, from whence it is pumped or allowed to flow into a tank.

We have discovered and demonstrated that the receiving of the petroleum into the vacuum-retort and striking it with such force with the vapor of water (thus rapidly atomizing and evaporating the entire mass) without separating into any of its elements and subsequently condensing it and separating it from the water, the water retains the impurities and undesirable portions of the oil, leaving us the product described and desired. We obtain a much higher percentage than usual of the grade of oil most desired. In fact, when no accident occurs and everything works properly, we convert all the crude product, except the undesired portion extracted from it by the force and the vapor of water, and such chemical action as occurs in the interim, into illuminating-oil of a high fire-test.

We have made provision for accidents and irregularities, which will be described hereinafter.

The evaporation of the petroleum is effected by uniform steam-heating, and also by mingling steam intimately with the petroleum, accompanied by violent mechanical action. The steam is employed in its natural state, by which we mean not superheated. (The temperature will be from 212° to 300° Fahrenheit.) The entire vaporous mass, composed of water and petroleum, is instantaneously forced into a surface-condenser, where it comes in contact with metallic surfaces kept at a low temperature by a liberal flow of water between the pipes or other elements of which the condenser is composed. We present the steam to the petroleum in the form of a jet having such force and being so presented to a properly-shaped nozzle that it will draw up the petroleum from a level a little below. Such devices have been long known for atomizing perfumery. Such have been applied in various stages in the treatment of oils for producing vapors, but always for the purpose of destructive or more or less fractional distillation.

To prevent discoloration, it is necessary, as usual, to treat the oil with acid and alkali. We provide an additional nozzle in close proximity to the others, through which acid or alkali is supplied to the oil and steam in a highly diffused condition. The liquid is drawn up by the force of the injector and mingles intimately with the mixed vapor of oil and steam. We have no deposit of oil in the retort. The oil enters in a continuous stream, and is immediately passed into the condenser. It is not allowed to rest, to be vaporized, separated, or otherwise treated, as with the usual processes. We do not decompose the oil.

The accompanying drawings form a part of this specification, and represent what we consider the best means of carrying out the invention.

Figure 1 is a general longitudinal section of the entire apparatus, partly in elevation. Fig. 2 is a cross-section on the line *x x* in Fig. 1. Fig. 3 is a plan view of a portion.

Referring to the drawings, A is a steam-boiler, from the dome of which steam is led at high pressure into a jacket or space between the shells B B′ of an evaporating and atomizing chamber or retort, *b*, which is surrounded by a body of sand, B^3, serving to preserve and equally distribute the temperature. Heat produced by fire in a furnace or chamber, B^4, below aids to prepare the temperature in the retort *b* and to maintain the temperature of the steam in the jacket, notwithstanding the great consumption thereof due to the rapid evaporation of the material going on in the interior of the retort. A steam-pipe, A′, conducts ordinary saturated steam at high pressure from the boiler A to what we term a "triple injector," a device located within the evaporating chamber or retort *b*. The construction and arrangement of the triple injector is such that by means of a pipe, C′, leading upward from a tank, C, containing the oil to be refined, and a pipe, L′, also leading upward from the tank L, containing acid, (pure or more or less diluted,) it will, by the action of the strong blast of steam escaping from the pipe, draw up the oil and sulphuric acid together and mingle them with the steam. At the same time the oil and acid are struck with such force by the steam escaping through the pipe A′ that they are thoroughly commingled and the acid so impinged upon the globules of oil as to do its work effectually and promptly. The intimate mingling with the saturated steam also has a good effect. It washes and cleanses the oil.

The force with which the oil and acid are struck by steam, and the continual escape of the steam from the pipe A′ under such high pressure, together with the effect of maintaining a vacuum in the retort *b*, blows and carries the oil, acid, and steam immediately into the neck D of the retort *b* and into the condenser E, with the exception of any particles which may, through any irregularity, or from the action of the acid or alkali, or density of the oil, or the presence of foreign non-volatile matter, drip down the sides of the retort through the small orifices *t t t* into the pocket B^5, where it is allowed to run at intervals through the pipe B^6 into the tank B^7. When this operation is performed, the cock *b′*, which has been opened to allow the material to run down the pipe B^6 as far as the cock b^2, is closed and the cock b^2 opened, which allows the contents of the pocket B^5 to pass off with very slight disturbance of the vacuum, which is instantly overcome and removed when the cock b^2 is closed and the cock *b′* opened, and the pumps E^2 have been worked for a few moments. All the remainder of the mass, consisting of oil, sulphuric acid, and vapor of water, is, by the force of the steam combined with the action of the pump E^2, and aided by a nearly complete vacuum in the retort, carried instantly over into the neck D and condenser E.

Our retort is tapered, as shown, from the body *b* to the neck D, so as to offer no resistance to the rapid transfer of the mingled steam, oil, and acid, and to aid in preventing any tendency to premature condensation in the retort which would be liable to occur if the passage were irregular or angular and not directly opposite the injector and in line with the direction of the flow.

The condenser E may be of any suitable style or form adapted to the ends in view. We at present use "Lighthall's," which has vertical tubes, the material being conducted through the interior of the tubes by the vacuum and the constant suction, a liberal flow of cold water being circulated in the intermediate spaces.

In the condenser E the vaporized portion of the mass is condensed, and the entire liquid mass, consisting of oil, acid, and water, flows from the bottom of the several pipes and is drawn through a pipe, E′, by an air-pump, E^2, operated by a steam-engine or other suitable power. The liquid, being thus forced from the vacuum-retort and condenser, is discharged into a trough or long tank, F, in which it is allowed to separate. The water is drawn out through a pipe, F′, and need be further referred to. The oil is drawn out from a proper level in the tank F, through one of a series of pipes, *g h i*, into corresponding tanks or receptacles, G H I, the selection being controlled by an attendant, who operates controlling-cocks *g′ h′ i′*, according to the density of the liquid. Under the best conditions the liquid will contain, first, water resulting from the condensation of the steam, and a portion of the acid holding in suspense much of the impurities, which will easily separate at any subsequent stage by gravity on allowing the liquid to rest; and, second, a practically uniform grade of refined petroleum for illuminating purposes. The condition in this respect is indicated by a hydrometer, which is applied in the ordinary or any suitable way to determine the gravity of the liquid. Whenever the liquid is too dense for a good illuminating-oil, the attendant operates the cocks *h′ g′* and discharges it through the pipe *g* into the tank G. Whenever the opposite conditions obtains and the liquid is too light for a proper illuminating-oil, the attendant opens the cock *i′* and discharges it through the pipe *i* into the tank I, excluding it from the other pipes, *h g*, and tanks H G; but if no accident or irregularity occurs in the process, the oil will be all illuminating-oil of the required density and fire-test, and will only be discharged into the tank H.

Tanks G I are a provision for irregularity or accident. When an accident or irregularity does occur to necessitate the oil being conveyed into the tank G or I, then the product in these tanks is returned to the tank C, and the process repeated until the desired product is obtained.

The tank H differs from the tanks G and I. It contains a filter, H′, of lime or other alkali

in the form of small lumps or granules confined in place between sheets of wire-gauze or perforated sheet metal. All traces of acid and other impurities are removed from the oil in its passage through the filter, and the oil is then drawn away through the pipe h^2, and either with or without further filtering is ready for storage and use.

This air-pump insures the maintenance of the vacuum in the retort. It will be noticed that there is no air admitted to the retort except the small quantity contained in the pipe B between the cocks b' and b^2, which enters when the pocket B^5 is emptied. The condensation of the steam in the condenser E aids the air-pump in maintaining the vacuum.

We prefer that the pressure in the boiler A and in the jacket B B′ shall be about two hundred and fifty pounds per square inch. A cock, a', in the pipe A′, operated to control the discharge of steam into the chamber b, may considerably lower the pressure at the points of discharge, while still leaving a sufficient force to act with the violence required in impinging against the particles of the petroleum, and mechanically disintegrating the latter and driving them instaneously into the condenser E. The flow of petroleum through the pipe C is controlled by the cock c'. The flow of the acid through the pipe L′ is controlled by a cock, l'.

The fire in the furnace may be maintained by coal or other ordinary fuel, or by crude petroleum applied by any desirable or economical means. The cold water may be circulated in the condenser by a pump or other ordinary or suitable means. (Not represented.)

On the admission of steam through the injector it meets the oil and acid in the retort described *in vacuo*. The force of the steam striking the globules of the oil, together with the peculiar effect due to its being *in vacuo*, breaks them up completely. It further intimately mixes the oil and acid with the vapor of water. The form of this injector is such that the oil and acid are impinged upon the steam passing through the upper nozzle, and the steam meeting it at that point under pressure incorporates itself in such a manner with the volatile portion of the oil as to wash and cleanse it without separating it in any way, as where destructive distillation or superheated steam is used. It amalgamates the whole mass of vaporized oil and water. No separation of the component elements of either occurs.

By the above means, together with the rapid condensation which follows, we produce one oil. Usually, and always when no accident occurs, an illuminating-oil is produced of a marketable fire-test, and a larger percentage thereof than is obtained by destructive or fractional distillation or by the use of superheated steam. The acid introduced through the nozzle L′ at the same time performs the important function of cutting out the undesirable portion and assisting very materially to rapidly and effectually accomplish the desired results.

In the treatment of petroleum or other oils, acid and alkali are always used, but with petroleum either before or after distillation. In vegetable oils it is usually applied by saturating with acid, and then decanting through alkali into tanks, or vice versa, until perfectly cleaned. The introduction of acid in the form of spray or in small particles to the vapor of oil and water allows a particularly close and intimate contact therewith.

The inclosing of the retort b and the jacket B B′, together with the neck D of the retort in sand, as shown in the drawings, is a very important part of the means employed to carry out our invention as applied to petroleum. It maintains the heat in the retort b at the uniform temperature desired, and is intended to prevent the premature condensation, which would cause some of the particles of oil to drip through the orifices $t\ t\ t$ into the pocket B^5. An indicator (not shown) on the end or side of the pocket indicates when there are sufficient drippings in the pocket to necessitate their removal, as set forth.

The tank C contains the crude petroleum or product to be refined, and the pipe C′, when the crude oil is not so dirty as to require previous settling or treatment with acid or alkali, could be inserted in any storage-tank from which the oil is flowing, or into any receptacle into which the oil is received from the well, and thus the refining process could be carried on at the wells or in their immediate vicinity.

In the practical operation of our invention we first thoroughly heat the sand surrounding the steam-jacket B B′ and retort b, operate the air-pumps and allow steam to pass into the retort b from the boiler A through the pipe A′, test the vacuum and uniformity of heat obtained throughout the retort b and neck D and the efficiency of the condenser E, and, when all is working satisfactorily, operate the cock C^3 and allow the oil to be drawn into the retort b from the tank C, and also open the cock l', allowing acid to flow from the tank L. As soon as the oil and acid enter the retort from the pipes C′ L′, they are impinged upon by the steam entering continuously through the pipe A′, and by the combined action of the air-pump referred to and the force of the steam are instantaneously conveyed to the neck D of the retort b and into the condenser E. This action is so rapid and the intermixing of the saturated steam so thorough and complete that no decomposition of the oil nor separation into its elements or into different grades occurs, but the oil is taken from the condenser the same natural or virgin product that it was when it entered the retort b from the tank C, except that it is cleaned and purified by the thorough intermingling of the vapor of water and the action of the acid and alkali.

Modifications may be made in the forms and

proportions of the several parts of the apparatus.

We can use other forms of condensers than Lighthall's.

The heat of the jacket B B′ may be maintained by an active circulation of the high-pressure steam between it and a boiler having sufficient heating-surface to maintain the temperature and pressure.

When all is in proper condition, we can allow the fire in the furnace to go out and depend upon our sand bath and steam-jacket B B′ to maintain the required heat.

We have described the tank I as containing acid, and the filter H′ in the tank H as containing alkali. These conditions may be reversed, and the tank L may contain an alkaline solution, and the filter be arranged to contain acid. The filted may be placed in any desirable position between the trough F and the tank H; or a series of filters may be employed. In the case of vegetable or animal oils the product in the pocket B^5 may be conveyed to another tank than the tank B^7 for treatment; but with hydrocarbon oils the contents of the pocket B^5 are allowed to flow into the tank B^7, as described, and after remaining therein a sufficient time to cool, are returned to the tank C and the process repeated.

A single air-pump or set of air-pumps properly connected may maintain the vacuum throughout the retort *b*, neck D, and through a single condenser, E, as shown, or a series of condensers.

We can use hot air or superheated steam for the jacket B B′ when the vaporization in the retort *b* is sufficiently rapid. In that case we would require to arrange a separate apparatus to superheat the steam, as the steam passing into the retort *b* must not be superheated.

Some of the advantages due to certain features of the invention may be separately enumerated, as follows:

First. By reason of the pipes C′ and L′ admitting both the oil and the acid or alkali into the retort, we are able to subject the oil to chemical action at an earlier stage than heretofore, and to insure a more prompt and efficient action with a given quantity of acid.

Second. By reason of the steam-pipe A′ and the oil-pipe C′, and the pipe L′ bringing acid or alkali, with the parts arranged as an atomizer, in combination with the vacuum retort, we are able to diffuse the acid with the oil and steam under conditions which prevent the separation of the oil into its elements.

Third. By reason of the retort *b* having its tapering neck D, in combination with the steam-pipe A′ and oil-pipe C′, arranged to serve as an injector, and means for maintaining the vacuum, we are able not only to induce the desired reactions between the oil and steam, but also to attain an unusually rapid motion of the whole through the retort.

Fourth. By reason of the retort *b*, steam-jacket B B′, and sand bath B^3, we are able to maintain the temperature desired with unusual uniformity.

Fifth. By reason of the furnace B^4, in combination with the sand bath B^3, retort *b*, steam-jacket B B′, and means for maintaining the vacuum, and with the pipes for admitting oil and saturated steam, as shown, we are able to conveniently raise the temperature and induce the desired conditions at the commencement of the process.

Sixth. By reason of the pocket B^5 in the base and provisions for communication between it and the interior of the retort, as shown, we provide for rapidly taking away any oil which remains fluid under any conditions without impairing the action.

Seventh. By reason of the retort *b*, condenser E, and means for maintaining the vacuum in the system, in combination with the pipe for admitting steam, we are able to maintain the vacuum notwithstanding the admission of large quantities of fluid.

Eighth. By reason of the trough F and its several pipes and connections, we are able to deliver the product continually in the proper tank, so long as it is of proper gravity, and to deflect it into other tanks when required.

Ninth. By reason of the filter H′ containing acid or alkali to neutralize the previous alkali or acid, in combination with the other parts, we are able to deliver the refined oil continuously in condition for storage or use.

Tenth. By reason of the retort *b* having its gradual contraction or neck D opposite the point at which the fluids are admitted, and of the pipes A′, C′, and L′, condenser E, and means E^2, for exhausting the whole, we are able to avoid the necessity of having any body of oil in a fluid condition in the retort either at the beginning or during the continuance of the process.

The processes incidental to this apparatus have been made subject of separate application—viz., Serial No. 173,213, filed August 1, 1885, and Serial No. 170,252, filed June 30, 1885.

We claim as our invention—

1. In an apparatus for refining oils, substantially as described, the combination, with a retort, as *b*, and a connected condenser and vacuum-pump, of the oil-pipe C′, having its exit end arranged within the retort, and the acid-reservoir L, having acid-pipe L′ similarly arranged, and having its exit closely adjacent to that of the oil-pipe, whereby the stream from either pipe is impinged directly upon that of the other, as set forth.

2. In an apparatus for refining oils, substantially as described, the combination, with a retort, as *b*, and a connected condenser and vacuum-pump, of the steam-pipe A′, oil-pipe C, having its ends arranged within the retort, and the acid-pipe L′, similarly arranged and having its exit closely adjacent to that of the oil and steam pipes, whereby the stream from

the steam-pipe is impinged directly upon that of the others to atomize the passing liquids, as set forth.

3. In an apparatus substantially as described, the combination, with an oil-pipe, C′, and a steam-jet for atomizing the oil as it leaves the pipe, and with a vacuum-pump, of the retort *b*, having tapered neck D of size approximating one-third the diameter of the retort and arranged on an approximate level with said steam and oil jets, whereby the combined vapor of oil and steam may be immediately conveyed from the retort with little or no resistance, as specified.

4. In an apparatus, as described, for refining oils, the combination, with the furnace-body, of the retort *b*, steam-jacket B B′, and sand bath B^3, surrounding said steam-jacket and arranged to leave a space between itself and the furnace, as herein specified.

5. The combination, with the retort *b*, having steam-jacket, and with the furnace B^4, of the steam-generator A, having pipes A′ A′, one connecting with the steam-jacket and the other having its exit adjacent to that of an oil-pipe, as C′, to atomize the oil within the retort at a point approximately opposite the exit D, as specified.

6. The retort *b*, having a jacket, B^5, and a connecting passage or passages, as *t t t*, for collecting the products of premature condensation or imperfect volatilization, as herein specified.

7. In an apparatus for refining oils, the vacuum-retort *b*, having pockets B^5, and passages *t*, in combination with the condenser E, air-pump E^2, or its equivalent, and pipe admitting steam under pressure, substantially as herein specified.

8. The combination of the pipe A′, oil-pipe C′, acid or alkali pipe L′, retort *b*, condenser E, and tank H, having acid or alkali filter H′, all arranged for joint operation, as herein specified.

9. In an apparatus for refining oils, the retort *b*, with means for heating it, having the neck D arranged as shown, in combination with the steam-pipe A′, oil-pipe C′, and acid or alkali pipe L′, condenser B, and air-pump E^2, or equivalent means, for maintaining a vacuum in the retort, and its connections, arranged for joint operation, substantially as herein specified.

In testimony whereof we have hereunto set our hands, at New York city, New York, this 10th day of August, 1885, in the presence of two subscribing witnesses.

JAS. B. GRANT.
ALLAN MASON.

Witnesses:
M. F. BOYLE,
MANIERRE ELLISON.