(No Model.) 4 Sheets—Sheet 1.

H. FRASCH.

PROCESS OF AND APPARATUS FOR REFINING LIMA OR SIMILAR PETROLEUM.

No. 564,924. Patented July 28, 1896.

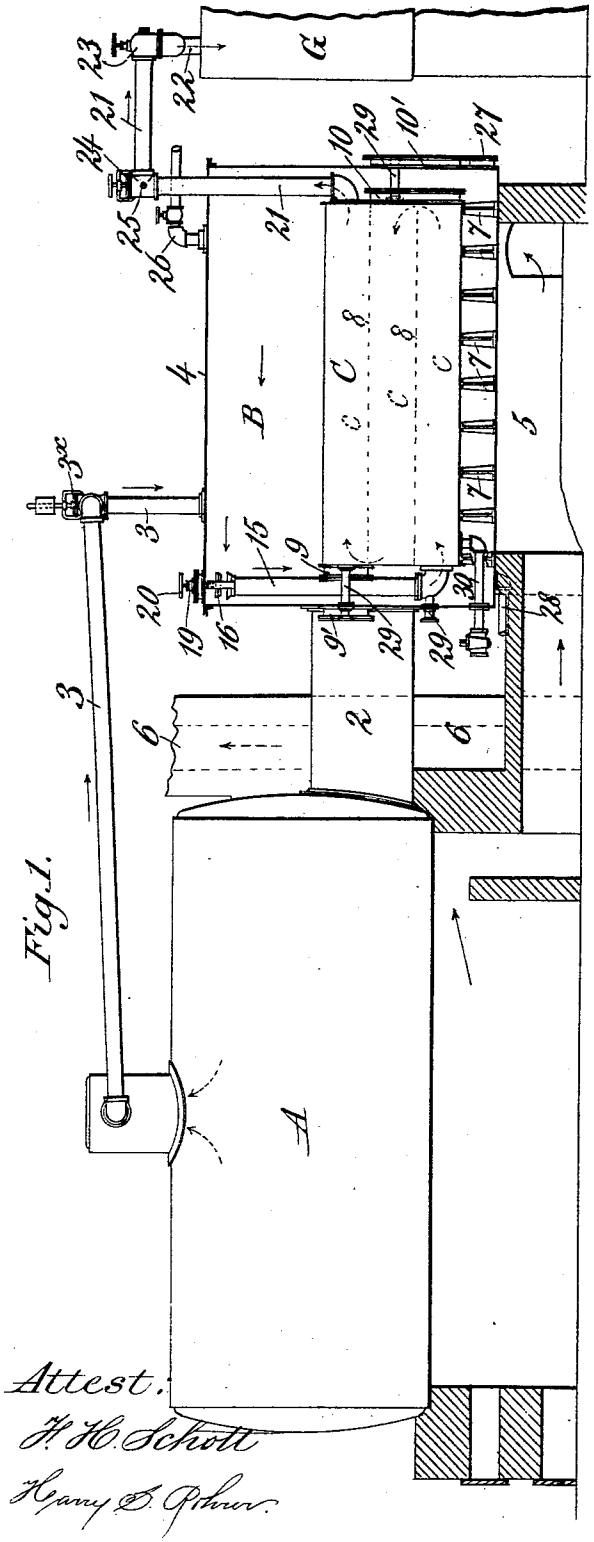

Fig. 1.

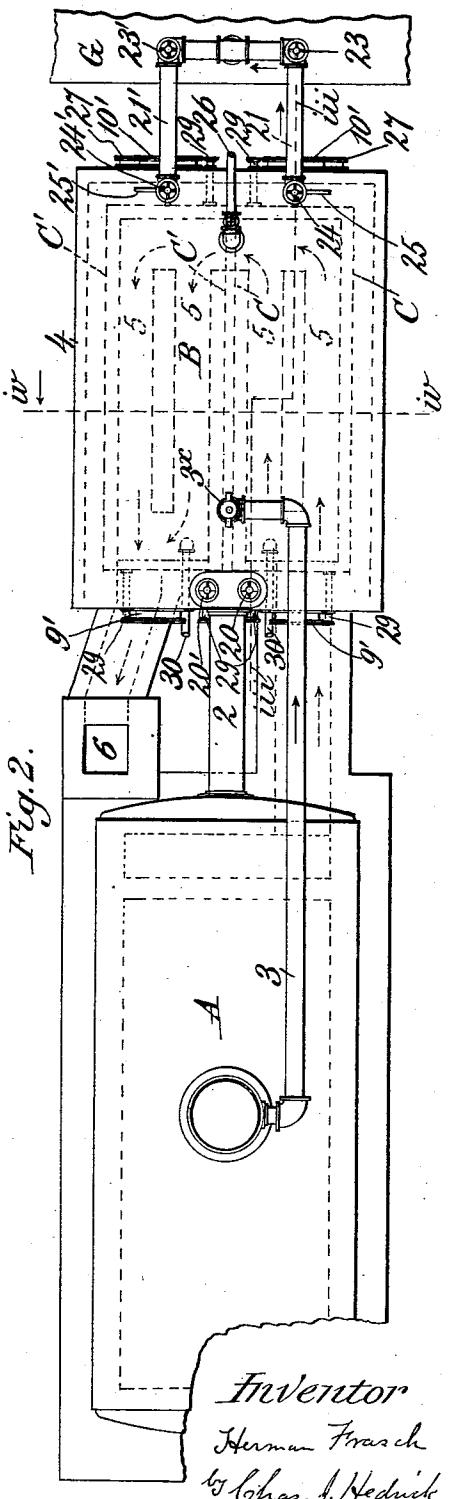

Fig. 2.

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(No Model.) 4 Sheets—Sheet 2.

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PROCESS OF AND APPARATUS FOR REFINING LIMA OR SIMILAR PETROLEUM.

No. 564,924. Patented July 28, 1896.

Fig. 3.

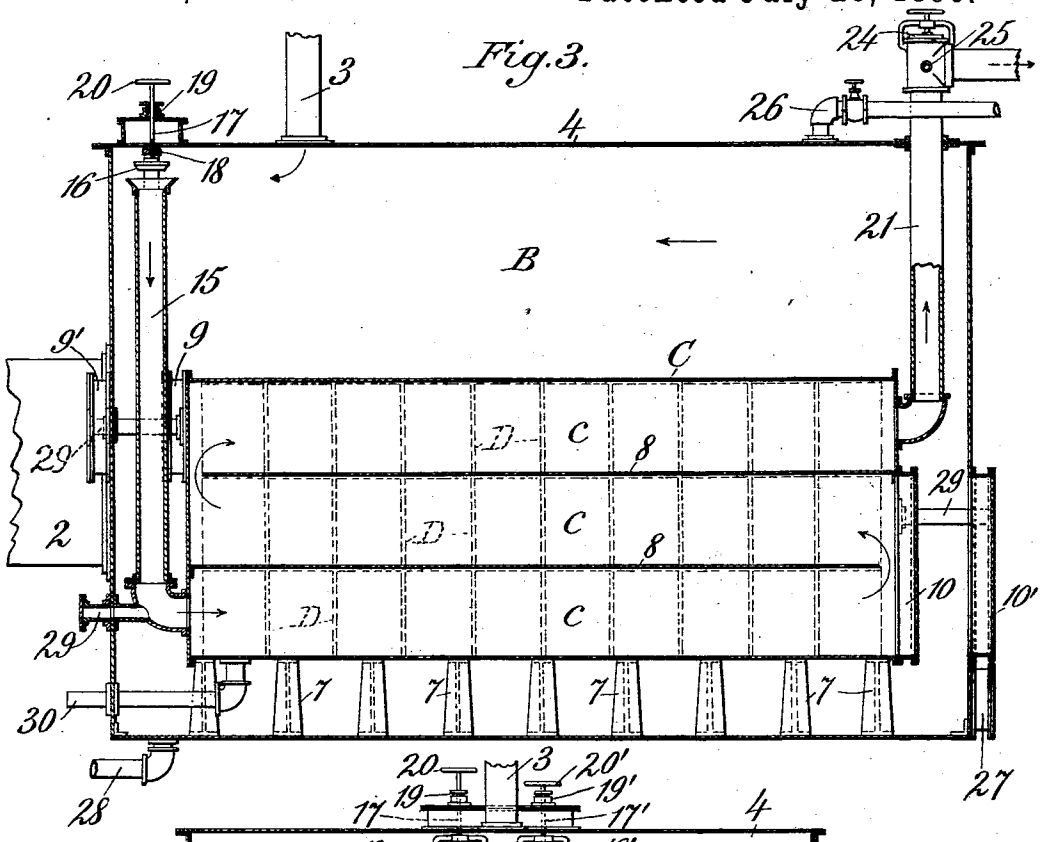
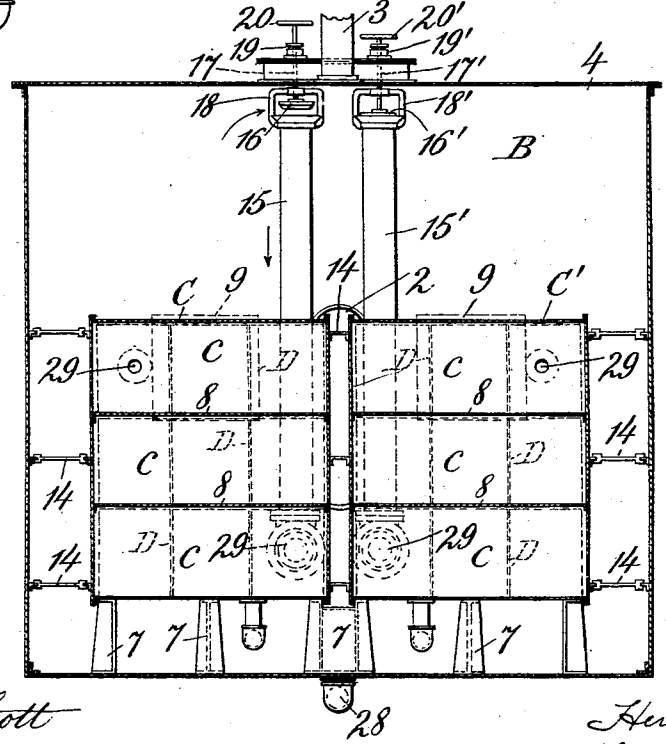


Fig. 4.



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PROCESS OF AND APPARATUS FOR REFINING LIMA OR SIMILAR PETROLEUM.

No. 564,924. Patented July 28, 1896.

Fig. 6.

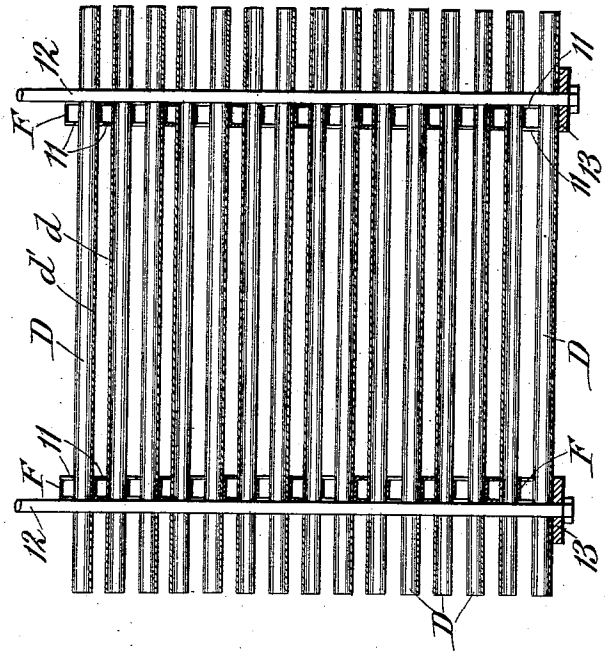
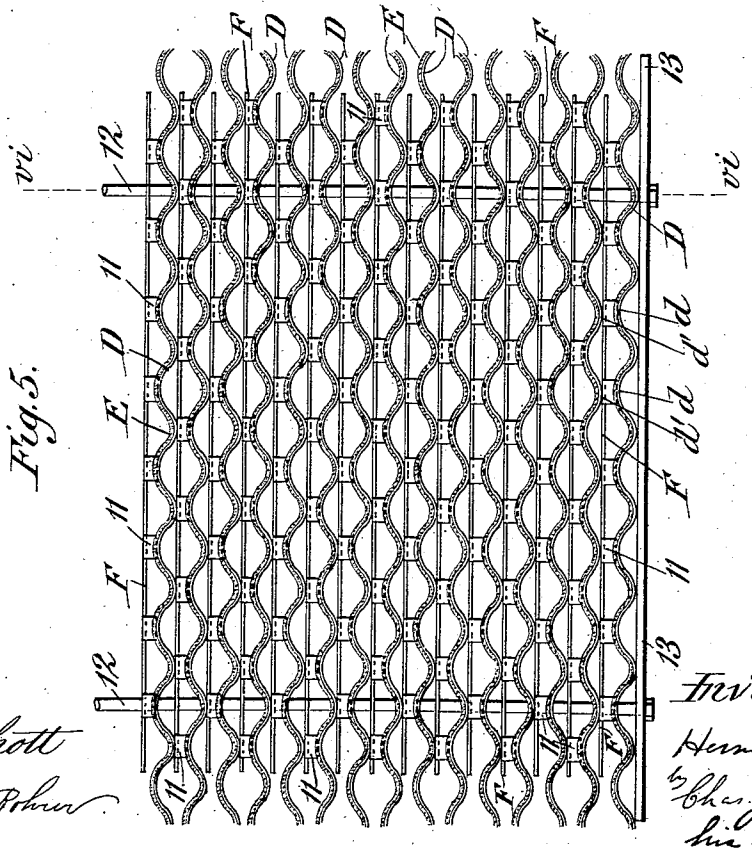


Fig. 5.



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PROCESS OF AND APPARATUS FOR REFINING LIMA OR SIMILAR PETROLEUM.

No. 564,924. Patented July 28, 1896.

Fig. 7.

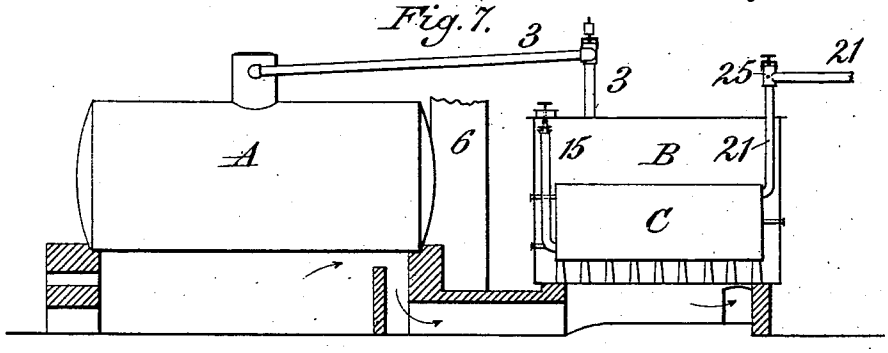


Fig. 8.

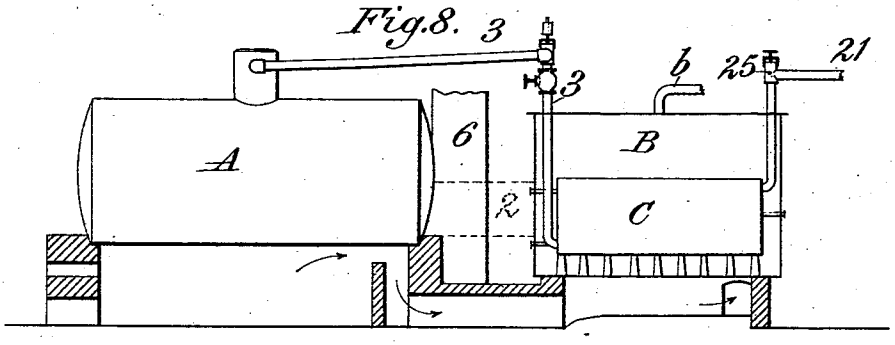


Fig. 9.

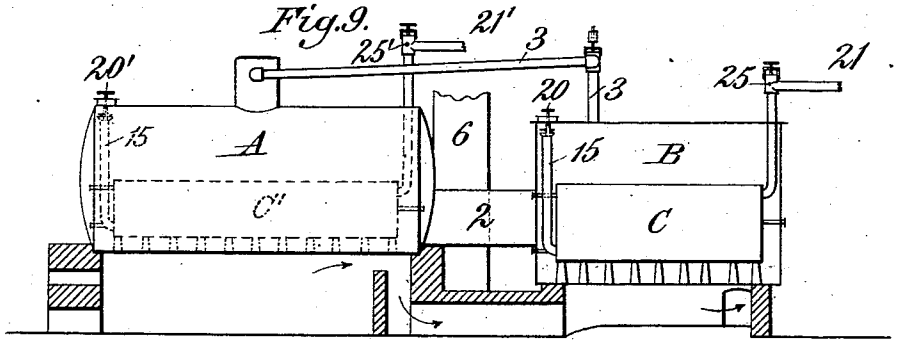
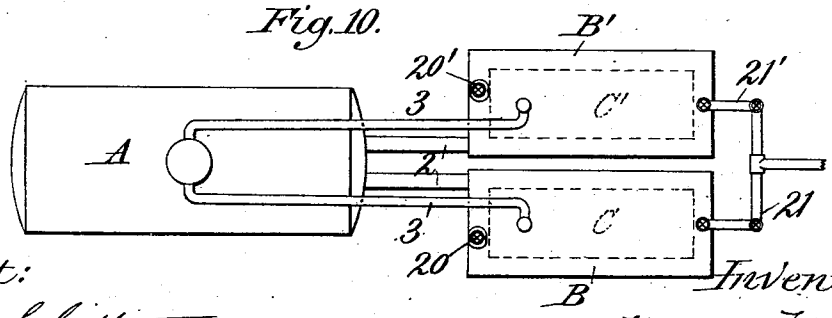


Fig. 10.



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UNITED STATES PATENT OFFICE.

HERMAN FRASCH, OF CLEVELAND, OHIO, ASSIGNOR TO THE SOLAR REFINING COMPANY, OF OHIO.

PROCESS OF AND APPARATUS FOR REFINING LIMA OR SIMILAR PETROLEUM.

SPECIFICATION forming part of Letters Patent No. 564,924, dated July 28, 1896.

Application filed December 31, 1894. Serial No. 533,487. (No model.)

To all whom it may concern:

Be it known that I, HERMAN FRASCH, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Processes of and Apparatus for Refining Lima or Similar Petroleum; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

This invention relates to the removal from Lima or similar petroleum of what is known as "skunk" among workers in that class of oil, the said skunk resisting removal (as is well known) by the ordinary sulfuric acid and alkali treatment by which oils of the Pennsylvania class have long been satisfactorily refined; but each part of the invention is, of course, intended to be secured for all the uses to which it may be applicable.

Skunk-bearing oils are found not only about Lima, (whence the name,) but also in other parts of Ohio, in Canada, and to a less extent in States of the Union other than Ohio. As they come from the well they contain a very considerable percentage of sulfur, (usually upward of one-half of one per cent.,) have a penetrating disagreeable odor, and dissolve litharge (lead oxid) in considerable proportions, the peculiar odor and the property of dissolving litharge without the aid of oleic acid, rosin, or other added agent being believed to be characteristic of them and proving the presence of skunk in the oil. The burning oil distillates from ordinary distillation of skunk-bearing petroleum (whether given the ordinary sulfuric-acid and alkali treatment or not) have the skunk odor and dissolve litharge. When tested by the addition of a small quantity of an aqueous solution of plumbate of soda, they turn yellow, provided they have previously been freed from sulfureted hydrogen. Otherwise this latter substance causes a dark or black discoloration. On burning in lamp they give a bad odor and cause a cloud on the chimney and a crust on the wick. There has, however, been long known a process (commonly called the "Canadian" treatment) by which the burning oil from Lima petroleum can be deprived of its odor and of the property of dissolving litharge without, however, removing the skunk, for on redistillation of Canadian-treated oil the skunk odor reappears and the distillate from such redistillation dissolves litharge and (if free from sulfureted hydrogen) turns yellow with plumbate-of-soda solution. On burning in lamps the Canadian-treated oils give a bad odor, cloud the chimney, and crust the wick. By the Canadian treatment, therefore, the skunk is concealed but not removed.

For the purpose of removing the skunk from this class of oils I have heretofore devised a number of processes and apparatus. I discovered, among other things, that the skunk could be made to react with suitable substances having a basis of metal and could thus be decomposed with the formation of a metallic-sulfur compound easily separable from the hydrocarbons, and I further discovered various modes whereby such reaction could be brought about industrially. In such working it is not practical to throw away the metallic-sulfur compound which results, as just stated, from the skunk decomposition and use a fresh supply, because the expense would be so large as to be prohibitive. It was necessary, therefore, when the substance ceased to decompose the skunk to restore its activity. Practically it was burned (or oxidized) and converted into a metallic oxid or sulfate, or mixture of oxid and sulfate, in which condition it became again capable of reacting chemically with the skunk. Heretofore this burning or revivification of the spent substance has been carried on apart from the distillation of the oil, either in pits and special furnaces to which the spent substance has been removed, or (as in my application filed December 5, 1894, and serially numbered 530,875) in a purifier-box which has held the skunk-decomposing substance during the preceding and succeeding skunk-removing operations as well as during the revivifications.

In accordance with the present invention,

the revivifying operation is made to furnish heat for a contemporaneous oil distillation by burning the spent substance under distillable oil and thus at the same time generating oil-vapors and utilizing the cooling effect of such vapor generation to keep down the temperature of the burning substance. While possible, it is not necessary that the oil-vapors so generated should be due merely to the combustion of the spent substance, for it is in fact preferred to supplement the heat of such combustion with heat applied by means of flues under the distilling-chamber, which contains the box wherein the spent substance is burned. The heat from the combustion of the spent substance could also be supplemented in other ways; or, as before said, the oil under which the said box is placed may be vaporized merely by the heat of such combustion. The vapors generated (wholly or in part) by such combustion are conveyed away and condensed either alone or with other vapors and with or without being purified, although the invention includes also certain new improvements connected with the purification of the so-generated vapors before condensation, as hereinafter set forth.

Further, in accordance with the present invention, the combustion of the spent substance is made to furnish the whole or a part of the heat for maintaining the temperature of active skunk-decomposing substance to which skunk-bearing vapors are exposed contemporaneously with such revivification, the spent substance being burned under a liquid adapted to sustain the temperature of oil distillation and forming a bath for the box containing the said active substance.

The liquid most advantageously employed is distillable oil, which is vaporized by the heat of the burning spent substance, (with or without other heat,) while at the same time said oil acts as a bath to keep down the temperature of the burning substance and to maintain the temperature of the active substance to which skunk-bearing vapors are contemporaneously exposed.

The vapors generated by the heat from burning the spent substance may constitute or form part of the said skunk-bearing vapors, so that vapors generated from the oil which cools the burning spent substance and maintains the temperature of the active substance are purified by exposure to said active substance, and this method is advantageous and constitutes a special improvement; but if there are two sets of vapors, (as there may be,) then instead of having the vapors which have been generated (in whole or in part) by the heat of the burning spent substance to pass through the active substance, whose temperature is also maintained (in whole or in part) by such heat, the so-generated vapors can be separately purified, or (if desired) they can be conveyed away and condensed in an impure state.

The advantages of utilizing the oil in process of purification as well to keep down the temperature of the burning spent substance as to maintain the temperature of the active substance by which the vapors of said oil are purified are not, however, restricted to the case where the combustion of the spent substance furnishes the whole or a part of the heat for maintaining the temperature of said active substance; for, if the spent substance be burned under one part of said oil and another part (say in a distinct chamber, whether communicating or not) serves as the bath to maintain the temperature of the active substance, the said parts might be so separated as to prevent an interchange of heat between them, and still the advantages be secured of having but one kind of liquid to deal with, and that liquid the oil to be purified, while at the same time allowing the temperature of the active substance to become higher as the vapors to be purified become heavier and hotter. This method is intended, therefore, to be secured when carried out in its several modes, the use of the same or of communicating bodies of oil to maintain the temperature of the active and to keep down that of the revivifying substance, being the more advantageous, since then the oil all stands by gravity at the same level, and the flow of the oil and diffusion of the oil tend to keep it all at about the same gravity.

In carrying out the foregoing improvement, use is made of apparatus consisting of purifier-boxes adapted to be used also as revivifying-furnaces, and provided with various pipes and connections, as hereinafter specified. Such apparatus, with the various new combinations embodied therein, also forms part of the invention. Any suitable means may be used for supporting the skunk-decomposing substance within such purifier-boxes, although it is specially intended to employ numerous trays (each provided with a layer of said substance thereon) arranged in piles, so as to leave a space above the layer of skunk-decomposing substance on each tray for the passage of oil-vapors (or air, as the case may be) over the said layer between it and the bottom of the overlying tray, and to arrange a number of such piles of trays in a zigzag vapor-duct within the purifier-box, so that the oil-vapors (or air) will pass through a number of piles in succession. The trays in a pile are most advantageously held together by clamping means, separators being placed between the trays to keep them apart. Interior arrangements of this kind are shown, described, and claimed in my before-mentioned application, and they or other like arrangements may be used in the purifier-boxes of the present invention; but this latter consists also in certain improvements in such arrangements, which improvements are preferably used in connection with the other parts of the present invention, but may be used otherwise. Thus, for example, the improved arrangements can be used in the purifier-

boxes of my said application. These improvements in interior arrangements include the corrugation of the trays which uphold the skunk-decomposing substance, so that each layer (being corrugated likewise) exposes a larger surface for the same amount of substance than a flat layer would, while at the same time the trays may be lighter and are less apt to warp than a flat tray; also they include the arrangement of the trays and their clamping means, so that the presence of the latter tends to flatten out the corrugations which thus act as springs, or, in other words, yield slightly to the presence of said clamping means and bring the resiliency of the metal into action to exert an elastic or yielding stress; also they include the arrangement of the corrugated trays, so that the tops of the corrugations of a lower tray are just beneath the bottoms of the corrugations of a higher tray. Further, they include the arrangement of separators between the trays where these most closely approach, and, lastly, separating-strips are used, each separator consisting of a small projecting portion or ear forming part of said strip.

In the accompanying drawings, Figure 1 is an elevation, partly in section, of apparatus in accordance with the invention. Fig. 2 is a plan of the same. Fig. 3 is a vertical longitudinal section of the purifier on the bent line III of Fig. 2, the piles of trays being indicated only in outline by dotted lines. Fig. 4 is a cross-section of the purifier on line IV, the piles of trays being simply indicated by dotted lines, as in Fig. 3. Fig. 5 is an end elevation of a pile of trays as each of those indicated in Fig. 4 would appear therein if illustrated fully, and Fig. 6 is a vertical section on line VI of Fig. 5, the plane of this view corresponding with or being parallel to the plane of Fig. 3; but in Fig. 6 the skunk-decomposing substance is omitted. Figs. 7, 8, 9, and 10 are diagrams illustrating a number of arrangements of still and purifier which can be used, Figs. 7 to 9 being views partly in elevation and partly in section, and Fig. 10 a view in plan.

The still A is shown as a cylinder-still of ordinary construction except for the pipe connections with the chamber B, which forms the jacket of the purifier-boxes C C′. This chamber or jacket communicates at the bottom through the large pipe 2 with the liquid-space and at the top through the pipe 3 with the vapor-space of the still, so that during a run the oil stands at the same level in the said chamber or jacket as in the still. The cover 4 closes the top of the chamber vapor-tight. At 3× is a safety-valve.

The object of connecting the chamber B with the still A is to enable the oil in distillation to serve as a jacketing fluid around each of the boxes C C′. The oil could be made to serve in this way by placing the boxes in the main still; but it is considered more advantageous to have a separate chamber, such as B.

Underneath the chamber or jacket B are flues 5, (see Fig. 2,) conveying the products of combustion from the space beneath the still to the chimney, whose position is shown at 6. They supply heat to keep up the temperature of the jacketing fluid.

The boxes C C′ rest on posts 7, which in turn rest on the bottom of the jacketing-chamber B. (See Fig. 1.) Within each box are floors 8, by which the box is divided into a vapor-duct *c*, rising in a zigzag fashion from the bottom of each box, the floors alternately terminating at opposite ends at a distance from the corresponding end walls, so that the duct *c* runs back and forth lengthwise of the box. On each of the floors are piles of many trays D, charged with the skunk-decomposing substance. These piles are introduced above the top floor 8 of each box through the rectangular manholes 9 and 9′, Fig. 3, in the walls of the purifier-boxes and jacketing-chamber, respectively, (at the left-hand ends thereof, as shown,) and into the lower portions of the duct through the rectangular manholes 10 and 10′, (which are shown at the right-hand ends of the purifier-boxes and jacketing-chamber.)

The trays D are made of corrugated sheet metal and are each provided with a layer of skunk-decomposing substance, say a layer about an eighth of an inch deep of black oxid of copper ground fine and bolted, that oxid being preferred which results from carefully roasting the solid residue of a skunk-removing operation in which an oily solution of copper oxid is used as the purificator. The layers E of skunk-decomposing substance are made corrugated also to conform with the corrugations of the trays, as shown in Fig. 5, thus exposing a larger surface for a given quantity of the substance than would be the case with flat layers.

The trays D are so arranged that the tops *d*, Fig. 5, of the corrugations of a lower tray are just beneath the bottoms *d*′ of the corrugations of a higher tray, and between the trays are the separator-strips F, which have small projections or ears 11. The strips F are so placed as to bring the separators 11 at the points where adjacent trays come closest together. Bolts 12 pass through the trays D and also through top and bottom strips 13 and clamp the whole together. Owing to their corrugated form and the transmission of the pressure through the corrugations, these have a spring action by which, when the bolts are tightened, the trays, strips, and bolts are pressed together elastically. After the piles of trays have been placed in their boxes C C′ the manholes 9 9′ 10 10′ are closed. As indicated in Figs. 3 and 4, there are three piles widthwise and ten lengthwise on each floor, thus making thirty piles to a floor, but the number as well as the size of the piles can be varied.

The purifier-boxes C C′ are fastened to each other and to the walls of the jacketing-chamber B by stays 14. A pipe 15 leads from the vapor-space of the chamber B to the portion of the vapor-duct *c* at the bottom of the box C, and a similar pipe 15′, Fig. 4, leads from the same vapor-space to the duct at the bottom of the box C′. Each of these pipes has a valve 16, (or 16′,) adapted to be raised and lowered by a screw 17, (or 17′,) tapped through a stirrup 18 (or 18′) and extending through a stuffing-box 19, (or 19′.) Each screw has a hand-wheel 20 (or 20′) for turning it.

From the upper end of the vapor-duct in each purifier-box a pipe 21 (or 21′) leads to the condenser G through the connection 22, which serves for both. The condenser should be lead-lined, owing to the sulfur dioxid, which in the practical operation of the invention (as it is preferred to use it) would pass to the condenser with the skunk-free oil-vapors.

Each of the pipes 21 and 21′ has a stop-valve 23, (or 23′,) so that the condenser connection of either or both can be shut off at will. Each pipe has also a removable cover 24 (or 24′) and an aspirating steam-jet supplied by a pipe 25, (or 25′.)

There is a valved pipe 26, which extends from the vapor-space of the chamber B to a small condenser. (Not shown.) The chamber B is further supplied with manholes 27 and with a draw-off 28 for the tar.

The boxes C C′ have air-inlet pipes 29 extending through the jacket B to the outside. There is one of these pipes for each floor. It can be closed with a removable plate or plug, and when open can (if necessary) have the inlet-openings adjusted by means of perforated plates or reducers or the like. The boxes also have each a draw-off 30 with a stop-cock therein, as shown for the box C in Fig. 1. In case oil should leak into the boxes, the draw-offs serve to remove it; but it is intended to have the boxes tight.

The still A is filled to the usual level with Lima oil, preferably crude oil. The oil flows through the pipe 2 into the chamber B and stands therein at the same level as in the still A. The fire is started under the still and the oil heated to the distilling temperature in still A and chamber B.

One of the boxes (say, for example, the box C′) receives no oil-vapor, the valves 16′ and 23′ being closed. The skunk-bearing vapors pass by the pipe 15 into the vapor-duct *c* at the bottom of box C. Here and in the duct above each floor 10 the volume of vapors is divided into numerous small streams which flow between the trays over the skunk-decomposing substance thereon, the box C and its contents being kept by the surrounding oil at a temperature to prevent condensation without danger of overheating the vapors. In the spaces or small chambers between the piles the vapors have a chance to mix together before they are again divided into numerous small streams by the trays of the succeeding piles. The skunk reacts with the copper oxid, (or whatever skunk-decomposing substance is used,) forming a metallic-sulfur compound which remains on the trays. Other products of the reaction pass off with the oil-vapors.

After traversing the tortuous duct of box C the vapors pass by the pipes 21 and 22 to the condenser G. They are thereby reduced to a liquid which may be subjected to any further treatment which may be desired. The burning oil in practice would be finished by the well-known sulfuric-acid and alkali treatment. The naphtha (if not removed from the crude oil before this is placed in the still, as by preference it would not be) also would be deprived of skunk and would also be finished in the usual way. Although heavier fractions can be freed from skunk, the distillation would ordinarily be stopped and the residuum (or tar) drawn off after the removal of the burning-oil fraction.

After the still A and chamber B have been emptied they are filled again with oil (preferably crude Lima oil, as before) and the valves 16′ and 23′ are opened, so that the vapors can pass through the pipe 15′ into the vapor-duct of box C′ and the pipes 21′ and 22 to the condenser. During this time the valves 16 and 23 are closed, so that the vapors have no access to the box C. In passing through the box C′ the vapors are brought into contact with the skunk-decomposing substance on the trays D therein, the same as described for the box C. In the meantime the cover 24 of pipe 21 is removed, one or more of the air-inlet pipes 29 of the box C are opened, and the steam-jet at 25 is started, so that a draft is created through each of the air-inlet pipes which is open into and through the duct *c* of box C and out by the pipe 21. Under the influence of the indrawn air the spent substance E in box C ignites spontaneously and burns with active combustion, which may or may not be visible to one looking through an air-inlet. Preferably all the air-inlets of the box C are left open, so that the combustion is maintained simultaneously on all the floors. The rapidity of combustion is readily controllable by regulating the amount of air introduced. For this purpose use may be made of adjustable covers or of perforated plates or reducers; but it is considered best to use pipes of a suitable bore which can be left full open during the revivification. The power of the exhaust at 25 can also be regulated; but this (like the size of the air-inlets) is preferably constant during the revivification. It is entirely feasible, while carrying on the distillation with the usual rapidity, to cause a combustion which is sufficiently active to revivify the purificator in box C before the oil in still A and chamber B has been run off in vapor form through the box C′, and which yet produces no more heat than can be carried off by the escaping products

of combustion and the surrounding oil without permitting the temperature within the box C to rise so high as to injure the purificator, (or skunk-decomposing substance,) or the apparatus, or the surrounding oil. It is recommended that the temperature be not allowed to rise above a temperature indicated by a dull red glow in the dark at the beginning of the revivification. As already suggested, it is not necessary that such a glow should be visible. The desideratum is to finish revivification at or shortly before the run is completed.

For a purifier-box of the form and arrangement shown, containing thirty piles of twenty-three corrugated trays, each provided with an eighth-inch layer of finely ground and bolted oxid of copper and each twenty-two by eighteen inches surface area, (whether after or before corrugating,) it will suffice to have one circular air-inlet of two inches diameter of opening for each floor and a steam-aspirating jet from a circular orifice of one-quarter inch diameter supplied with steam from a boiler whose pressure is maintained at sixty pounds to the square inch. The outlet-pipe 21 (or 21′) may be ten inches in diameter. The air-inlets may then be left fully open and the steam-jet be turned on full during the revivification.

The dimensions are given, it will be understood, only by way of illustration. They may be varied. It is not essential, for example, to use the skunk-decomposing substance in eighth-inch layers; and it is evident also that the revivification can be carried on in other sizes and forms of box having other internal arrangements and provided with other forms, sizes, and arrangements of air-inlets, outlet-pipe, and draft-creating means.

As the revivification proceeds the heat generated is conveyed and carried off by the surrounding oil, so that the distillation of said oil and the maintenance of the substance E in box C′ at the desired temperature are assisted, while at the same time the temperature in the box C is kept within limits by the operation of the oil as a cooling medium. The distillation of the charge of oil in still A and chamber B should preferably not be completed before the revivification. The completion of the latter will be evidenced by the diminished flow of distillate from the condenser or worm end when the combustion in box C gives out for lack of fuel and the same heat is no longer furnished to the surrounding oil.

After the run, or, in other words, after the distillation of a charge of oil until the burning oil or whatever fraction is desired has been passed through the box C′ and condenser G, the tar or residue of the charge is drawn off, the revivification having previously been completed and the steam-jet at 25 shut off. The still A and chamber B are then supplied with a new charge, the air-inlet pipes 29 of box C are closed, and the cover 24 of pipe 21 restored to close the top of said pipe.

Before opening the valves 16 and 23 it is well to commence the distillation and by opening the pipe 26 to allow the vapors generated to pass to the small condenser (not shown) until the air has all been expelled from the still A and chamber B. This procedure is precautionary merely and does not affect the invention, and is resorted to for fear that in rapid working a little fire may exist in box C when distillation of the new charge is commenced. Such fire would be apt to cause an explosion if the air mingled with oil-vapors were allowed to enter said box C, but would have no effect if hydrocarbon vapors only be allowed to enter. After the air is out of the still A and chamber B the valves 16 and 23 are opened and the vapors passed in contact with the revivified substance in box C. If copper oxid be used originally, this substance will consist of a mixture of copper oxid and copper sulfate, and, moreover, it will be found to have increased in volume and become swollen and to possess a greater activity in skunk removal than in the original state. During this run the substance of box C′ is revivified in the manner described for the box C; and so the boxes are used alternately as vapor-purifiers and as revivifying-furnaces for the spent substance.

In order not to uncover the boxes during the revivifying operation and thus leave any part of them without the cooling influence of the oil, the said boxes are placed in the lower part of the chamber B, below the tar line or level of the residuum at the end of a run.

The jacketing-chamber B is shown in Figs. 1 to 4 as having its liquid-space in communication with the still A and as surrounding both boxes C C′. This is the best arrangement, and specially claimed; but my claims (except claim 12) are not limited to that arrangement; for, first, it is evident that if chamber B be disconnected from the liquid-space of still A, as indicated in Fig. 7, the revivification in the boxes could be used to distil or aid in distilling oil in chamber B. In such case the vapors from both still A and chamber B could be led into the duct of the desired box C or C′, or the vapors from still A could be so led, as indicated in Fig. 8, while those from chamber B could be conveyed away, say by pipe *b* of Fig. 8, and condensed with or without purification in any ordinary or suitable way. Moreover, even if chamber B had its liquid-space in communication with the still A, as indicated in dotted lines in Fig. 8, the vapors generated in the former could be conveyed away separately. Further, it is evident that if still A be dispensed with and the chamber B be of a size to contain a sufficient quantity of oil, distillation and skunk removal with revivification could be carried on. Again, instead of having a distilling apparatus of two cham-

bers, (as still A and chamber B,) with the boxes in the same chamber, said boxes could be in different chambers, as one in still A and another in chamber B, as indicated in Fig. 9. In either case it could properly be said that the boxes were in the apparatus composed of the distilling-chambers; so, too, would an arrangement of more than two chambers, as A, B, and B′ of Fig. 10, of which one or more might contain no box. Such chambers might or might not have their liquid-spaces in communication with each other.

Other omissions or modifications will suggest themselves as capable of being made while yet employing some one or more of the new things of the present invention.

In the following claims the reference to a condenser, a chamber, a box, a pipe, and the like is not intended to exclude the use of more than one such thing. Still and distilling-chambers are not of different significance in the claims; but they are sometimes used in the same claim to make the wording clearer, or because still and distilling-chamber have been used, respectively, as designations of the parts A and B in the drawings, and it may therefore be more easy to apply the terms of such claims to the said drawings.

I claim as my invention or discovery—

1. The improvement in refining Lima or similar petroleum, consisting in burning the spent skunk-decomposing substance for the purpose of revivification, keeping the degree of heat below a caking temperature by conducting away the excess of heat as generated by means of the oil in distillation, and conveying away and condensing the so-generated vapors, substantially as described.

2. The improvement in refining Lima or similar petroleum, consisting in burning the spent skunk-decomposing substance under a liquid adapted to sustain the temperature of oil distillation so as to have the heat of such combustion absorbed by said liquid, and by the so-heated liquid maintaining active skunk-decomposing substance at a temperature to prevent the condensation of skunk-bearing vapors, which are exposed to said active substance contemporaneously with the burning of the spent substance, substantially as described.

3. The improvement in refining Lima or similar petroleum, consisting in burning the spent skunk-decomposing substance under distillable oil, so as to generate vapors from said oil and to keep down the temperature of the burning substance, maintaining active skunk-decomposing substance by the so-heated oil at a temperature to prevent condensation of skunk-bearing vapors, which are exposed to said active substance contemporaneously with the burning of the spent substance, and conveying away and condensing the vapors generated by such burning (preferably after exposure to said active substance as constituting or forming part of the said skunk-bearing vapors), substantially as described.

4. The improvement in refining Lima or similar petroleum, consisting in distilling skunk-bearing oil, and subjecting the vapors to active skunk-decomposing substance maintained by the distilling oil (or a part thereof) at a temperature to prevent condensation of the vapors, while at the same time burning spent skunk-decomposing substance under said oil (or a part thereof) so as thereby to generate oil-vapors which are purified as aforesaid and to keep down the temperature of the burning substance, substantially as described.

5. The combination with a still, and a distilling-chamber, of a purifier-box adapted to serve also as a revivifying-furnace arranged in said chamber, a vapor-pipe between the said box and the vapor-space of said still (whether said pipe be or be not also in communication with the vapor-space of said chamber), one or more air-inlet pipes for said box, means for opening and closing said pipes, a condenser, a condenser connection for the said box, and a separate condenser connection for the said chamber (the last-mentioned connection being preferably by way of a companion purifier-box), substantially as described.

6. The combination with a distilling-chamber, of a purifier-box adapted to serve also as a revivifying-furnace arranged in said chamber, a vapor-pipe between the said box and the vapor-space of the chamber containing the same, one or more air-inlet pipes for said box, means for opening or closing said pipes, a condenser, a condenser connection for said box, and a separate condenser connection for said chamber (the last mentioned connection being preferably by way of a similar purifier-box), substantially as described.

7. The combination with a still, of purifier-boxes, each adapted also to serve as a revivifying-furnace, a chamber containing said boxes, a vapor-pipe between each box and the vapor-space of said still, one or more air-inlet pipes for each box, means for opening and closing said pipes, a condenser, and a condenser connection for each box, substantially as described.

8. The combination with a still, and a distilling-chamber, of purifier-boxes each adapted also to serve as a revivifying-furnace arranged in said chamber, a vapor-pipe between each box and the vapor-space of said still (whether said pipe be or be not also in communication with the vapor-space of said chamber) one or more air-inlet pipes for each box, means for opening and closing said pipes, a condenser, and a condenser connection for each box, the said chamber having also a condenser connection (preferably by way of each of said boxes in turn), substantially as described.

9. The combination with a distilling-chamber, of purifier-boxes each adapted also to serve as a revivifying-furnace arranged in said chamber, a vapor-pipe between each

box and the vapor-space of said chamber, one or more air-inlet pipes for each box, means for opening and closing said pipes, a condenser, and a condenser connection for each box, substantially as described.

10. The combination with a distilling apparatus composed of distilling-chambers, of purifier-boxes in said apparatus, each box being adapted also to serve as a revivifying-furnace, a vapor-pipe between each box and the vapor-spaces of said chambers, one or more air-inlet pipes for each box, means for opening and closing said pipes, a condenser, and a condenser connection for each box, substantially as described.

11. The combination with a distilling apparatus composed of distilling-chambers having their liquid-spaces in communication with each other, of purifier-boxes in said apparatus, each box being adapted also to serve as a revivifying-furnace, a vapor-pipe between each box and the vapor-spaces of said chambers, one or more air-inlet pipes for each box, means for opening and closing said pipes, a condenser, and a condenser connection for each box, substantially as described.

12. The combination with a still, and a distilling-chamber having its liquid-space in communication with that of said still, of purifier-boxes in said chamber, each box being adapted also to serve as a revivifying-furnace, a vapor-pipe between each box and the vapor-spaces of said chambers, one or more air-inlet pipes for each box, means for opening and closing said pipes, a condenser, and a condenser connection for each box, substantially as described.

13. A pile of corrugated trays clamped together and provided with pressure-transmitting means or bearings intermediate the bottoms of the grooves and the tops of the ridges on adjacent trays, whereby said corrugations permit expansion and contraction, substantially as described.

14. In combination with a vapor-duct, one or more piles of corrugated trays clamped together and provided with pressure-transmitting means or bearings intermediate the bottoms of the grooves and the tops of the ridges on adjacent trays, whereby said corrugations permit expansion and contraction, substantially as described.

15. A pile of corrugated trays arranged with the tops of the ridges in the respective trays under the bottoms of the grooves in overlying trays so as to form passages of a circular form and clamped together in that position, substantially as described.

16. In combination with a vapor-duct, one or more piles of corrugated trays arranged with the tops of the ridges in the respective trays under the bottoms of the grooves in overlying trays so as to form passages of a circular form and clamped together in that position, the said passages being arranged lengthwise of said duct, substantially as described.

17. The combination with corrugated trays arranged in a pile, and clamping means whereby the pile of trays is secured together, of strips arranged between the trays transverse to the corrugations so as to bear against the bottoms of the grooves of overlying and the tops of ridges of underlying trays, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

HERMAN FRASCH.

Witnesses:
T. W. LOTHMAN,
F. D. WILLIAMS.