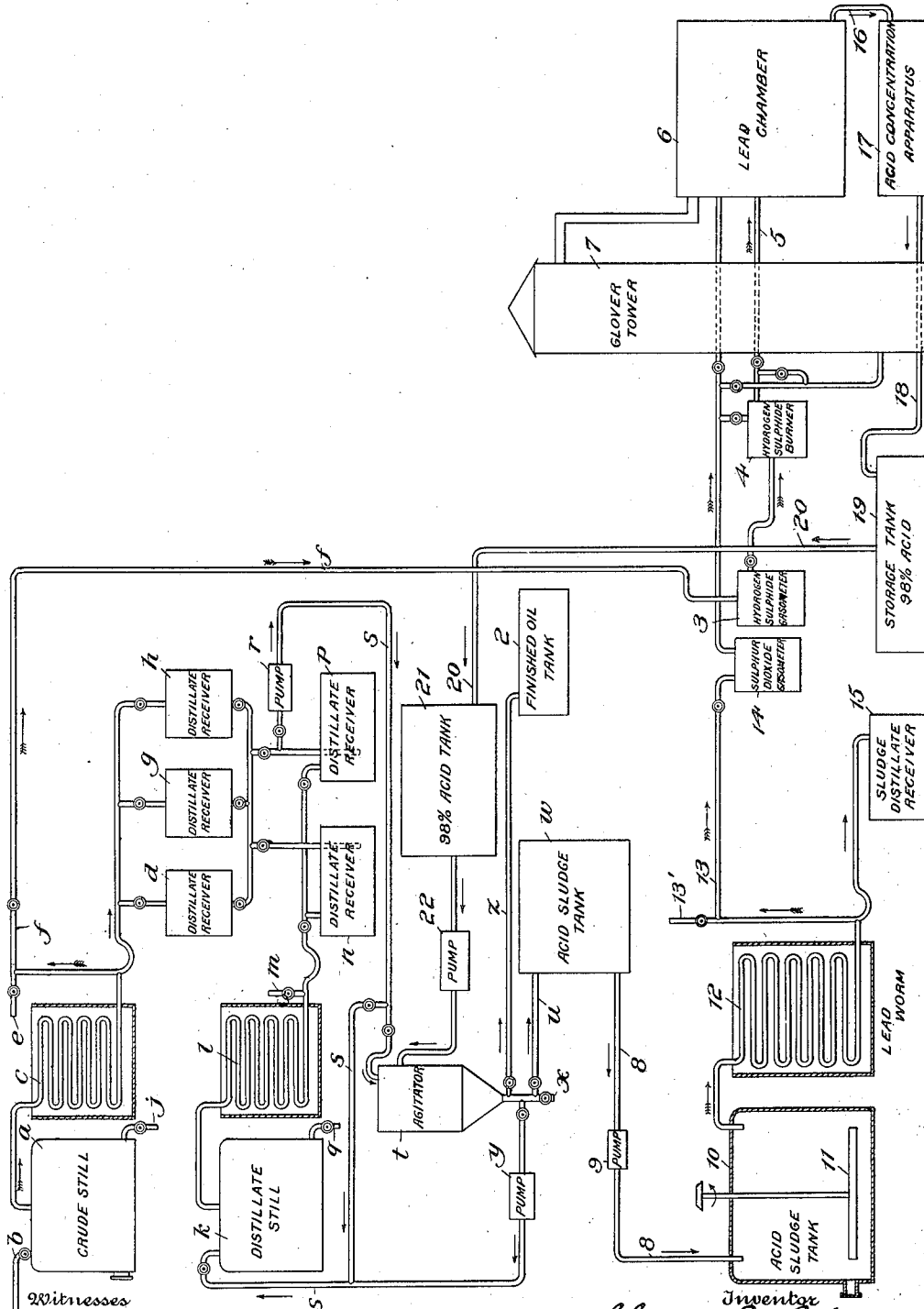


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 APPARATUS FOR USE IN CONNECTION WITH THE REFINING OF PETROLEUM.
 APPLICATION FILED MAR. 21, 1907.

1,057,395.

Patented Mar. 25, 1913.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR USE IN CONNECTION WITH THE REFINING OF PETROLEUM.

1,057,395.

Specification of Letters Patent.

Patented Mar. 25, 1913.

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To all whom it may concern:

Be it known that I, CLARENCE I. ROBINSON, a citizen of the United States, residing at West New Brighton, in the county of Richmond and State of New York, have invented certain new and useful Improvements in Apparatus for Use in Connection with the Refining of Petroleum, of which improvements the following is a specification.

This invention relates more particularly to apparatus for use in connection with the refining of such petroleum as is obtained from the oil fields in the State of Texas, near the town of Beaumont, in Jefferson county, the object of the refining being to obtain burning oil (kerosene). Said petroleum is herein referred to as Beaumont oil or Beaumont petroleum for convenience of reference. The designations are each of them intended to include oil of the same or substantially similar character wherever found or however obtained. For the purposes of this specification, such substantial similarity in character to the oil obtained near Beaumont is sufficiently shown for any crude oil by the fact that it responds to each of the two following tests, that is to say, first, the sulfur naturally present therein is given off (in utilizable proportion) in the form of hydrogen sulfid when the crude oil is heated to between about 300° F. and about 500° F., and, second, on distilling the crude oil, with or without cracking, and on collecting by itself the fraction coming over between 250° F. and 600° F., more or less, the so collected distillate, after treatment with sulfuric acid of 66° B. (in however large proportion) and subsequent washing with water and caustic soda lye (all in the known way) will smoke badly when burned in the ordinary petroleum (kerosene) lamps. For refining such petroleum I have discovered or invented certain processes by which non-smoking burning oil can be obtained from Beaumont petroleum by the aid of sulfuric acid of greater strength than the concentrated acid of 66° B. commonly used in petroleum refining; but the amount of such stronger sulfuric acid to be employed in so obtaining non-smoking burning oil is in excess of the small quantity of 66° B. acid customarily employed in refining Pennsylvania or Lima

petroleum; and, in order to obtain the requisite supply of acid economically, I have availed myself of the sulfur naturally present in Beaumont petroleum and also of the sulfur of the acid sludge from the refining operations, of which acid sludge the quantity produced is naturally larger than in the refining of Pennsylvania or Lima petroleum, on account of the greater amount of acid employed in said refining operations. These processes are described and claimed in my applications of August 21, 1903, and March 21, 1907, Nos. 170,326, 170,327 and 363,712 which last is a division and continuation of my said application No. 170,327, having been made in consequence of official requirement of division. To carry out these processes suitable apparatus is necessary; and in my said applications I have described such apparatus; but it has been held by the Patent Office that my claims on the apparatus must be secured separately from my process claims. The present application is, therefore, made (in consequence of such official requirement of division) in order to protect the apparatus which I have invented for carrying out said processes; and it is filed as a division and continuation of my said application of August 21, 1903, No. 170,327 and in part also as a continuation of my application of same date No. 170,326, the apparatus shown in No. 170,326 being included in and forming part of the apparatus shown in No. 170,327.

Portions of my new or improved apparatus can be used separately within the limits of the present invention. For example, appropriate portions thereof can be so used without the residue in case it should be desired to utilize the sulfur which is naturally present in the crude Beaumont oil, but not the sulfur content of the acid sludge of the refining operations; or conversely, in case it should be desired so to utilize the sulfur of such acid sludge, but not the sulfur which is naturally present in the crude Beaumont oil. Also portions at least of the apparatus can be employed in case there should be other petroleum analogous to Beaumont oil in having sulfur naturally present therein in such form that it can be utilized similarly to that of Beaumont oil, and it should be desired so to

utilize it, or in case it should be desired to utilize the sulfur content of acid sludge from refining petroleum other than Beaumont oil, whether analogous or not analogous thereto in respect to either or both of the before mentioned tests. Additions to the apparatus, or to portions thereof, can be made; and modifications of the apparatus, other than simple omissions and additions, are also permissible within the limits of the invention. For example, in what is considered the best form of the apparatus the sulfur both of the crude oil and of the acid sludge is converted into sulfuric acid; but the sulfur of either or both the crude oil and the acid sludge can be converted into other products, such as sulfite or bisulfite salts, sulfurous acid solutions, elemental sulfur, and so on, by employing appropriate known appliances in place of means for making sulfuric acid.

Each of the parts, improvements or combinations composing the present invention is, in fact, intended to be secured for all the uses to which it can be applied; and additions, omissions and other modifications can be made indefinitely so long as the substance is taken of any one or more of the claims at the end of this specification.

So far as I am aware, naturally present sulfur has never been recovered in utilizable form from any crude petroleum, although it has long been known to be a common constituent of petroleum and to exist in considerable proportion in some varieties, as in the oil from the Lima, Ohio, and Ontario, Canada, fields, for example. The crude oil from the Pennsylvania fields is nearly free from it. Beaumont crude oil contains, according to my experience, between one and two per cent. of sulfur. The sulfur in Lima or Canadian oil is not utilizable as I have found that of Beaumont petroleum to be. To recover it from crude Beaumont petroleum (or petroleum analogous thereto in respect to its sulfur content as aforesaid) the same is best heated in a suitable still gradually to about 500° F., more or less, and the sulfur-containing gas which is given off during such rise of temperature (all, or part, as may be determined) is collected, conveyed away and oxidized to form sulfuric acid. This oxidation is effected, first, by combustion in hydrogen sulfid burners; and, second, by subjection in lead chambers or contact apparatus to the agencies necessary to convert sulfur dioxide into sulfuric acid. In this conversion, when it is accomplished in the lead chambers, the sulfur trioxid unites with water to form chamber acid which can then be concentrated in any known or suitable way. Should the conversion be accomplished in contact apparatus, the sulfur trioxid may remain free as sulfuric anhydrid or it may be combined

with water, as sulfuric acid, more or less hydrated as may be desired. Before the combustion in hydrogen sulfid burners, the gas should be freed from oil vapors by cooling. Said combustion results in the formation of water as well as of sulfur dioxide; and said water may be removed or not before the oxidation of the sulfur dioxide to sulfuric acid, according to the case.

In order to recover the sulfur from acid sludge to the best advantage, I have discovered that it is important, first, to heat the sludge in bulk (say, in a compact body of several barrels at a minimum), in order rapidly and economically to obtain a good yield of sulfur dioxide; second, to agitate the sludge during the heating in bulk as aforesaid, in order to avoid foaming; third, to raise the temperature of the sludge to above 500° F. (to wit, to about 600° F.), in order to get off practically all of the sulfur from the sludge, some of it coming over as hydrogen sulfid; and, fourth, after condensing the oil vapors therein and so effecting their separation and prior to subjecting the sulfur dioxide to oxidation for converting it into sulfuric acid, to expose the gas to heat with access of air, as by passage in contact with burning sulfur, or sulfur bearing material (as pyrites or hydrogen sulfid) in a state of combustion, in order to burn its combustible constituents and at the same time raise its temperature. It is believed also that the passage of this gas over burning sulfur (or sulfur bearing material) may be advantageous in other respects. The heating of the gas, in this way, can be effected without expenditure of fuel for the purpose, the products of the combustion of the sulfur or sulfur bearing material being converted into sulfuric acid along with the gas from the sludge and yielding their surplus heat to the latter.

Between the agitator in which the oil to be refined is subjected to sulfuric acid and the acid sludge still in which the acid sludge is heated there is an acid sludge line composed best of a pipe or other conduit and (if necessary or expedient) a pump or pumps; but said line may consist of other conveying means, as tank cars, for example, whereby the acid sludge can be transported from said agitator to said still. Between the said agitator and the means for making sulfuric acid out of the sulfur contents of hydrogen sulfid given off by the crude Beaumont oil and of sulfur dioxide (or sulfur dioxide and hydrogen sulfid) given off by the acid sludge there is an acid line composed best of a pipe or other conduit and (if necessary or expedient) a pump or pumps; but said acid line may consist of other conveying means, as tank cars, for example, for transporting the acid between the said means for making sulfuric acid and

the said agitator. The transportation by pipe or otherwise of the acid sludge and the acid (or either of them) may be with or without intermediate storage.

The accompanying drawing is a diagram of an apparatus or plant in accordance with the invention for use in refining Beaumont petroleum.

The crude Beaumont petroleum is supplied after the usual manner to the crude oil still *a* by a charging line *b*; and when the still has been filled to the desired level it is heated so as gradually to raise the temperature of the still's contents. The gas and vapors as they are formed by the heat pass over to the condenser *c* wherein they are cooled to condense the oil vapors. The liquid of condensation flows into the distillate receiver *d*. The gas, including any uncondensed vapor, passes either by the line *e* to be burned as fuel or otherwise disposed of, or by the gas line *f* to be utilized in sulfuric acid making. While the temperature of the vapors as they leave the still *a* is below about 500° F., more or less, the gas from the condenser *c* consists of about or above 85% hydrogen sulfid (ordinarily, if not always) and is then delivered to gas line *f*. The temperature is raised to this degree more gradually than in ordinary distillation, being regulated with special reference to the production of hydrogen sulfid to the best advantage, and the distillate being allowed to take care of itself.

Should the hydrogen sulfid given off at any time below about 500° F. be found to be unsatisfactory in quantity or quality, it can be sent into line *e* as long as it may be so; but in my experience this change of gas line has not been found expedient until about 500° F. is reached. At about or above this degree the gas should be turned into the line *e*, so soon as the evolution of hydrogen sulfid fails in quantity or quality, the line *f* remaining closed during the rest of the run.

While the temperature is rising toward 500° F., the distillate collects in the receiver *d* until it becomes too smoky for utilization without removal of smoky hydrocarbons therefrom beyond what can be accomplished by treatment with 66° B. acid and redistillation. This has been found in my experience to be when the gravity of the distillate at the worm end (that is, before it enters the receiver *d*) is about 42° B., more or less, the temperature of the vapors escaping from the still *a* being about 400° F., more or less. The distillate then in the receiver is hereinafter referred to as the first burning oil cut. It belongs to the lighter end of the burning oil fraction. It amounts, in my experience, to from five to ten per cent. of the crude oil supplied to still *a*. The inlet of receiver *d* is then closed and that of receiver *g* is opened, so that the distillate from condenser

c will flow into this latter receiver. This change of receiver has been effected, in my experience, before the yield of hydrogen sulfid becomes unsatisfactory; so that for a time after the change of receivers the heating of the still *a* is regulated with special reference to the evolution of hydrogen sulfid. Afterward the heat of still *a* is regulated (as customary) with special reference to the distillate to be obtained.

The distillation is carried on with cracking which commences (in my experience) when the temperature of the liquid oil in the still *a* is about 600° F., more or less, the distillate in the two receivers *d* and *g* then amounting to about 40%, more or less, of the crude oil supplied to the said still *a*. The distillation is continued as long as it is safe to do so, say, till the distillate in said two receivers amounts to about 85% of said crude oil. The oil in receiver *g* is herein termed the cracked oil distillate; although a large percentage is composed of uncracked products.

It is customary to have a receiver into which the distillate can be turned whenever it becomes undesirable in quality, the result of something accidental; the receiver *h* is provided for such purpose. When necessary, its inlet can be opened, those of the receivers *d* and *g* being closed. Any one of the three receivers could be used for this purpose, the other two serving to collect the first burning oil cut and the cracked oil distillate, respectively. After the completion of a run, the crude oil still *a* can be emptied through the tar line *j* or in any suitable way, preparatory to refilling with crude oil for a new run.

The cracked oil distillate from receiver *g* is delivered by pump *r*, through line *s*, into distillate still *k*, wherein it is distilled to separate the burning oil from the heavier fraction. The vapors pass over to the condenser *l*, where they are reduced to the liquid state, any uncondensed products escaping by the line *m*, to be used as fuel or as may be desired. The distillate is collected in the receiver *n* until it becomes too smoky to be used in burning oil without removal of the smoky hydrocarbons beyond what can be effected by treatment with 66° B. acid and redistillation. In my experience, this occurs when the oil from the worm end is about 42° B., the temperature of the vapors from the still *k* being about 420° F., more or less, and the distillate in receiver *n* being about eight per cent. of the crude oil supplied to still *a*. This portion of distillate is hereinafter referred to as the second burning oil cut. Like the first burning oil cut, it belongs to the lighter end of the burning oil fraction. After it has been collected, the oil from condenser *l* is run into receiver *p*, so long as the distillate from the worm end

can be made non-smoking by treatment with a moderate amount of 98% acid and distillation of the so-treated oil. In my experience, the distillate (hereinafter termed the third burning oil cut) can be thus collected in the receiver *p* until it amounts to about 30% of the crude oil supplied to the still *a*, the gravity of the oil at the worm end being about 31° B., more or less, and the temperature of the vapors escaping from the distillate still *k* being about 550° F., more or less.

The residuum in the distillate still *k* is then withdrawn through tar line *g*, leaving the still empty for another run. This next run may be made on another lot of cracked oil distillate from receiver *g*, or it may be a distillation after treatment with acid of one or other of the burning oil cuts or of a mixture of said cuts; for as shown the one still *k* serves for both distillations. It is to be understood, however, without further statement, that where one still, agitator or other vessel is shown, in practice as many of such vessels as desired can be used, and that it is not material to distill or to collect different oils, or to treat different oils with acid in the same vessels.

The first and second burning oil cuts are treated with ordinary concentrated acid either separately or mixed together, as may be preferred. They are delivered from their respective receivers *d* and *n* by the pump *r* through a branch of the oil line *s* to the agitator *t*. Here the oil is agitated as customary in the sulfuric acid treatment with acid of 66° B.; and, after settling and drawing off the acid sludge through pipe *u* into sludge tank *w*, the oil is washed repeatedly with water and then with a solution of caustic alkali. The water and alkaline solution can be removed (after proper settling in each case) through the draw-off *x*. In my experience, about ten pounds of 66° B. acid to a barrel of the distillate treated is sufficient.

The treated oil is delivered by pump *y* through part of oil line *s* into distillate still *k* and is subjected to an incomplete distillation therein, that is to say, it is distilled so long as the oil from the worm end is satisfactory. The oil from condenser *l* during this distillation collects in the receiver *n*. The residuum in still *k*, amounting, in my experience, to between ten and twenty per cent. of the charge of said still *k*, is then run off through the tar line *g*, leaving the still *k* ready for the next run.

The third burning oil cut is pumped from receiver *p* into agitator *t* and is there agitated with 98% of acid in moderate amount for about an hour. In this time, according to my experience, the effect of the acid will be exhausted. The acid should be applied in two portions and may be in all about two pounds, more or less, of acid to each gallon

of the oil treated, namely, of the third burning oil cut. The oil should have a temperature of about 90° F., more or less, at the beginning of the treatment. The acid sludge is drawn off into the tank *w*, and the treated oil is washed repeatedly with water and afterward with a solution of caustic alkali as in the ordinary sulfuric acid treatment.

The treatment with 98% acid greatly improves the oil; but it will still contain an excess of smoky hydrocarbons, as well as acid compounds which would cause the lamp wick to be charred were the oil without further refining burned in a lamp. The treated oil is, therefore, delivered by pump *y*, through oil line *s*, into distillate still *k* and subjected to an incomplete distillation, that is, a distillation so long as the collected distillate constituting the third burning oil cut, after mixture with the light ends (first and second burning oil cuts) furnishes a product which as a whole shows either by burning in a lamp or by the refractometer the proper freedom from smoky hydrocarbons. According to my experience, the distillation would best not be continued after the oil from the worm end reaches 29½° B. or somewhat lighter (say, between 30° B. and 31° B.) if the still should be running slowly.

The third burning oil cut is collected in the receiver *p*, or in the receiver *n*, if desired. The residuum, amounting, in my experience, to about ten per cent., more or less, of the treated oil charged into the still *k*, will contain the worst (smokiest) portions of the oil. It is run off by the tar line *g*.

By the preceding operations there will have been obtained one, two or three lots of oil, according to the collection in one, two or three receivers of the distillates from the incomplete distillation of the three burning oil cuts. The refining of said distillates is finished by subjecting them, separately or two or more of them in admixture, to treatment in the usual way with a small quantity of 66° B. acid in the agitator *t*; and the finished oil is thence run by line *z* into the tank 2, wherein the oil from different cuts can be mixed, if not already in admixture.

In my experience, Beaumont crude oil contains such a small percentage of light products that steam stilling is not necessary for low test burning oil (kerosene); but if it should be desired to increase the fire test, the finished oil, or one or both the lighter burning oil cuts, may be steam stillled to bring the product to the desired test. According to my experience, it should suffice to steam still the finished oil from the second burning oil cut. Either or both of the finished light ends could be mixed with the finished heavier portion and the whole steam stillled.

The hydrogen sulfid from the crude oil still *a*, together with a small proportion of

other aeriform fluid therein, is conveyed by the gas line *f* to a storage gasometer 3, from which it is supplied to the burner 4, wherein both it and other combustible substances present are burned, the hydrogen sulfid being converted thereby into sulfur dioxide and water. These may both be delivered through gas line 5 into the lead chamber 6 for making sulfuric acid. They could be delivered into a Glover tower 7; but this is not considered desirable, in view of the large proportion of water vapor in admixture with the sulfur dioxide. The water could, however, be separated by condensation and the sulfur dioxide, being heated, could be sent either into tower 7 or lead chamber 6. It could be sent into other sulfuric acid making apparatus.

The acid sludge from tank *w* is delivered through acid sludge line 8 by pump 9 into the acid sludge still 10 until the latter is filled to the desired level (say, 200 barrels of acid sludge in a still of 500 barrels capacity). The still may be of iron and be heated by fire in any known or suitable way. As shown it is provided with a rotary stirrer 11, in order to check foaming. After charging the still is heated so as to keep up a good delivery of sulfur dioxide, say, about 2,500 cubic feet, more or less, per hour.

The evolution of gas begins at about 220° F. (temperature of the liquid), and at about 600 F° should be practically complete, only coke remaining in the still.

The gas and vapors from still 10 (which may be of iron) are passed through the condenser 12 (which should have a lead worm), in order to separate the small amount of oil vapors carried over with the sulfur dioxide. The sulfur dioxide then passes by gas line 13 to a storage gasometer 14, from which (after being heated) it is sent either into tower 7 or chamber 6, in order to be converted into sulfuric acid. At 13' is indicated the beginning of a valved branch gas line for switching out the gas, instead of allowing it to pass to the apparatus for making sulfuric acid, should it be desired at any time to do so. Occasion for this would be most apt to arise, if at all, at the beginning of the decomposition, on account of the larger proportion in some cases of hydrocarbons then present in the gas. The gas, when switched out, can be used as fuel or be otherwise disposed of, as the manufacturer may determine.

Toward the end of the operation, in removing the last portion of sulfur from the sludge, some hydrogen sulfid comes over. To convert this into sulfur dioxide (and water) the gas may be passed through the burner 4 on its way to the lead chamber 6. As the gas from condenser 12 is cold throughout the operation, it should be heated before it is admitted into tower 7 or

chamber 6. This can be done by passing all the gas through a burner (as 4, for example) in which combustion yielding sulfur dioxide is going on. Such passage insures also the combustion of any small quantities of hydrocarbons which may be present in the gas. All the sulfur dioxide from such burner would pass into the sulfuric-acid-making apparatus.

The oil from condenser 12 runs into the receiver 15. It and the coke (removed from the still 10 preparatory to the next run) can be used as fuel or otherwise disposed of.

The dilute sulfuric acid from the lead chamber 6 is carried by line 16 to an apparatus 17, where it is concentrated to 98% acid by heating or by adding sulfuric anhydride or by the aid of both operations. It is delivered by acid line 18 to a storage tank 19 from which it passes by line 20 to the tank 21 from which it is delivered by pump 22 into the agitator *t* as above described. The acid of 66° B. can be obtained from another portion of the same dilute acid and be delivered in the same way to the said agitator.

Should it be so desired, all, or any part, of the acid produced can be sold in any desired kind or degree of concentration. Should it be desired to utilize the sulfur-containing gas given off from Beaumont or analogous crude oil and collected according to the preceding description through the line *f*, otherwise than for the preparation of sulfuric acid, it could be done by subjecting the said gas to any known or suitable procedure for the utilization of hydrogen sulfid. I believe I am the first to collect such gas for the utilization of the hydrogen sulfid therein. So also the gas from the distillation of the acid sludge could be subjected to any known or suitable procedure for the utilization of sulfur dioxide.

The expression "means for utilizing the sulfur content" in those of the hereinafter written claims in which it occurs designates primarily one or more lead chambers, with such appurtenances and additions as may be necessary for making sulfuric acid by appropriate conversion; but by extension said expression also includes contact apparatus, with necessary appurtenances and additions, and in general any known or suitable means for utilizing the sulfur content specified in making sulfuric acid; and by still further extension said expression includes any known or suitable means in general for utilizing such sulfur content, the same comprising not only means for making sulfuric acid therefrom, but also means for forming sulfite and bisulfite salts, sulfurous acid solutions, elemental sulfur, and so on, from such sulfur content.

Each of the expressions "still as specified" and "box like still as specified"

means primarily an acid sludge still, but it includes also a still for heating an oily liquid in general for evolving therefrom gas which shall contain sulfur in the form of hydrogen sulfid or of sulfur dioxid, or of both, in utilizable amount, acid sludge from petroleum refining operations being such liquid, but not necessarily the only such. Crude Beaumont oil is another such liquid; and there are no doubt others. The cheese box still and the horizontally disposed cylinder still of the oil refiner are both included in the expression "box like," which, moreover, is not necessarily restricted to these forms.

I claim herein as my invention or discovery:

1. The combination with a crude oil still provided with a crude oil charging line and adapted to keep up a good delivery of aeriform products with gradual heating of the still's contents, of a condenser, a hydrogen sulfid burner, means for converting sulfur dioxid into sulfuric acid, a gas line leading from said still first through said condenser and then through said burner to said means, a gas line communicating with the vapor space of said still and leading elsewhere than to said means, and appliances whereby the aeriform products evolved in said still can be sent through one gas line to said means in order to form sulfuric acid therefrom or can be otherwise disposed of through the other of said gas lines, substantially as described.

2. The combination with a crude oil still provided with a crude oil charging line and adapted to keep up a good delivery of aeriform products with gradual heating of the still's contents, of a condenser, a hydrogen sulfid burner, means for utilizing the sulfur content of sulfur dioxid, a gas line leading from said still first through said condenser and then through said burner to said means, a gas line communicating with the vapor space of said still and leading elsewhere than to said means, and appliances whereby the aeriform products evolved in said still can be sent through one gas line to said means in order to utilize the sulfur content of the sulfur dioxid therein or can be otherwise disposed of through the other of said gas lines, substantially as described.

3. The combination with a crude oil still provided with a crude oil charging line and adapted to keep up a good delivery of aeriform products with gradual heating of the still's contents, of a condenser, means for utilizing the sulfur content of hydrogen sulfid, a gas line leading from said still through said condenser to said means, a branch line communicating with the vapor space of said still and leading elsewhere than to said means, and appliances whereby

the aeriform products evolved in said still can be sent through one gas line to said means in order to utilize the sulfur content of the hydrogen sulfid therein or can be otherwise disposed of through the other of said gas lines, substantially as described.

4. The combination with a crude oil still adapted to keep up a good delivery of aeriform products with gradual heating of the still's contents and provided with a crude oil charging line and also with a line for drawing off and conveying away in a liquid state the residual contents of said still, of a condenser, a hydrogen sulfid burner, means for converting sulfur dioxid into sulfuric acid, and a gas line leading from said still first through said condenser and then through said burner to said means, substantially as described.

5. The combination with a crude oil still adapted to keep up a good delivery of aeriform products with gradual heating of the still's contents and provided with a crude oil charging line and also with a line for drawing off and conveying away in a liquid state the residual contents of said still, of a condenser, a hydrogen sulfid burner, means for utilizing the sulfur content of sulfur dioxid, and a gas line leading from said still first through said condenser and then through said burner to said means, substantially as described.

6. The combination with a crude oil still adapted to keep up a good delivery of aeriform products with gradual heating of the still's contents and provided with a crude oil charging line and also with a line for drawing off and conveying away in a liquid state the residual contents of said still, of a condenser, means for utilizing the sulfur content of hydrogen sulfid, and a gas line leading from said still through said condenser to said means, substantially as described.

7. The combination with a box like acid sludge still arranged to hold several barrels of sludge at a minimum and to keep up a good delivery of aeriform products with gradual heating of the sludge and consequently without carrying sludge over into the vapor outlet to clog the same, of means for purifying sulfur dioxid and converting it into sulfuric acid, and a gas line leading from said still to said means, substantially as described.

8. The combination with a box like acid sludge still arranged to hold several barrels of sludge at a minimum and to keep up a good delivery of aeriform products with gradual heating of the sludge and consequently without carrying sludge over into the vapor outlet to clog the same, of a condenser, a burner for effecting the combustion of combustible aeriform products and leaving sulfur dioxid unoxidized, means for converting sulfur dioxid into sulfuric acid, and

a gas line leading from said still first through said condenser and then through said burner to said sulfur dioxid converting means, substantially as described.

5 9. The combination with a box like acid sludge still arranged to hold several barrels of sludge at a minimum and to keep up a good delivery of aeriform products with gradual heating of the sludge and consequently without carrying sludge over
10 into the vapor outlet to clog the same, of a condenser, means for converting sulfur dioxid into sulfuric acid, a gas line leading from said still through said condenser to
15 said means, and a burner located in said gas line intermediate said condenser and said converting means and provided with instrumentalities for supplying additional sulfur thereto in a combustible form, substantially
20 as described.

10 10. The combination with a box like acid sludge still arranged to hold several barrels of sludge at a minimum and to keep up a good delivery of aeriform products with
25 gradual heating of the sludge and consequently without carrying sludge over into the vapor outlet to clog the same, of means for purifying sulfur dioxid and utilizing its sulfur content, and a gas line leading from
30 said still to said means, substantially as described.

35 11. The combination with a box like acid sludge still arranged to hold several barrels of sludge at a minimum and to keep up a good delivery of aeriform products with gradual heating of the sludge and consequently without carrying sludge over into the vapor outlet to clog the same, of a stirrer
40 in said still adapted by its agitation of the sludge to lessen the foaming of the latter, means for purifying sulfur dioxid and utilizing its sulfur content, and a gas line lead-

ing from said still to said means, substantially as described.

12. The combination with stills, one of 45 them being a crude oil still adapted to keep up a good delivery of aeriform products with gradual heating of the still's contents and provided with a crude oil charging line and also with a line for drawing off and con- 50 veying away in a liquid state the residual contents of said still, and another of said stills being a box like acid sludge still arranged to hold several barrels of sludge at a minimum and to keep up a good delivery of 55 aeriform products with gradual heating of the sludge and consequently without carrying sludge over into the vapor outlet to clog the same, and provided with a stirrer which is adapted by its agitation of the sludge to 60 lessen the foaming of the latter, of condensers, a hydrogen sulfid burner, means for converting sulfur dioxid into sulfuric acid, a gas line leading from each of said stills first through a condenser and then through 65 said burner to said means, a gas line communicating with the vapor space of said crude oil still and leading elsewhere than to said means, and appliances whereby the aeriform products evolved in said crude oil still 70 can be sent through one gas line to said means in order to form sulfuric acid therefrom in connection with the aeriform products evolved in said acid sludge still or can be disposed of otherwise through the gas 75 line leading elsewhere than to said means, substantially as described.

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

CLARENCE I. ROBINSON.

Witnesses:

LEE TOADVINE,
A. P. ARNOLD.