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PROCESS OF TREATING MINERAL OIL FOR THE PRODUCTION OF GASOLINE.

APPLICATION FILED APR. 20, 1918. RENEWED MAY 20, 1921.

1,407,340. Patented Feb. 21, 1922.

2 SHEETS—SHEET 1.

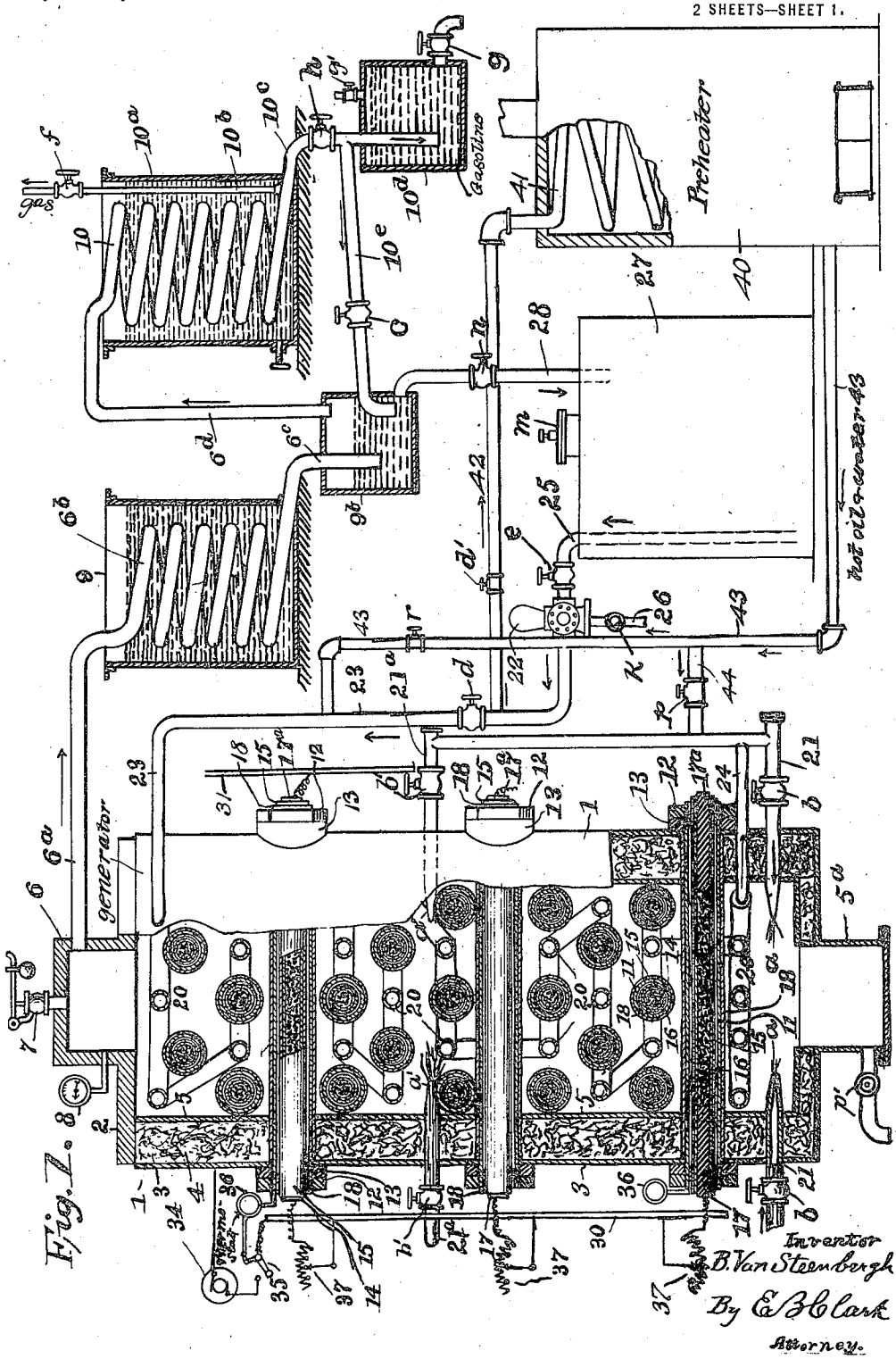


Fig. 1.

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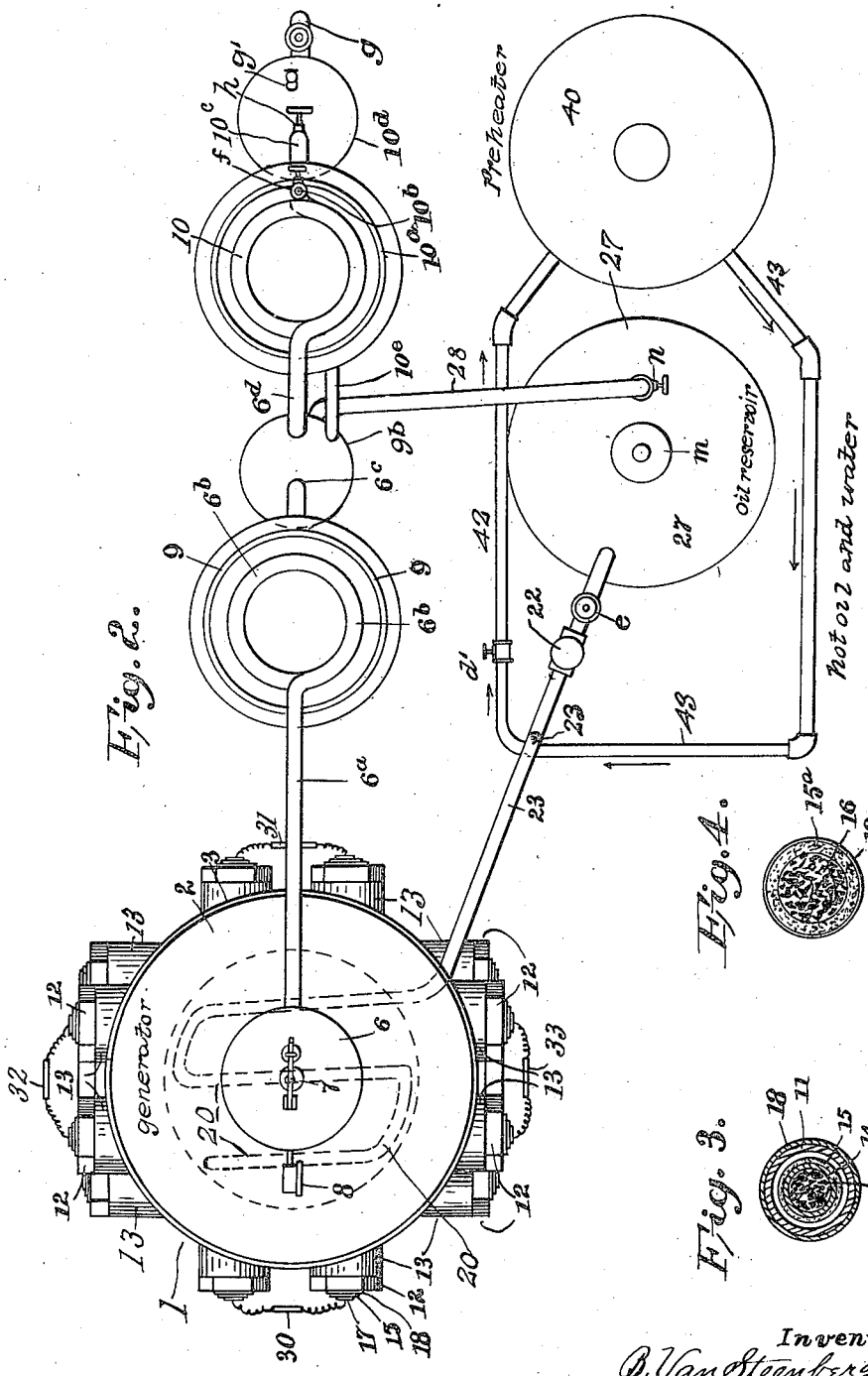


Fig. 2.

Fig. 4.

Fig. 3.

Inventor.
B. Van Steenbergh
By E. B. Clark
Attorney.

UNITED STATES PATENT OFFICE.

BURHANS VAN STEENBERGH, OF GOSHEN, NEW YORK.

PROCESS OF TREATING MINERAL OIL FOR THE PRODUCTION OF GASOLINE.

1,407,340. Specification of Letters Patent. Patented Feb. 21, 1922.

Application filed April 20, 1918, Serial No. 229,707. Renewed May 20, 1921. Serial No. 471,176.

To all whom it may concern:

Be it known that I, BURHANS VAN STEENBERGH, a citizen of the United States, residing at Goshen, in the county of Orange and State of New York, have invented certain new and useful Improvements in Processes of Treating Mineral Oil for the Production of Gasoline, of which the following is a specification.

This invention relates to a process for increasing the yield of low boiling point hydrocarbons, commonly known as gasoline, from petroleum or distillate products by decomposition or cracking of the higher boiling point oils.

The principal object of my invention is to provide a continuous process for dissociating or cracking the heavier oils into oils of lighter gravities by spraying an excess quantity of the heavy oil into contact with a heated surface or numerous heated surfaces and repeatedly subjecting the resulting mixture of cracked and uncracked vapors to contact with heated surfaces at a temperature to produce decomposition or cracking into vapors of lower boiling point oils with the maximum production of vapors of lower boiling point oils and the minimum production of fixed gas by destructive decomposition of the oil.

By excess quantity of oil or oil vapor to be thus injected I mean a quantity which cannot be wholly decomposed or cracked by first contact with the heated surfaces in the normal flow of the mixed vapors through, and out of, the treating chamber or generator. Part of the injected and sprayed oil or vapor will be decomposed or cracked by the first contact with the heated surfaces, while a part will pass on as vapor, and part of this vapor will, in passing along, be decomposed or cracked by contact with other heated surfaces into vapors of lower boiling point oils, and at the same time largely prevent destructive decomposition of the first produced light products, resulting in the formation of lamp-black or hard carbon and loss of gasoline or other low boiling point oils. In this way I secure a maximum production of low boiling point product—gasoline—and a minimum production of fixed gases. The undecomposed vapor first produced protects the gasoline products resulting from the cracking operation from further undesired and wasteful destructive decomposition. However, by providing a succession of heated surfaces a large proportion of the merely vaporized oil will be successively cracked into low boiling point products and a large yield of such products thus obtained as the condensate.

Another object of my invention is to provide for spraying oil into contact with heated catalytic agent surfaces at a temperature to decompose the oil into lower boiling point oils and at the same time bring free hydrogen or a hydrogen carrying gas or vapor into contact with said surfaces for hydrogenating the unsaturated hydrocarbons and carrying them along away from the heated surfaces and out of the generator to prevent over-cracking or destructive decomposition and formation of fixed gases.

Another object of my invention is to provide for generating hydrogen carrying gas by contact of steam and oil or steam in the presence of carbon, with surfaces heated approximately to 2,000° F. in the lower part of the treating chamber or generator and passing it directly into contact with the hydrocarbon vapors and the heated catalytic agent surfaces above where dissociation or cracking is effected for expediting the operation and exercising its hydrogenating effect at the moment of dissociation.

Another object is to provide for cracking oil by contact with a plurality of heated surfaces into vapors of lower boiling point oils, passing the remaining uncracked portions down over successively more highly heated surfaces to crack additional portions thereof and pass residual heavy oil or tarry matter into a receiver outside of the heating zone so that it will not be baked as hard carbon or lampblack upon the heated surfaces.

The catalytic agent coatings which form the heated surfaces serve the useful purpose of preventing the deposit and accumulation of carbon on the heaters; also the purpose of making gasoline of sweeter odor and better quality when hydrogen is present.

I preferably employ electric heaters for constantly maintaining the exact temperature, between 650° and 850° F. in the main and upper part of the generator for best effecting the cracking operation, depending upon the quality and gravity of the oil being treated. The lower heaters are preferably heated to a higher temperature and may be heated to a temperature between 1,800° F.

and 2,000° F. to serve as steam decomposing surfaces and for cracking heavier portions of oil which may flow down over them for final deposit of residual oily or tarry matter in a receiving chamber below or outside of the heating zone.

An apparatus adapted for carrying out my process is illustrated in the accompanying drawing, in which:

Figure 1 represents a sectional elevation, showing part of the electric heaters in longitudinal section and part in cross section.

Fig. 2 represents a top plan view.

Fig. 3 represents, on enlarged scale, a transverse section of an electric heater, such as shown in Fig. 1.

Fig. 4 represents, on enlarged scale, a transverse section of an electric heater of modified construction.

I have discovered that cracking of high boiling point oil can be most economically and rapidly effected by direct contact with a heated surface and at a distance of from one-half to three-quarters of an inch therefrom, and, therefore, provide that the surfaces in my apparatus shall be between one and two inches apart, and so arranged that the currents of mixed oil vapor and steam shall be repeatedly deflected and caused to impinge on numerous heated surfaces. In this arrangement I heat the contact surfaces only to that temperature which will decompose or crack the oil into lower boiling point fractions which are condensable to gasoline, and with the least possible destructive decomposition to fixed gas and fixed carbon. If the heated surfaces are too close together the hydrocarbon will be held too long in contact and will result in destructive decomposition and deposit of carbon. If the surfaces are too far apart the vapors are apt to flow past them too fast and escape proper cracking. The tendency, then, is for the operator to more highly heat the surfaces, with the result that those hydrocarbons brought into direct contact with the surfaces will be overheated and caused to deposit fixed carbon and make fixed gases, instead of the desired gasoline.

I preferably employ internally heated electric heaters for maintaining a large external heating surface at the exact degree required for the most economical and effective operation. In order to expedite the cracking operation, I preferably preheat oil and water under pressure to approximately 800° or 1,000° F. before subjecting them to contact with the catalytic agent coatings of the electric heaters where cracking is effected. The oil and water will preferably be preheated in coils of pipe in any desired heating furnace outside of my generator, but I also arrange coils or serpentine folds of one-inch pipe between the electric heaters in the generator. They thus act as heating surfaces and serve to deflect hydrocarbon vapors and steam into contact with the catalytic agent coatings of the electric heaters and to intermingle the cracked and uncracked vapors, so that a larger percentage of uncracked vapors will be caused to make contact with the heated surfaces.

Referring to the drawing, the treating chamber or generator 1 is preferably constructed with a double plate iron shell 3 and 5, between which is placed a filling of non-conducting material 4, which may be of asbestos, mineral wool, ashes or brick. If brick is used, the outer metal shell may not be required. The top is closed by a cover 2, having a dome 6, and from the latter leads the vapor escape pipe 6^a which connects with the first condensing coil 6^b in a water tank 9. The coil 6^a terminates in an outlet pipe 6^c which extends down into a seal-box 9^b, where its opening is sealed in the liquid. An outlet vapor pipe 6^d rises from the box and connects with the second condenser coil 10 in water tank 10^a, and this coil terminates in an outlet pipe 10^c having a valve *h* and extending down into a seal-box 10^d. This box is provided with a draw-off pipe and valve *g* for gasoline. A gas outlet pipe 10^b rises from the outlet end of coil 10 and is provided with a valve *f* to control the outflow of gas to a holder or a place of immediate use. The seal-box 10^d is not intended to serve as a reservoir, but merely as a trap or seal to prevent back flow of air into the condenser. The box may be filled, or partially filled, with liquid and a vent *g'* provided at the top in a well known manner. The representation is somewhat diagrammatic, but will be understood, and the apparatus will be made operative by those skilled in the art. A return pipe 10^e, having a valve *c*, connects with vapor pipe 10^c and with seal-box 9^b for returning any desired portion of oil to be again run through the treating apparatus.

A safety valve 7 and a pressure gage 8 are preferably applied to the dome 6.

In making my electric heater I may use an exterior iron tube 11, into which is inserted the electric heater proper, constructed as follows: A cardboard cylinder 14 is coated externally with insulating material, consisting of finely ground silica and finely ground carbonate of lime mixed with sodium silicate diluted with water to form a paste. This paste is moulded around the cylinder 14 and forms a coat or jacket 15. The tube thus formed is partially filled with granular carbon 16, and then carbon electrodes 17, 17^a are thrust into the ends of the tube making a tight fit and so as to compress the carbon into the middle part of the tube and form a resistance connection between the ends of the electrodes 17, 17^a.

The tubes 14, after the insulating jacket

has hardened, is inserted in the outer iron tube 11 and the latter is placed in openings in the wall of the generator, extending at both ends beyond the same. The ends of the tube are screw threaded. Washers 13, provided with horizontally concave inner faces, are slid over the ends of the tubes and fit against the curved wall and nuts 12 are then screwed onto the tubes so as to clamp them securely in place. Before the iron tubes are fitted into the generator walls they are covered with a coating or jacket of a catalytic agent containing a metallic oxide, such as oxide of calcium and oxide of magnesium mixed with diluted silicate of sodium. These are made into a paste which is applied as a coating or jacket 18 to each tube 11 before it is secured in place. This coating aids by catalytic action in cracking the oil into lower boiling point products, and also prevents deposit of carbon.

When the electric current is passed through the heaters the cardboard tubes will be carbonized, forming in effect part of the resistance material of the heater. The heating member may be further insulated from the iron tube 11 in any suitable manner.

A modified form of electric heater is shown in Fig. 4, in which a fire clay tube 15^a, baked at a temperature of about 3,000° F. is used instead of the iron tube 11. This also makes unnecessary the inner pasteboard tube and its insulating coating, since the fire clay tube acts as an insulator. The catalytic agent coating 18 may be applied to the outer surface of the fire clay tube.

The body of granular carbon 16 compressed between the ends of the electrodes 17, 17^a forms a resistance, by means of which a succession of small or short electric arcs are produced, thus converting electric energy into heat, thereby heating the tubes at that part filled with granular carbon from the inside to the surface.

The heat will be largely confined within the space between the walls of the generator, by reason of the heat insulating material in the walls. Since the granular material offers a much greater resistance to the electric current than is offered by the electrodes, heat will be generated principally in the parts of the heaters located between the inner walls of the generating chamber. Such localized heat is imparted to the superheater pipes 20 and the intervening space between them and the heaters.

Though I have shown and described a special construction of electric heater, I wish it to be understood that my process is not confined to the use of such specific construction. Modifications in details of construction may be made which may be effectively used to carry out my process. Other kinds of electric heaters may be used. My process is not limited to the particular catalytic agent coating above described, but may be carried out with any one or more of the known catalytic agents which may be successfully used in hydrogenating oils, and particularly cracked hydrocarbon oils for saturating and making them sweet and of agreeable odor.

Within the generator chamber I arrange a series of preheater pipes 20 in the form of a serpentine, as indicated by dotted lines in Fig. 2 between the electric heaters, Fig. 1, thereby forming numerous deflectors and tortuous passages. They also become highly heated and effective as decomposing surfaces, and fill the wider spaces between the electric heaters so as to divert the oil vapors into contact with the catalytic agent coatings of the electric heaters. A mixed fluid, composed of approximately eighty per cent oil and twenty per cent of water may be forced into the pipe 20 at the top through a feed pipe 23, having a valve d, by a proportioning force pump 22 of a known kind. This pump connects by a pipe 25, having a valve e, with the oil reservoir 27, and by pipe 26, having a valve k, with a water supply, not here shown. An outlet pipe 24 connects at the bottom of the generator with the preheater pipe 20 and connects by branches with the injector spray pipe 21, 21^a, located at different heights in the generator. The injectors have contracted nozzles a, a' and valves b, b'.

For the purpose of preheating the mixed oil and water to a temperature of approximately 1,000° F. I provide a separate heating furnace 40 having a preheating coil 41, and heat the same with a coal or oil fire in a well known manner. The same mixing and forcing pump 22 will serve for supplying mixed oil and water to the preheating coil 41 by the pipe connections shown. A discharge pipe 42 having a valve d' for mixed oil and water leads from the discharge pipe 23 of the pump below its valve d and connects with the preheating coil 41. A discharge pipe 43 having a valve r leads from the bottom of coil 41 and connects with pipe 23 which leads to the serpentine pipe 20 in the generating chamber 1. A branch pipe 44 having a valve p connects pipe 43 directly with the injector spray pipe or nozzles 21, 21^a.

The oil reservoir 27 has a supply opening and cover m. A return oil pipe 28, having a valve n, leads from the seal-box 9^b into reservoir 27, for the return of heavy oil.

At the bottom the chamber of the generator is provided with a settling pocket 5^a, having a draw-off faucet p' for any heavy oil or tarry matter which may collect.

The electric heaters which are parallel and lying at different levels are connected by bus-bars 30, 31 and 32, 33, respectively, which bars are connected in circuit with a

source of energy 34; and a switch 35 controls the circuits. An automatic device, such as a thermostat 36, may be located at the outlet of each electric heater, or at suitable points in the wall of the generator to control the temperature by cutting out or cutting in the circuit, according to variations in the temperature. The temperature may thus be kept within fixed limits and practically uniform, and so long as the proper quantity of oil vapor and superheated steam is supplied the process will be continuous.

A rheostat 37 is preferably connected with each pair of electric heaters for controlling the electro-motive force, and consequently the temperature in each set of heaters. The heat will thus be regulated and controlled to the exact degree required for cracking the heavier hydrocarbon into lower boiling point hydrocarbons to make gasoline.

The mixed stream of oil and water may be superheated in a detached coil 41 in a separate chamber 40, which may be heated in any well known manner and passed therefrom to the spraying injector devices 21, 21ª, or first into the pipe 20 and then into the injectors, as above described.

The operation is very simple and can be readily carried out by any one skilled in the art of distilling and refining oil. It will be simply necessary to turn on the electric current at the switch 35 and heat the electric heaters to the proper degree of temperature, between 650° and 850° F., and maintain them at that temperature during the cracking operation. The pump will be so set as to draw in about 80% of oil and 20% of water by volume. This mixture will be forced into a preheating coil preferably in the outside furnace 40. The temperature in the preheater coil 41 will be maintained at about 800° or 1,000° F. and the mixed oil and water and their vapors will be forced under pressure into and through the preheating coil or serpentine 20. By maintaining the fluids under pressure they will remain in a liquid condition and thus be more readily superheated. Of course, when the compressed liquids escape from the spraying nozzles of the supply pipes 21, 21ª, they expand and lose part of their heat, but are immediately brought into contact with the heated catalytic coating surfaces of the electric heaters, where decomposition or cracking is effected.

This reduction of pressure on the oil and vapor in the generating chamber is important, as it permits them to expand and separate more or less from the water vapor and be impinged directly upon the heated surfaces where decomposition or cracking is effected at a lower temperature than would be possible under the pressure maintained in the preheating or superheating coils 41 and serpentine 20. Decomposition of comparatively heavy oil into vapors of lower boiling point oils is, therefore, very rapid in the generating chamber. Owing also to the low pressure or lack of pressure in the generating chamber and to the fact that hydrogen is being passed up through the chamber, the vapors of freshly cracked oil will be quickly carried out of the chamber, so as to prevent destructive decomposition by too long exposure to the heated surfaces.

Hydrogen for exercising a hydrogenating effect by contact with the catalytic agent coatings and the vapors at the moment of cracking may be admitted by one of the lower injector pipes 21. I also propose to heat the lower group of electric heaters to a temperature between 1,800° and 2,000° F. and spray in contact therewith a mixture of superheated oil and steam, thereby decomposing the steam by causing its oxygen to combine with carbon present, either in the sprayed oil or that which has been deposited on the heaters, to form carbon monoxide and liberate hydrogen. The hydrogen of this mixture or that which is separately admitted by a pipe 21 will pass up through the generator and act as the hydrogenating agent to combine with the unsaturated hydrocarbons and make a pleasant, sweet odored gasoline. The carbon monoxide with other permanent gases will eventually pass off through the pipe 10ᵇ to a holder.

The lower group of electric heaters being more highly heated, as described, will cause heavy oily matter which may flow down over them to be cracked and converted into gasoline, so that very little tarry matter will pass into the pocket 5ª. It will be understood that most of the heated oil which is sprayed into the generator by the upper injectors 21ª will be vaporized and cracked by contact with the heaters above, but that, after such cracking operation, some of the remaining heavier oil will drop down and pass over the more highly heated surfaces below and become cracked or decomposed into oils of lighter gravity.

Any heavy uncracked oil, remaining after the cracking of oil in contact with the heaters above, will flow down over the more highly heated surfaces between 1,800° F. and 2,000° F., below and be cracked into vapors of lower boiling point oils, and the residual heavy oil or tarry matter will pass down into the receiving chamber or pocket 5ª outside of the heating zone.

The apparatus can be operated with very little attention or manual labor and will be rapid and economical in operation.

I am aware that hydrocarbon oil has been decomposed and gasified by spraying it into contact with a heated surface, and I make no claim to such step separately in my process. Oil or oil and water have also been heated and circulated under pressure

for gasifying the same, and I do not herein claim such a step or operation. The above steps or operations, however, are important parts of my process as set forth in the claims. By preheating oil or a mixture of oil and water under pressure to or above the cracking temperature of the oil, then spraying the same at reduced pressure against a heated contact surface at a cracking temperature the oil is rapidly cracked into vapors of lower boiling point oils which are passed into contact with other heated surfaces for making a homogeneous product which is passed directly to a condenser without opportunity to pass into heavier oils and be reabsorbed. Redistillation of my gasoline product is not, therefore, usually required.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. The process of treating mineral oil for the production of gasoline, which consists in spraying an excess quantity of preheated oil in contact with an interiorly heated surface at a temperature to decompose part of the oil by the first contact into vapors of lower boiling point oil, and to simply vaporize part of said sprayed oil, then repeatedly deflecting the mixed vapors by contact with a succession of spaced and interiorly heated surfaces at a cracking temperature till the desired percentage of the vapor has been decomposed or cracked to lower boiling point oil, whereby the cracked products first obtained will be largely protected from destructive decomposition by the excess vapors which have not been cracked and whereby a minimum of fixed gas will be produced.

2. The process of treating mineral oil for the production of gasoline, which consists in preheating oil under pressure, then spraying the same at reduced pressure in contact with numerous heated catalytic agent coated surfaces at a temperature to decompose a desired percentage of the oil into vapors of lower boiling point oil and at the same time passing a hot hydrogen carrying gas into contact with the oil vapors at the catalytic agent coated surfaces and thence up between said surfaces for facilitating the cracking operation, improving the odor and quality of the lower boiling point oil produced and carrying upward the light vapors.

3. The process of treating mineral oil for the production of gasoline, which consists in spraying an excess quantity of oil in contact with numerous spaced and interiorly heated catalytic agent coated surfaces at a temperature to decompose part of the oil by first contact into vapors of lower boiling point oil, and to simply vaporize part of said oil, and at the same time bringing a hot hydrogen carrying gas at a high temperature into contact with the oil vapors at the catalytic agent coated surfaces for facilitating the cracking operation and improving the odor and quality of the cracked product, then repeatedly deflecting the mixed vapors by contact with a succession of such heated surfaces at a cracking temperature till the desired precentage of the vapors has been decomposed to lower boiling point oil, whereby the vapors resulting from cracking will be protected from destructive decomposition and a minimum of fixed gas produced.

4. The process of treating mineral oil for the production of gasoline, which consists in spraying heated oil in contact with a catalytic agent coated surface at a temperature to decompose part of the oil by first contact into vapors of lower boiling point oil, and to simply vaporize part of said oil, at the same time generating hydrogen by decomposition of steam in contact with a carbon in a separate part of the treating chamber or generator and bringing such hot hydrogen gas at a temperature higher than said coated surfaces into contact with the oil vapors at the catalytic agent coated surfaces for facilitating the cracking operation and improving the odor and quality of the cracked product, then repeatedly deflecting the mixed vapors and hydrogen by contact with a succession of spaced and interiorly heated catalytic agent coated surfaces for increasing the yield of lower boiling point oil vapors and hydrogenating the same.

5. The process of treating mineral oil for the production of gasoline, which consists in preheating a mixture of oil and water and their vapors to a temperature between 800° F. and 1,000° F. and then causing the resulting vapors to impinge upon a plurality of spaced and interiorly heated surfaces at a temperature to decompose part of the oil vapors by first contact into vapors of lower boiling point oils, then repeatedly deflecting the mixed vapors by contact with a succession of said heated surfaces to decompose other parts of the oil vapors till the desired percentage of the oil vapor has been decomposed to lower boiling point oils, whereby the cracked light products obtained by first contact will be protected from destructive decomposition by the vapors which have not been cracked, and whereby a maximum of lower boiling point oils will be produced and a minimum of fixed gas will be generated.

6. The process of treating mineral oil for the production of gasoline, which consists in forcing a mixture of oil and water through a heating coil at a temperature of approximately 1,000° F., then spraying the resulting hot liquid into contact with spaced and interiorly heated surfaces at a temperature to cause decomposition of the oil by cracking into vapors of lower boiling point oils, at the same time passing hot hydrogen into said

vapors and thereby carrying them through and out of the generating chamber to a condenser.

7. The process of treating mineral oil for the production of gasoline, which consists in forcing a mixture of oil and water through a heater and therein heating the same to approximately 1,000° F., then spraying the hot liquid into contact with spaced and interiorly heated catalytic agent coated surfaces at a temperature to decompose the oil by cracking into vapors of lower boiling point oils, at the same time passing hot hydrogen into contact with said vapors at the catalytic agent coated surfaces for improving the odor and quality of the cracked product and carrying the vapors out of the generator to a condenser.

8. The process of treating mineral oil for the production of gasoline, which consists in preheating oil and water to a temperature between 800° and 1,000° F. and then spraying the resulting hot liquids and vapors into contact with spaced and interiorly heated surfaces in the presence of hydrogen and a catalytic agent at a temperature to decompose the oil by cracking into vapors of lower boiling point oils for hydrogenating the cracked oil products, and passing the resulting vapors to a condenser.

9. The process of treating mineral oil for the production of gasoline, which consists in spraying heated oil into contact with upper spaced and interiorly heated surfaces at a temperature for cracking part of the oil by contact therewith and causing any remaining uncracked oil to flow down over more highly heated surfaces below for cracking an additional portion of the oil and then causing deposit of the residual oily or tarry matter into a receiver below or outside of the heating zone, and conducting all vapors of lower boiling point oils resulting from the cracking operation to a condenser.

10. The process of treating mineral oil for the production of gasoline, which consists in spraying oil upon a plurality of spaced and interiorly heated surfaces at a temperature to crack the oil into vapors of lower boiling point oils, then causing any remaining uncracked oil to flow down over successively more highly heated surfaces to crack additional portions thereof into vapors of lower boiling point oils, passing residual heavy oil or tarry matter into a receiver outside of the heating zone and passing the vapors resulting from cracking to a condenser.

11. The process of treating heavy mineral oil for the production of gasoline, which consists in preheating the oil, then spraying such oil in contact with a plurality of spaced and interiorly heated surfaces at a temperature to crack part of the oil by first contact into vapors of lower boiling point oils, then repeatedly deflecting the resulting mixed vapors by contact with a succession said heated surfaces for cracking further portions till the desired percentage of the vapors has been decomposed to vapors of lower boiling point oils, whereby the cracked light products obtained will be protected from destructive decomposition into fixed gas by the vapors which have not been cracked, and whereby a minimum of fixed gas and carbon will be produced.

12. The process of treating mineral oil for the production of gasoline, which consists in preheating oil and water under pressure to a temperature between 800° and 1,000° F. and then spraying the resulting hot liquids and vapors under reduced pressure into contact with spaced and interiorly heated surfaces at a temperature to decompose the oil by cracking into vapors of lower boiling point oils in the presence of hot free hydrogen and a catalytic agent for hydrogenating the cracked oil products, and passing the resulting vapors to a condenser.

13. The process of treating mineral oil for the production of gasoline, which consists in preheating oil and water under pressure to or above the cracking temperature, then causing the resulting hot liquids and vapors to impinge at a reduced pressure upon spaced and interiorly heated surfaces at a temperature to cause decomposition of the oil by cracking into vapors of lower boiling point oils and passing the resulting cracked products to a condenser.

14. The process of treating mineral oil for the production of gasoline, which consists in forcing a mixture of oil and water through a heating coil and therein heating the same and their vapor under pressure to approximately 1,000° F., then spraying the hot liquid at a reduced pressure upon spaced and interiorly heated surfaces at a temperature to cause decomposition of the oil by cracking into vapors of lower boiling point oils and passing the resulting product off to a condenser.

15. The process of treating mineral oil for the production of gasoline, which consists in forcing a mixture of oil and water under pressure through a heating coil at a temperature of approximately 1,000° F., then spraying the resulting hot liquid at a reduced pressure into contact with heated surfaces at a temperature to cause decomposition of the oil by cracking into vapors of lower boiling point oils, at the same time passing hydrogen at a temperature of approximately 1,000° F. into said vapors and thereby carrying them through and out of the generating chamber to a condenser.

16. The process of treating mineral oil for the production of gasoline, which consists in preheating the oil under pressure, then spraying such oil at a reduced pres-

sure in contact with a heated surface at a temperature to crack part of the oil by first contact into vapors of lower boiling point oils, then subjecting the mixed vapors to contact with a succession of spaced and interiorly heated surfaces at a temperature for cracking further portions thereof, causing remaining uncracked oil to flow down over successively more highly heated surfaces to crack additional portions, passing residual heavy oil into a receiver outside of the heating zone, and passing vapors resulting from cracking to a condenser.

17. The process of treating mineral oil for the production of gasoline, which consists in spraying oil in contact with an upper heated surface in a chamber, at a temperature to crack part of it by first contact into vapors of lower boiling point oils, at the same time heating lower surfaces in the same chamber to a temperature between 1,800° and 2,000° F. and spraying in contact therewith steam in the presence of carbon to generate hydrogen, passing the hydrogen up into the cracked vapors above, and causing remaining uncracked oil admitted above to flow down over the more highly heated surfaces below for cracking additional portions thereof, and passing all vapor products to a condenser.

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

BURHANS VAN STEENBERGH.

Witnesses:

A. BURROWS,

J. H. MORE.