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PROCESS AND APPARATUS FOR THE VAPORIZATION OF LIQUIDS AND THE PRODUCTION OF FIXED GASES.

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Fig. 1.

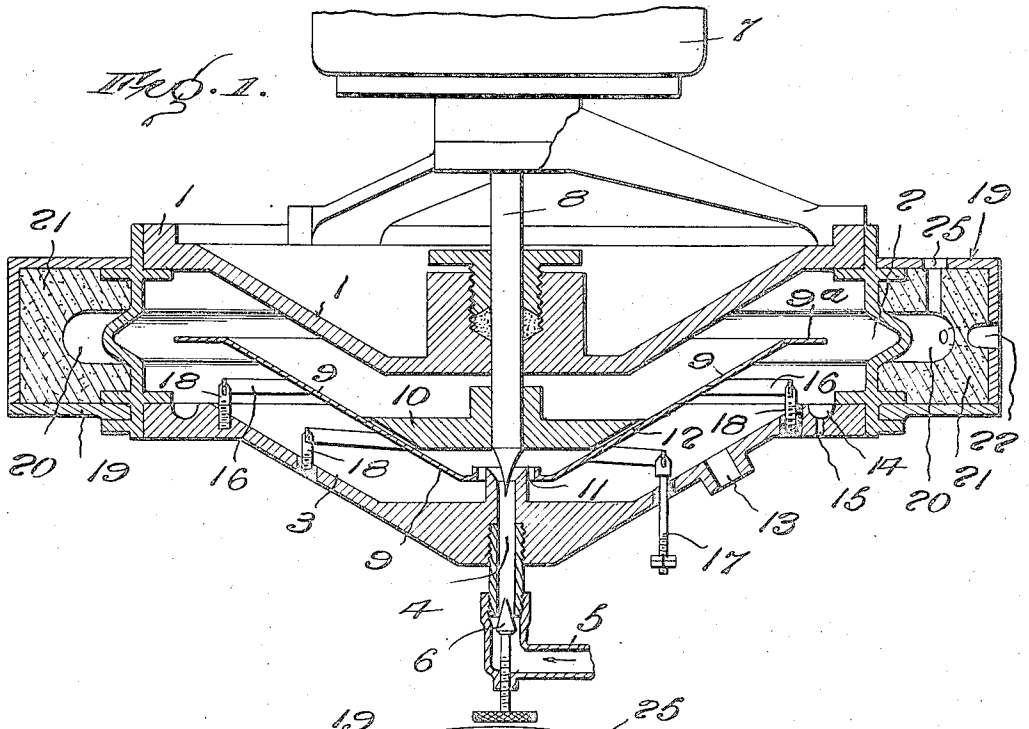
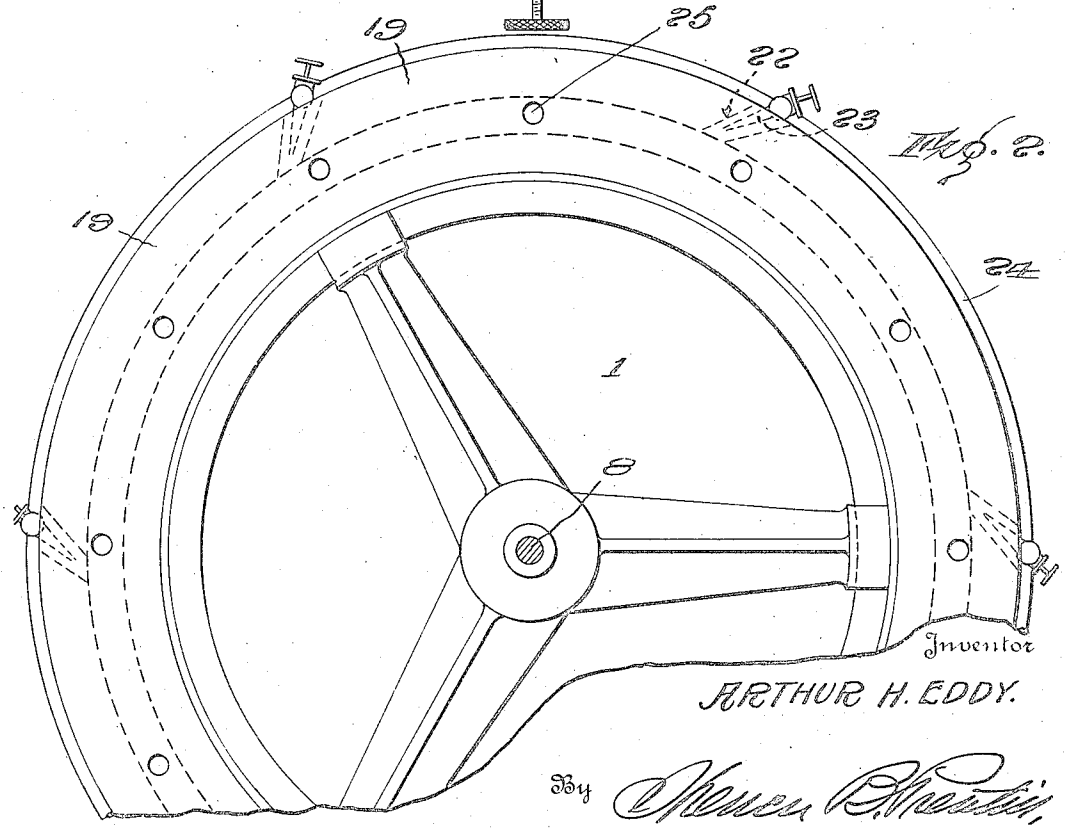



Fig. 2.




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# UNITED STATES PATENT OFFICE.

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## PROCESS AND APPARATUS FOR THE VAPORIZATION OF LIQUIDS AND THE PRODUCTION OF FIXED GASES.

Application filed October 23, 1917. Serial No. 198,143.

*To all whom it may concern:*

Be it known that I, ARTHUR H. EDDY, a citizen of the United States, residing at Windsor, in the county of Hartford and State of Connecticut, have invented new and useful Improvements in Processes and Apparatus for the Vaporization of Liquids and the Production of Fixed Gases, of which the following is a specification.

This invention relates to processes and apparatus for vaporizing liquids in general, and particularly to the vaporizing of liquid fuel and hydrocarbon liquids of relatively high boiling points, and to the production of a fixed gas from such vapors.

The principal object of the invention is the efficient vaporization of liquid fuel and hydrocarbon liquids of relatively high boiling points, and as the invention finds, so far as now known, its greatest field of usefulness in that application. I will describe the process as carried out in connection with, and the apparatus embodying the means for operation with, such materials, it being understood that both the process and the apparatus may be useful with other liquids.

The invention includes, in its physical embodiments, constructions in apparatus for transforming liquids into vapors and then heating and cracking said vapors to produce a fixed gas, and also to the formation of explosive mixtures by combining the vapor or gas with air.

In the vaporization of liquid fuel and hydrocarbon liquids of relatively high boiling points, such as distillates, including kerosene and fuel oils, it has been found that when the vapor is produced with apparatus now in use in conjunction with a small amount of heat, the vapor particles are large and unsuitable for use at high efficiency for the reason that all of the vapor is not consumed at the temperature and in the time of subjection to the combustion temperature. This is particularly true when the combustion takes place in internal combustion motors. It has been found also, that vaporization of such fuels or oils by the employment of a wick to burn a small portion of the oil with restricted air supply to heat the balance of the oil, is objectionable for the reason that the wick cakes up and a large amount of smoke is produced which results in the deposit of quantities of carbon. Further, the hot tube vaporizer, in which oil is sprayed under pressure into a heated tube, has been found unsatisfactory for the reason that the tube chokes up with carbon and must be frequently cleaned out or replaced.

My invention involves reducing the oil by mechanical means to an exceedingly fine state of subdivision, that is, vaporizing it, and then utilizing this vapor in any suitable manner. This I accomplish by subjecting the oil to combined pressure against and friction with a surface so that the oil is entirely vaporized thereby and rises from said surface in the form of a fine mist or fog. The result is that the liquid is vaporized to an exceedingly high degree of fineness and when visible appears like a greyish white smoke. This action with the surface I obtain by centrifugal force, the surface being inclined at an angle to its axis of revolution and the oil supplied to the surface so as to be caused to flow along and against the same. This surface is preferably in the form of a cone rotated at very high speed, the angle of inclination of the surface with the axis and the speed of rotation being selected according to the density of the liquid treated. One effective angle of inclination is shown in the drawings, and the area of surface and size of cone are also factors to be considered in connection with speed and output. The speed may be six thousand revolutions, and may even reach thirty thousand revolutions per minute. Under such conditions the pressure of the liquid against the cone surface is so high, and the friction so great that the liquid is vaporized while it passes along the surface and before it reaches the edge thereof. While I do not fully understand the theory of the action which takes place I believe that the excessive pressure against the surface causes a heating friction between the liquid and surface, and possibly between the particles of liquid also, and by reason of the adhesion of the liquid to the surface becoming greater than the cohesion of the liquid, the liquid is torn apart and a high degree of fineness of vaporization results. My experiments show that the liquid does not reach the edge of the cone, but leaves the cone surface fully vaporized before reaching the edge. If allowed to reach the edge of the cone, it would be thrown off in a spray of large particles not suitable for efficient use.

In order to secure the necessary high speed of rotation of the cone, I employ a direct connected electric motor designed for sufficient speed. The power consumed, the watts used in running the motor, seems to indicate that the above theory is correct, as it corresponds substantially to the heat units which would be required for vaporization. The work done in the actual vaporization may be ascertained by subtracting the amount done in rotating the cone without the liquid from that done rotating the cone with the liquid. Actual measurements show that the former is only about one-fourth of the latter.

I am aware that it has been proposed to employ various forms of surfaces, including the conical form rotated at low speed as by the suction of an internal combustion motor. In these devices the liquid is thrown off from the edge of the surfaces as a spray of large particles. Others have proposed to rotate various disk constructions by power, but here the adhesion of the liquid to the disk is not sufficient to produce proper friction to accomplish my results, even if the speed of the disk is very high. The liquid exerts practically no pressure upon the disk, and hence very little friction.

In the practice of the invention the oil is supplied to the cone surface in such quantity as to form a thin layer or film, and the rate of flow of the supply may be regulated according to the conditions.

The vapor produced as above indicated may be utilized in any suitable manner, as by supplying it to a burner or mixing it with air and burning it in an internal combustion motor. In these uses the vapor is highly efficient, especially in warm weather, but as a further improvement I prefer to convert it into a fixed gas. This may be accomplished, owing to the fineness of the vapor, by bringing it in contact with a heated surface or heated surfaces of the proper temperature to crack the oil and convert the vapor into a permanent gas. The gas so produced gives remarkably efficient results as compared with the vapor.

The invention includes the apparatus and process whereby hydrocarbon oils having high boiling points are transformed into vapor state and the heat treatment of such material while in a vapor state to so change its nature that it may be used to advantage to form hydrocarbon oils having low boiling points.

The invention provides a rotatable conically shaped vaporizer, a high speed electric motor directly connected to said vaporizer, and means for applying liquid fuel to the same, the centrifugal action of the vaporizer causing the fluid to be delivered as a fog or vapor and not in the form of a sheet of fluid.

The above features and others to be specified are described and claimed in the following specification and claims and illustrated in the accompanying drawings, in which—

Figure 1 is a vertical sectional view showing an annular heating chamber immediately surrounding a vaporizing chamber containing the centrifugal vaporizer cone and showing tangential gas jets or nozzles for furnishing a gas flame for heating the wall of the vaporizing chamber in addition to the electric wire heater.

Figure 2 shows the arrangement in plan view of the gas jet nozzles and the valves for regulating the same which may be used with the structure shown in Fig. 1.

Referring in detail to the drawing, 1 is a main casing having a centrally located vaporizing chamber 2 having oblique walls 3 flaring outwardly and upwardly. The roof of the vaporizing chamber 2 is formed by the upper surface of the main casing 1 and is substantially imperforate to the passage of air. At the bottom of the casing is a fuel inlet passage 4 which communicates with the vaporizing chamber 2. A suitable oil supply pipe 5 is connected to the inlet passage 4 and a needle valve 6 regulates the flow of oil. A suitable level control device, not shown, which may be outside of the casing may limit the height of the oil within the passage 4. A high speed electric motor 7 is mounted on its vertical axis above the casing 1 and has a downwardly projecting rotatable drive shaft 8 which extends into the casing 1 and downwardly terminating with a tapered lower end projecting just below the level of the liquid oil in the inlet passage 4. A conical vaporizer 9 is mounted on the shaft 8 near the lower end thereof. This vaporizer cone has a circular periphery and is provided with straight oblique imperforate walls extending from a point near the shaft 8 to the immediate periphery which is slightly bent to form a narrow horizontal rim as indicated 9a. The mounting of the cone 9 on the shaft 8 is accomplished by means of a support member 10 carried by the shaft 8 and to which the upper surface of the cone is fastened. The vaporizer cone 9 is adapted to fit over this support 10 and has an enlarged opening 11 to receive the shaft 8. Passage for fuel to the upper surface of the cone is provided for by the conduits 12 formed in the member 10 as grooves covered and enclosed by the surface of the cone 9. 13 represents the discharge opening for vaporized fuel. 14 represents a drain groove formed in the lower wall of the casing and adapted to catch any condensed vapor or superfluous liquid matter discharged from the cone. 15 is a discharge opening for the drain groove 14.

Heating means for the vaporized fuel

discharged from the cone 9 is provided by a metal wire or band 16 mounted within the vaporizing chamber and spaced from and encircling the same. This wire or band is electrically heated and is suitably insulated from the walls 12 of the vaporizing chamber. A conductor post 17 is shown insulated from the casing wall and connected to the electric heater member 16. Additional supporting posts 18 are shown and the wire 16 is supported on these and insulated from all but one which is located at the end of the wire and makes the electrical connection between the wire and the casing. A suitable source of electricity, not shown, for heating the wire has one terminal grounded on the casing. An additional heating means is provided for by an annular casing 19 surrounding the side walls of the vaporizing chamber 2 and is spaced therefrom and provides an annular heating chamber 20. A lining of refractory material 21 is provided within the casing 19 and around the annular chamber 20. Openings 22 in the side walls of the casing are provided for the insertion of gas jet nozzles 23 leading from a supply pipe 24. These nozzles project into the annular chamber 20 tangentially. By this means a circumferential ring of flame may be applied to the exterior of the vaporizing chamber wall. A vent for the gases of combustion generated by the flame from the nozzle 23 in the annular chamber 20 is indicated at 25. The material discharged from the cone is thrown off in the form of a vapor or fog and is subjected to the heat from the side walls.

After this heat treatment the material is passed out of the vaporizing chamber through the discharge port 13 and through suitable separators or condensers such as are well known in the art.

The operation of the vaporizer provides for the flow of the liquid oil into the inlet passage 4 where it rises to a point above the lower tapered end of the shaft 8. When the motor is operated and the shaft 8 and cone 9 rotated, oil is drawn up the tapered end of the shaft 8 by centrifugal force and is thrown therefrom and passes through the conduits 12 onto the upper surface of the vaporizer cone 9. The oil moves in a thin film upward over the surface of the cone and passes from the same in the form of fog and in a vaporous state. There is no sheet of liquid discharged from the periphery of the cone. This result is obtained by the particular construction of the cone and its mounting together with the fact that the electric motor is designed to operate at very high speeds. It is not necessary that the motor be restricted to an electric motor but it is necessary that high speeds be furnished. In one form of apparatus which has been successfully operated with a light oil, a speed of 6000 R. P. M. was used. Speed requirements must also vary with the viscosity of the material treated, and the temperature. A small turbine motor having a powerful blast for driving the same may accomplish the correct results. The movement of the liquid on the inner surface of the cone has been described as follows: Centrifugal force impels the liquid outwardly against the surface of the cone to which it adheres. Additional particles of liquid, on being supplied to the cone, flow over those adhering to the surface and in turn adhere thereto. Under correct conditions the liquid thus spread out is vaporized before it reaches the outer edge of the cone. The reason for this action, as at present understood, may be summarized in the statement that the heat generated as result of the adhesion of the liquid to the cone surface being greater than the cohesion of the liquid, is sufficient to vaporize the liquid. In other words when a given amount of liquid is spread sufficiently, the energy used to force the liquid out over the surface is sufficient to vaporize it. The conditions necessary for proper vaporization vary with the nature of the liquid and the speed, lighter oils vaporizing at lower speeds and with less energy than the heavier oils. It is understood that the centrifugal force impels the particles of liquid against the surface of the cone with a force several thousand times greater than the cohesion of the particles of the liquid. To rotate the vaporizer idly, that is, without the application of liquid to the surface it has been found that but four units of work have been required as compared to the twenty units required when liquid is being fed to the cone surface. It is estimated that this difference is consumed in overcoming and breaking up the liquid, and that this work, perhaps in the form of heat, is taken up by the liquid and by the cone. Or it may be that the film is torn apart and thus broken up into minute particles which constitute the very fine mist or fog referred to. When the fuel is discharged from the cone it rises from the surface of the cone in the form of a fine mist or fog and moves as a cloud of vapor directly against and over the electrically heated member 16, and while it is in a vapor state the material is cracked so that it is impossible to use in this apparatus oil which has heretofore been too heavy to be successfully used in forming vapors and fixed gas.

In the performance of the process and in the operation of the apparatus of my invention complete vaporization of kerosene and other oils in the form of very fine mist or fog rising from the inner surface of the cone is effected without the use of heat, and the vapor so produced may be utilized in any manner desired, as above specified. In addition, it has been found that such vaporiza-

tion is accelerated and facilitated by the heating action of the heating coil and also the heating chamber around the periphery of the closed chamber; either form of heat when employed acting to raise the temperature of the high speed revolving cone and thereby the kerosene or other oil being acted upon. My invention therefore contemplates the employment of a certain amount of heat to assist in the vaporizing action when desired, as well as in the vaporization effected solely by the action of the high speed revolving cone upon the fuel alone.

In using the term fine mist or fog, I contemplate the very fine mist or vapor produced by my process and apparatus, as distinguished from a vapor or spray of large particles, for instance, this very fine mist or fog constitutes a nebula, which, when permitted to rise in the air from the surface of the revolving cone, remains suspended and floats off in the air for a considerable length of time.

While I have discussed the application of my invention to kerosene and other hydrocarbons which are heavier than the very light hydrocarbons commonly known as gasoline, I wish it understood that my apparatus may be used, and has been used by me, with gasoline, in which case highly satisfactory and desirable results were produced.

The various parts of the apparatus shown and described throughout the specification and claims and illustrated in the accompanying drawings may be made in any convenient manner and of any suitable material. The structure may be made of stamped sheet metal or cast accordig to the most advantageous method which can be used by the manufacturer. Changes in material and size of the various parts of the structure may be made without departing from the scope of the invention. The cone will perform its vaporizing function if placed in any position.

What I claim is:—

1. The process of vaporizing liquids which comprises subjecting a film of the liquid by centrifugal force to combined pressure and friction against a surface of limited extent such as to thereby cause the liquid to entirely vaporize from said surface within the limits thereof in the form of a fine mist or fog.

2. The process of vaporizing hydrocarbon liquids of relatively high boiling points, which comprises subjecting a film of said liquid by centrifugal force to combined pressure and friction against a surface of limited extent such as to thereby cause the liquid to vaporize from said surface within the limits thereof in the form of a fine mist or fog.

3. The process of vaporizing hydrocarbon liquids of relatively high boiling points, which comprises subjecting a film of said liquid by centrifugal force to combined pressure and friction against an interior conically shaped vaporizing surface rotating at high speed, such pressure and friction thereby causing the liquid to vaporize from said surface within the limits thereof in the form of a fine mist or fog.

4. An apparatus for vaporizing liquid fuel comprising an enclosing chamber, a surface of limited extent within said chamber mounted to rotate about an axis and inclined at an angle thereto, means for supplying liquid to the surface on the side towards the axis, said enclosing chamber closely encircling but spaced from the outer edge of said surface, means for withdrawing from said chamber the vaporized products formed therein, and means for rotating the surface at such a speed as to cause the liquid to entirely vaporize from said surface within the limits thereof in the form of a fine mist or fog.

5. In an apparatus for vaporizing liquid fuel, a casing having a vaporizing chamber, a vaporizer member within said chamber rotatably mounted to turn on a given axis and having a vaporizing surface inclined at an angle to said axis, means for supplying liquid to be vaporized to said surface, the walls of said vaporizing chamber closely encircling but spaced from the outer edge of said vaporizer member, means for withdrawing from said chamber the vaporized products formed therein, and means for rotating said vaporing member and surface at such a speed as to cause the liquid to entirely vaporize from said surface before reaching the edge of said surface in the form of a fine mist or fog.

6. In an apparatus for vaporizing liquid fuel, a casing having a vaporizing chamber, a vaporizer member comprising an interior conically shaped vaporizing surface rotatably mounted within said chamber to turn on the axis of the cone, means to supply a limited amount of liquid to said interior conical surface near said axis, the walls of said vaporizing chamber closely encircling but spaced from the outer edge of said vaporizer member, means for withdrawing from said chamber the vaporized products formed therein, and means for rotating said vaporizer member and conically shaped surface at speeds such that the combined action of the speed and the angle of said surface to the axis causes the liquid to entirely vaporize from said surface in the form of a fine mist or fog before reaching the periphery of said surface.

7. In an apparatus for vaporizing liquid fuel, a casing having a vaporizing chamber, a vaporizer member within said chamber rotatably mounted to turn on a given axis and including a laterally extending mem-

ber adapted to rotate therewith and having a vaporizing surface, means for supplying liquid to be vaporized to said surface at a point adjacent said given axis, the walls of said vaporizing chamber closely encircling but spaced from the outer edge of said vaporizer member, means for withdrawing from said chamber the vaporized products formed therein, and means for rotating said vaporizer member at such speeds as to entirely vaporize the liquid in the form of a fine mist or fog before it reaches the lateral edge of said vaporizing surface.

8. In an apparatus for vaporizing liquid fuel, a casing having a vaporizing chamber, a vaporizer member within said chamber rotatably mounted to turn on a given axis and including a laterally extending member adapted to rotate therewith and having a vaporizing surface disposed at an angle to the axis of rotation, means for supplying liquid to be vaporized to said surface at a point adjacent said given axis and on the side of said surface toward said axis, the walls of said vaporizing chamber closely encircling but spaced from the outer edge of said vaporizer member, means for withdrawing from said chamber the vaporized products formed therein, and motor means for rotating said vaporizer member at such speeds as to vaporize said liquid in the form of a fine mist or fog before it reaches the lateral edge of said vaporizing surface.

9. In an apparatus for vaporizing liquid fuel, a casing having a vaporizing chamber, a vaporizer member within said chamber rotatably mounted to turn on a given axis and having a conically shaped vaporizing surface concentric with and disposed at an angle to said axis of rotation, means for supplying liquid to be vaporized to said conically shaped surface at a point adjacent said given axis and on the side of the surface adjacent said axis, the walls of said vaporizing chamber closely encircling but spaced from the outer edge of said vaporizer member, means for withdrawing from said chamber the vaporized products formed therein and means for rotating said vaporizing member and surface at such speeds as to vaporize said liquid in the form of a fine mist or fog before it reaches the lateral edge of said vaporizing surface.

10. An apparatus for vaporizing liquids and changing their chemical composition, comprising an enclosing chamber, a surface within said chamber mounted to rotate about an axis and inclined at an angle thereto, means for supplying liquid to the surface on the side toward the axis, means for rotating the surface at such speed as to cause the liquid to entirely vaporize from said surface in the form of a fine mist or fog, said enclosing chamber closely encircling but spaced from the outer edge of said surface, means for withdrawing from said chamber the vaporized products formed therein, the walls of said vaporizing chamber closely encircling but spaced from the outer edge of said vaporizer member, means for withdrawing from said chamber the vaporized products formed therein, and means for heat treating said vapor to change its chemical composition.

11. In an apparatus for vaporizing liquid fuel and changing its chemical composition, a casing having a vaporizing chamber, a vaporizer member within said chamber rotatably mounted to turn on a given axis and having a vaporizing surface disposed at an angle to the axis of rotation, means for supplying liquid to be vaporized to said surface on the side of the surface towards said axis, means for rotating said vaporizing member and surface at such speeds as to vaporize the liquid in the form of a fine mist or fog before it reaches the lateral edge of said vaporizing surface, the walls of said vaporizing chamber closely encircling but spaced from the outer edge of said vaporizer member, means for withdrawing from said chamber the vaporized products formed therein, and means for heat treating the vapor to change its chemical composition and to convert at least a portion thereof into fixed gas or gases.

12. An apparatus for vaporizing hydrocarbon liquid fuel of relatively high boiling points comprising a vaporizing chamber, a vaporizer member rotatably mounted within said chamber to turn on the axis of the cone and having an interior conically shaped vaporizing surface, means to supply said liquid to said interior conical surface in proper quantity to provide a film on the surface, the walls of said vaporizing chamber closely encircling but spaced from the outer edge of said vaporizer member, means for withdrawing from said chamber the vaporized products formed therein, and means for rotating said vaporizer member at proper speeds which combined with the angle of vaporizing surface causes combined pressure and friction of said liquid film on said surface to vaporize said liquid from said surface within the limits thereof in the form of a fine mist or fog.

13. An apparatus for vaporizing difficultly vaporizable liquid fuel comprising an enclosing chamber, a surface of limited extent within said chamber mounted to rotate about an axis and inclined at a proper angle thereto, means for supplying liquid to said surface on the side towards the axis, said enclosing chamber closely encircling but spaced from the outer edge of said surface, means for withdrawing from said chamber the vaporized products formed therein, and means for rotating the surface at such high speed as at the angle of said surface to cause com-

bined pressure and friction of the liquid upon the surface to vaporize said liquid from said surface within the limits thereof in the form of a fine mist or fog.

14. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists in liquid to entirely vaporize from said surface in the form of a fine mist or fog before it reaches the outer edge of the surface.

15. The process of treating liquid hydrocarbons which consists in entirely vaporizing the material to be treated in the form of a fine mist or fog by centrifugal action from the inner surface of a high speed cone, and heat treating said vapor to change its chemical composition and to convert at least a portion thereof into fixed gas or gases.

16. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists in vaporizing the oil to be treated in the form of a fine mist or fog by centrifugal action from the inner surface of a high speed cone within the limits thereof, and heat treating said fine mist or fog to change its chemical composition and to convert at least a portion thereof into fixed gas or gases.

17. The process of producing hydrocarbon oils having low boiling points from hydrocarbon oils having high boiling points which consists in vaporizing the oil to be treated in the form of a fine mist or fog by centrifugal action from the inner surface of a high speed cone within the limits thereof, and cracking the resultant fine mist or fog.

In testimony whereof I have hereunto set my hand.

ARTHUR H. EDDY.