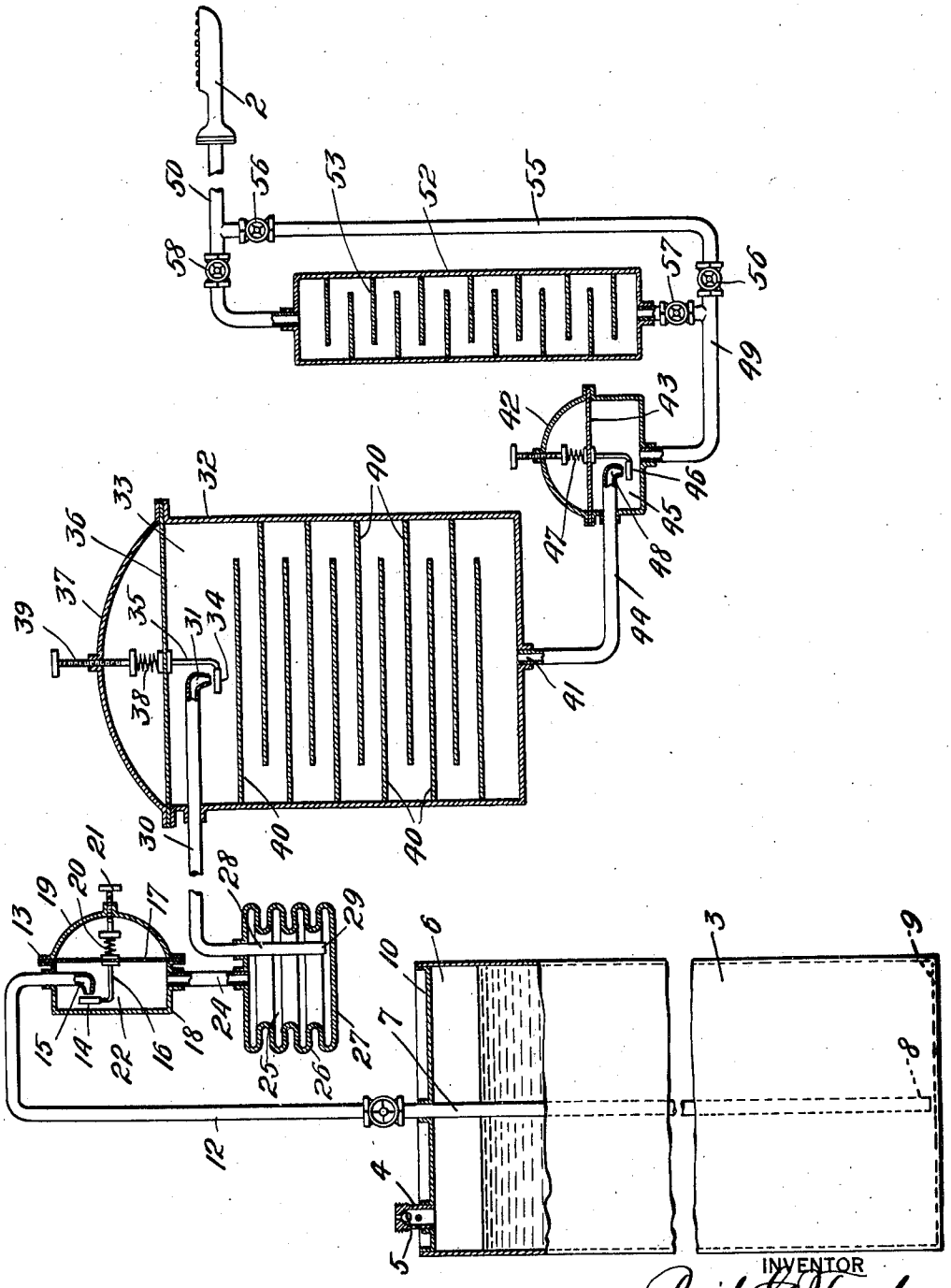
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APPARATUS FOR PREPARING HYDROCARBON MIXTURES FOR COMBUSTION

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APPARATUS FOR PREPARING HYDROCARBON MIXTURES FOR COMBUSTION

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The invention relates to an improvement in apparatus for preparing hydrocarbon mixtures for combustion.

In the recovery of gasoline from natural gas it is common practice to "weather off" or evaporate into the air the more volatile hydrocarbons, that is, those having a higher vapor tension than the recovered product. Up to this time, so far as I am aware, the market has recognized only two methods which attempt to utilize this wasted hydrocarbon as a fuel. One method deals with a mixture in which the less volatile hydrocarbons predominate and which develops a vapor tension of approximately 25 lbs. at 100° F. To utilize this fuel a specially constructed apparatus must be employed in which provision is made for heating the mixture immediately adjacent to the point of consumption so as to convert it into a gas. This apparatus is relatively expensive and is provided with burners of delicate construction which are constantly getting out of order. Moreover this hydrocarbon mixture is not economical because its yield per thousand feet of natural gas is relatively low.

The other method which utilizes some of these otherwise wasted gases attempts to segregate one member of the paraffine series having a very low boiling point. The gas from this product is fed directly to a standard gas burner. Such gas must be carefully fractionated so as to produce a pure product, otherwise its heating value would be constantly changing and cause excessive carbonizing at the burner. The disadvantage of utilizing this relatively pure hydrocarbon is the fact that it is expensive to produce because of the difficulty of separating it from the less volatile members of the series. Moreover, it must be shipped in heavy containers due to its high vapor tension.

The object of the present invention is to produce an apparatus for preparing these hydrocarbon mixtures for combustion in gas burners adapted for burning manufactured and natural gas. Such hydrocarbon mixtures will be composed essentially of propane, butane and pentane, although they may contain small portions of other hydrocarbons both higher up and lower down on the scale of the paraffine series. There will usually be a larger proportion of propane than of butane and pentane. Since the mixture will contain so large a proportion of propane it will have a vapor tension of about seventy-five pounds at 100° F. or about fifty pounds at 70° F. These proportions and figures are relative only and depend upon the constituents of the gas from the well. Any hydrocarbon mixture which will remain in gas form with but slight condensation at temperatures ranging from 0° F. upward may be regarded as suitable for treatment by the method and apparatus of the present invention. This mixture can not be burned in an ordinary gas stove adapted for manufactured and natural gas without special treatment, such as is provided by the method of the present invention. This is because the more highly volatile constituents tend to separate from the less volatile constitutents and be burned first; and because the less volatile constituents have a greater B. t. u. value than the more volatile constituents. Now the ordinary gas stove is arranged for burning a gas having a relatively constant B. t. u. value. Consequently the hydrocarbon mixture such as is treated by the method of the present invention can not be successfully burned on an ordinary gas burner unless the mixture is so treated that a gas having a relatively constant B. t. u. value is delivered to the burner. This the method and apparatus of the present invention accomplish. To these ends the invention consists in the improved method of and apparatus for preparing hydrocarbon mixtures for combustion more fully described hereinafter and particularly pointed out in the appended claim.

The hydrocarbon mixtures which are treated and prepared for combustion by the method of the present invention are liquefied under pressure and shipped to the consumer in metal tanks of about fifteen to twenty-five gallons capacity. It is a characteristic or property of these hydrocarbons that when compressed and liquefied they form homogeneous liquids. Consequently the constituents of the liquid drawn from any portion of

the tank will be substantially the same and of the same proportions as the constituents of the liquid drawn from any other portion of the tank. When this liquid is permitted to boil or evaporate, however, by reducing the pressure on it, the more volatile of the constituents tend to evaporate first and separate from the less volatile constituents. By the method of the present invention and the apparatus hereinafter described the gases from the liquid hydrocarbon are thoroughly mixed and delivered to the gas burner as a substantially homogeneous mixture having a substantially constant B. t. u. value.

The preferred form of apparatus in which the method of the invention is practiced is illustrated in the accompanying drawing which is a diagrammatic flow sheet in which the various members of the novel apparatus are shown in section. The liquid hydrocarbon mixture to be treated or prepared for combustion in the gas burner 2 is held in a tank 3. The gas burner 2 is of the usual construction adapted for burning natural or manufactured gas of substantially three ounces pressure. The tank 3 is a closed cylindrical receptacle provided at its top with an inlet 4 in which is seated a ball check valve 5. The liquid hydrocarbon mixture is introduced into the tank 3 through the inlet 4. After the tank has been filled, the vapor tension in the space 6 in the upper portion of the tank closes the check valve 5. As a matter of fire precaution the tank 3 will usually be located in an outhouse or vault specially prepared for it. The liquid hydrocarbon is delivered from the tank 3 for use through a dip pipe 7 arranged vertically and centrally in the tank 3, the lower intake end 8 of the pipe being located a short distance above the bottom 9 of the tank and the upper end of the pipe extending through a central opening in the top 10 of the tank. The vapor tension generated in the space 6 by the evaporated liquid is utilized to force the liquid hydrocarbon upwardly through the delivery pipe 7. By drawing the liquid hydrocarbon mixture from the bottom of the tank rather than the vapor from the space 6 in the top of the tank, the various constituents of the mixture are in the first instance prevented from separating.

In preparing the liquid hydrocarbon drawn from the tank 3 for combustion, the first step is to reduce the pressure thereon to permit it to vaporize. Assuming that the liquid hydrocarbon mixture in the tank 3 develops a vapor tension of fifty pounds at 70° F., this being the vapor tension of a typical hydrocarbon mixture to be treated and prepared for combustion by the present invention, it has been found advantageous in the further treatment of the hydrocarbon mixture to reduce the pressure to about ten pounds. At this lower pressure substantially all the liquid hydrocarbon drawn from the tank 3 will vaporize readily, except in the very coldest weather. To reduce the pressure on it to permit it to evaporate the liquid hydrocarbon is fed by the extension 12 of the pipe 7 into a reduction valve 13, which is of usual construction and comprises an offset valve member 14 adapted to coact with and open and close the outlet orifice 15 of the pipe section 12. The valve member 14 is provided with a stem 16 secured to the center of a flexible diaphragm 17 extending across the body portion 18 of the valve casing and secured thereto by a dome-shaped cover 19. On the outer side of the center of the diaphragm is mounted a spring 20 the tension of which may be adjusted by the handle 21. The reduction valve 13 is adjusted so that the pressure in the space 22 of the valve is substantially ten pounds. The object in reducing the pressure on the hydrocarbon mixture at this point in its treatment through so great a range of degree is to permit it to evaporate as rapidly as temperature conditions will permit. It will be understood in this connection that the problem with which the present invention is concerned is to convert a liquid hydrocarbon mixture into a homogeneous gas under climatic conditions in which the temperature may range from 40° below zero F., to over 100° F. It will be borne in mind that the nature of a mixture of hydrocarbons of the paraffine series is such that the less volatile constituents of the mixture tend to reliquefy when subjected to the lower temperatures. Consequently the mode of treatment must be such that irrespective of the temperature the hydrocarbon mixture will be delivered to the burner as a homogeneous gas. The first step in the method, namely, substantially reducing the pressure of the hydrocarbon mixture is simply giving the mixture an opportunity to evaporate, and the amount of reduction necessary will depend entirely on the temperature of the locality where the hydrocarbon mixture is used. For higher temperatures the amount of initial reduction of pressure need not be so much as for lower temperatures. Assuming an average temperature, I have found that the best results are obtained by initially reducing the pressure on the hydrocarbon mixture taken from the tank 3 to approximately ten pounds.

The liquid hydrocarbon mixture which escapes from the orifice 15 into the space 22 at the reduced pressure begins to boil and pass into the gaseous state. To facilitate the evaporation by permitting the expanding gas to absorb heat, the hydrocarbon mixture is led from the space 22 of the valve 13 through a pipe 24 into a heat absorption space or radiator 25 which is a closed receptacle provided with corrugated walls 26 to facilitate radiation. At the higher temperatures the hydrocarbon mixture will completely convert

into gas in the radiator 25. At the lower temperatures the less volatile constituents of the mixture will not gasify at once, but will fall to the bottom 27 of the radiator in liquid form and gather there. In order to maintain the hydrocarbons as a homogeneous mixture in the gaseous state, the outlet from the radiator 25 consisting of the pipe 28 has its lower end 29 located close to the bottom 27 of the radiator. As a result of this arrangement if the liquid hydrocarbons gathering on the bottom 27 of the radiator rise above the lower end 29 of the outlet pipe 28 the more volatile or gaseous hydrocarbons escaping from the radiator through the pipe 28 will take up or entrain the liquid through which they pass, it being understood that the more volatile hydrocarbons of the paraffine series have the property, when in the gaseous state, of absorbing (to their saturation point) the less volatile hydrocarbons in the liquid state.

The gases delivered by the radiator 25 are more or less saturated, depending upon the temperature, and in order that the liquid entrained in the mixture delivered from the radiator may fully expand, I further reduce the pressure of the mixture, this time to substantially one pound. The gases at this low pressure are then conducted through a tortuous passageway so that they may thoroughly mix. By leading the gases through a tortuout passageway I facilitate the entrainment of the less volatile constituents of the mixture which may have reliquefied or failed to gasify because of the lowness of temperature. These gather as drops or globules on the sides of the passageway where they are gathered up and entrained in the fresh gases passing through the passageway.

These steps of the method are carried out by passing the hydrocarbon mixture from the receptacle 25 through a pipe 30 the outlet orifice of which discharges into the upper end of a cylindrical tank or reservoir 32. In the upper part 33 of the reservoir 32 is located a reduction valve comprising an offset valve member 34 adapted to coact with the outlet orifice 31 of the pipe 30. The stem 35 of the valve member 34 passes through and is secured to the center of a diaphragm 36, which the cover 37 secures to the upper rim of the cylindrical reservoir 32. A spring 38, the tension of which is made adjustable by the member 39, regulates the pressure of the gases passing into the reservoir 32 from the discharge orifice 31. The reservoir 32 is of such size that the gases comprising the hydrocarbon mixture may expand freely; and in order that they may thoroughly mix for burning they are made to pass between the baffle plates 40 projecting inwardly in staggered relation from the sides of the reservoir. The reservoir 32 being preferably composed of metal and the baffle plates 40 being of the same material and secured to the sides of the reservoir, they act as excellent radiation surfaces to afford the expanding gases the necessary amount of heat. Any entrained liquid which may be deposited by the gas in the reservoir when the apparatus is not in use will gather as small drops or films on the baffle plates 40 and when the apparatus is put in use again the gases traveling through the tortuous passageway between the baffle plates will gather up or entrain this liquid hydrocarbon so that by the time the gases reach the discharge orifice 41 at the bottom of the reservoir all the liquid will have been converted into gas.

The gas drawn through the discharge orifice 41 of the reservoir 32 is now in condition for combustion, except that its pressure must be regulated to the adjustment of the burner 2, which being adapted to burn manufactured and natural gas is adjusted for a gas having substantially three ounces of pressure. Consequently the next step of the method is to introduce the gaseous hydrocarbon mixture into a precision regulator 42 set to three ounces. The regulator 42 is of substantially the same construction as the valve 13 except that the diaphragm 43 is preferably composed of leather, whereas the diaphragm 17 will usually be composed of metal. The hydrocarbon mixture is conducted from the discharge orifice 41 of the reservoir through the pipe 44 into the chamber 45 of the regulator 42. In the regulator 42 is an offset valve member 46 connected with the diaphragm 43. The spring 47 is so adjusted that the gases escaping from the discharge opening 48 of the pipe 44 into the chamber 45 have a pressure of about three ounces. The gas may now be led directly to the burner 2 through the pipe 49.

If the regulator 42 and the burner 2 are both located in the same room there will be no condensation of the gas passing from the regulator to the burner 2. In case, however, the regulator 42 is located in a relatively warm room at some distance from the burner 2 and it is necessary to pass the section 50 of the pipe 49 through an unheated space or room there will be some condensation at extremely low temperatures. In order that the gas passing from the regulator 42 to the burner 2 may entrain the small amount of condensate which gathers, I provide a drip tank 52 which may be cylindrical in form and provided with the baffle plates 53 connected with the walls of the tank 52 and extending toward each other in staggered relation to form a tortuous passage between them in the same manner in which the baffle plates 40 form the tortuous passage in the reservoir 32. The condensate which gathers in the section 50 of the pipe 49 will drain back and form films or minute drops on the baffle plates 53 in the tank 52, and will be in position to be entrained or gathered up by the gas coming

from the reduction valve 42. Under these circumstances the section 55 of the pipe 49 will be closed off and for this purpose it is provided with the valves 56 to direct the gas through the tank 52. When, however, there is no liability of condensation in the gas passing from the valve 42 to the burner 2 the section 55 of the pipe 49 will be in use and the tank 52 cut out. For this latter purpose the inlet and outlet pipes connected with the tank 52 will be provided with the valves 57 and 58, respectively. Or if the apparatus is used in very moderate climates the tank 52 may be eliminated together.

Having thus described the invention what I claim as new is:—

The combination with a tank containing a supply of liquid hydrocarbon mixture, and a burner, of means for gasifying the liquid hydrocarbon comprising a heat absorption chamber, a pipe leading from the bottom of the tank to the top of the chamber, a pressure regulator interposed in the pipe, and a discharge pipe for the gas vertically arranged with the chamber and connected with the burner, the inlet orifice of the discharge pipe being relatively close to the bottom of the chamber so that the gas entering the inlet orifice will pass through and entrain liquid hydrocarbon on the bottom of the chamber.

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