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CONTROL DEVICE

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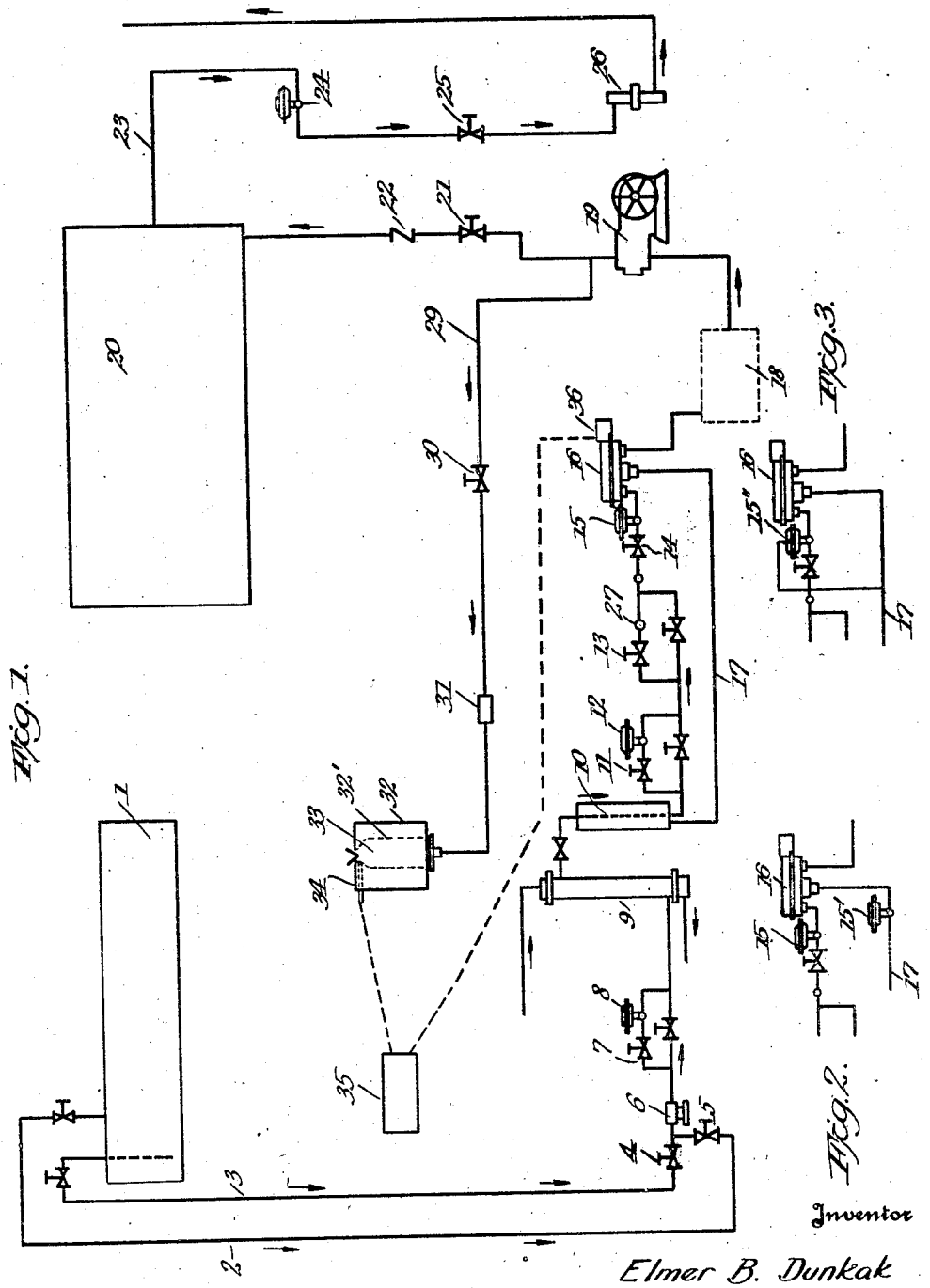


Fig. 1.

Fig. 3.

Fig. 2.

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CONTROL DEVICE

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1 Claim. (Cl. 48—180)

The present invention relates to a process and apparatus for the manufacture of a combustible gaseous mixture.

An object of the invention is to provide automatic means which will control the calorific value of the gas in accordance with a set standard.

A further object of the invention is to employ in combination with such means an automatic mixing valve for proportioning the constituents of the gas in a definite ratio, and wherein the calorific control means will act to control the ratio in accordance with the calorific standard.

An additional object of the invention is to combine the automatic control means and mixing valve with a means for preliminarily treating the constituents, so that as fed to the mixing valve, their densities will be relatively constant.

In constructions of this character, it is desirable that the method be practiced in a manner which will be thoroughly automatic and with the present invention, the density adjustment and calorific control are operated in such a manner that no manual actuation will be required.

The first figure is a diagrammatic view of the apparatus.

Figures 2 and 3 are detail diagrammatic views.

The numeral 1 indicates a tank, or a tank car, or some suitable receptacle in which is contained saturated or unsaturated hydrocarbons in liquid or gaseous state. It may contain a mixture of saturated and unsaturated hydrocarbons, and it is quite usual that the contents consist of a liquid layer and a gaseous layer which is volatilized therefrom.

Leading from the tank 1 are the line 2 for vapor and the line 3 for liquid. Suitable valves 4 and 5 are provided for controlling the pressure as well as cutting off the flow and the combined liquid and gas pass through a suitable strainer 6. In most cases, either the valve 4 or the valve 5 is cut off to permit flow of either liquid or gas alone. The numerals 7 and 8 indicate a valve and pressure reducer respectively through which the hydrocarbon is passed, and the numeral 9 indicates an expansion chamber in which the liquid is permitted to volatilize. A hot water or other heating means is provided for the expansion chamber to take care of the excessive cooling effect produced by the volatilization of the liquid hydrocarbon. From the expansion chamber the gaseous hydrocarbon is passed to a heat exchanger indicated at 10 and then through a valve 11, a pressure reducer 12, another valve 13, a further valve 14, and an additional pressure reducer device 15, to a mixing valve.

The heat exchanger which is indicated at 10 may comprise number of conventional forms. Thus, it may comprise a number of parallel pipes, or a number of tortuous passages, and I have also found that by using one or more coils, an effective result may be obtained. The passages exteriorly may be provided with fins if desired.

In the case of hydrocarbons of the methane series such as propane, etc., with which my invention may be satisfactorily employed, the calorific value or B.t.u. is ordinarily too high for many purposes and a diluent or tempering medium must be mixed with the butane gas. I propose to employ an inert gas of the order of nitrogen, or spent products of combustion, and in fact any medium which will dilute the butane gas and reduce its B.t.u. to the standard requirements. In this connection, however, I may also combine with the gas, air, using it as a diluent to reduce B.t.u. or as a supporter of combustion.

The diluent is passed through the heat exchanger 10 in heat exchange relation with the hydrocarbon gas and since these gases are normally at different temperatures when fed to the heat exchanger, the effect of the heat exchange relation is to alter their temperatures relative to each other. From the heat exchanger the diluent is passed by the line 17 to the mixing valve 16 and it will be seen, therefore, that in adjusting the relative densities of the gases which make up the mixture, no opportunity for expansion or contraction of one of the fluids will be permitted, thus overcoming or reducing the tendency toward variation in the B.t.u. content of the mixture. This is a vital factor in the production of a butane gas mixture, and I have found that by employing the heat exchanger 10, or some other equivalent means whereby the relative densities of the constituents of the gas are adjusted, that a thorough mixing is accomplished. This interposition of the heat exchanger obviously relieves the system from any manual care to secure the result, and is in effect an automatic equalization of the temperature and density.

In some cases, the gas will be fed rather rapidly through the expansion chamber 9, in which event it would be relatively cool when it enters the heat exchanger 10, so that its temperature will be raised if air, nitrogen, or other diluent at atmospheric temperature is used as a constituent of the mixture. On the other hand, if the gas is fed slowly through the expansion chamber 9, it will enter the heat exchanger in a warm or heated

condition, and will raise the temperature of the air, nitrogen, or other diluent, if such be supplied at room temperature. Where spent products of combustion are used as a gaseous constituent or diluent of the mixture, if it be warmer than the butane, naturally it will raise the temperature of the butane, and if it be of lower temperature, it will reduce the temperature of the butane, but of course, as well understood, the heat exchanger will tend to equalize the temperatures of the respective constituents and from the well known gas laws, likewise adjust or equalize their relative densities. It is this important result obtained by the use of a thermal equalizer or heat exchanger which enables me to control the quality of mixture for best results.

The mixing valve 16 is an automatic valve which opens to supply in a definite ratio butane and diluent or whatever gases are flowing in the system in accordance with the demand. That is to say, the valve is automatically operable to supply a large or small volume of the mixture dependent upon the demand conditions prevailing in the main. The mixer is well known in the art as the Kemp automatic valve and no invention is claimed per se for it.

Associated with the mixing valve 16 is the pressure governor 15 previously referred to. This governor comprises a diaphragm vented to the atmosphere, so that the pressure of gas, for example butane, will be controlled in accordance with the atmospheric pressure prevailing at the time of use. Thus, where air is used as the diluent, the relative pressures of the butane and air as supplied to the mixing valve would be maintained constant by the pressure regulator 15. By employing the heat exchanger or equivalent structure 10, the temperatures of the respective constituents, namely the butane and the air are adjusted with respect to each other or are equalized.

Thus, an absolute control is maintained over the pressures of the gases to retain their relative pressures constant while at the same time their temperatures are adjusted with respect to each other, so that the densities of the respective gases as fed to the mixing device will be substantially constant relative to each other.

While I have referred herein to the use of butane and air, it will be understood that other saturated hydrocarbons of the methane series may likewise be employed. Moreover, unsaturated hydrocarbons, for example ethylene, propylene, butylene, etc., may be utilized. Furthermore, mixtures of the saturated and unsaturated gases can be passed through the system, if desired.

The apparatus herein disclosed and the method for accomplishing the required result will obtain with equal efficiency if water gas, coal gas or other artificial gas is used. Such artificial gas may have as the second constituent air, which may serve as the diluent or the supporter of combustion.

With equal facility, the process and apparatus can be employed with natural gas and the air in this case may be a diluent or a supporter of combustion, as desired.

In some cases, it may be desirable to employ a mixture of natural and artificial gas and this can be prepared in the present system. Likewise, natural gas or artificial gas may be mixed with one of the saturated hydrocarbons or one of the unsaturated hydrocarbons, or both, and successfully treated in the system in the manner as herein described.

While I have mentioned as diluents, air, products of combustion and inert fluids of the order of nitrogen, there are, of course, numerous other diluents which can be successfully employed.

Where air is utilized the presssure governor 15 is disposed at the point shown, namely in the hydrocarbon line. This governor is vented to the atmosphere and since the air is at atmospheric pressure, the pressures barring a friction loss in the line 17 will be constant. In some cases, a second governor 15' similar to the governor 15 is placed in the line 17 and vented also to the atmosphere. This will take care of friction losses, so that the relative pressures of the constant gases will likewise be a constituent. Where other mediums than air are employed, this constant pressure relation can be maintained by having the governor 15 vented to the pressure of the particular diluent. Accordingly also, the two governors 15 and 15' may be vented to some constant pressure such as that of the specific diluent. In lieu of either of the embodiments described, I may utilize the governor 15'' in the hydrocarbon line but vent it to the pressure of the gas passing through the line 17. In this manner, the pressure of the butane, for example, will be a constant with respect to the pressure of the air passing through the line 17. This construction can be utilized where any of the mixtures above referred to are being formed and it will be observed that it is simply necessary to vent the governor 15'' to the pressure of the other constituent or constituents. In some cases, it may be desirable to place the governor on the line 17 and vent it to the pressure in the hydrocarbon line.

The mixed gas from the valve 16 passes to a surge tank 18, a compressor 19 and through the line past valves 21 and 22 to a storage tank which is indicated at 20. This storage tank may or may not be employed, and from the tank 20 the line 23 extends to the point of utility, there being a pressure reducing valve 24, a cut-off valve 25, and a send-out meter 26 generally interposed in the line or main.

The numeral 27 indicates a suitable meter for showing the volume of butane gas passing through the system to the mixing valve, and is usually employed for plant statistical purposes.

Leading from the line after the gas has been compressed is a conduit 29 in which are interposed pressure reducing valves or stops 30 and 31. Connected with the line 29 is the sampling tower 32 having a combustion chamber 32', in which is disposed a burner element 33, such as a Bunson burner, and to which combustion chamber is supplied heated air at a constant temperature. The heat developed in the sampling tower is translated by a thermo sensitive member such as a thermo-couple 34 to a recorder in the nature of a millivolt meter 35. Meter 35 is graduated for various readings and may be set to permit a gas of a certain calorific value to flow through the system. When the calorific value of the gas passing through the system varies, the meter 35 will react accordingly, and will, through control of an electrical circuit, actuate a motor 36 which operates valve 15. This motor is a reversing motor, and in accordance with the reading of the meter, will cause actuation of the valve to feed either more butane gas and less of the other constituent, or less butane gas and more of the other constituent, to produce a mixture having the standard calorific value, and which

will be so determined in the sampling tower and return the needle to normal.

This calorific control, it will be observed, is entirely automatic, and the test and control is made upon a mixture after passage through the compressor. While this in some cases is not essential, it is desirable for accurate and reliable testing, to examine the compressed mixture and make its condition the determining factor of calorific regulation.

The calorific control may be used with any particular mixture of gases as herein described with equal efficiency and, moreover, may be employed in other systems, wherever it is essential to determine and control calorific value.

It will be seen that while the mixing valve 16 will form a mixture having the required ratio of constituents if such mixture fall below the required calorific standard, such condition will be immediately corrected by the automatic control which will effect operation of the motor to decrease or increase the amount of either of the constituents.

I claim:

Apparatus for preparing a combustible mixture comprising a source of supply for combustible, a a source of supply for a tempering agent, means for volatilizing the combustible, a heat exchanger for regulating the relative densities of the combustible and the tempering agent with respect to each other, a mixing means automatically operable to proportion the ratio of combustible and tempering agent to produce a mixture having the desired calorific value, and means for automatically regulating the calorific value of the mixture comprising a thermally responsive member and automatically operable mechanism associated therewith for selectively controlling the ratio of combustible and tempering agent supplied through said mixing means.

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