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METHOD OF RECOVERING DESIRABLE CONSTITUENTS OF GAS OR VAPOR MIXTURE

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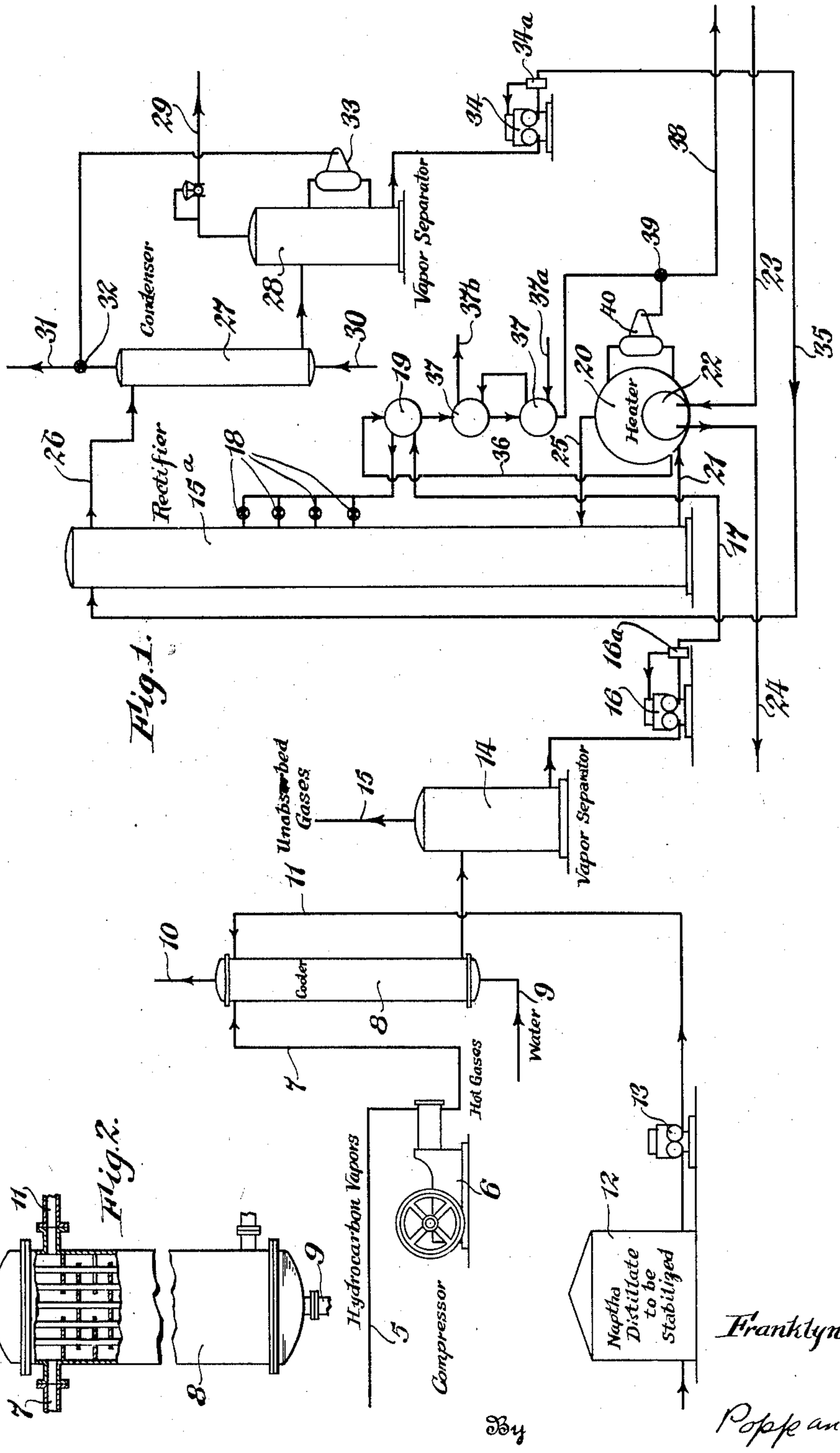

Fig. 1.

Fig. 2.

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METHOD OF RECOVERING DESIRABLE CONSTITUENTS OF GAS OR VAPOR MIXTURE

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5 Claims. (Cl. 196—8)

This invention relates to the recovery from gas or vapor mixtures such as, for example, casing-head gas and natural gas of the heavy liquefiable constituents which are suitable as components of gasoline or other light hydrocarbons and proposes a process which involves the use of an absorbing medium which itself consists essentially of constituents similar to those to be absorbed but in addition also contains undesirable lighter constituents of high vapor pressure which are subsequently to be removed by further treatment.

Although the invention is not so limited, the process has particular utility in connection with the recovery of the desired liquefiable constituents from gas mixtures resulting from the cracking operations carried out to produce low boiling hydrocarbon oils, such as gasoline. In the production of gasoline, this oil being referred to by way of example only, from petroleum oils and distillates, the cracking operations are usually carried on at superatmospheric pressures. The cracked products which are taken off are a mixture of vapors and gases and include vapors of the low boiling hydrocarbon oils which constitute a final product, that is to say, in the present example, gasoline and more lighter gases not suitable as components of gasoline. In the subsequent condensing operation, the greater part of the desirable lighter hydrocarbons are liquefied together with a portion of the lighter gases of high vapor pressure which are not suitable as components of the final product while at the same time the lighter gases which are uncondensed entrain or carry off a substantial part of those constituents which are suitable as components of the final product. In order to remove the light undesirable gases which tend to increase the vapor pressure of the gasoline distillate without undue loss of the heavier desirable constituents, it is the practice to resort to a stabilizing process. By this treatment the high vapor pressure of the final product which results in increasing the cost of handling is reduced and evaporation losses and other objectionable characteristics are eliminated.

The recovery of the desirable liquefiable constituents which escape in the condensing operation with the lighter gases not suitable as constituents of the final product is highly desirable so as to maintain a high yield. Heretofore, it has been the practice to recover such constituents by subjecting the gas or vapor mixture containing them to a scrubbing operation employed in connection with the cracking operations. As it is difficult to absorb the desired constituents in the proportion required without absorbing an appreciable part of the undesired lighter gases it has been necessary to subject the absorbed product to a rectifying or stabilizing process in the same manner that the gasoline distillate has been treated for the separation of the light gases of high vapor pressure liquefied during the condensing operation.

In accordance with the present invention, the recovery of the desired liquefiable constituents entrained in the light gases is accomplished by utilizing an absorbing medium which consists essentially of constituents suitable as components of the same final product as those to be recovered but which in addition also contains lighter absorbed unstable gases not suitable as constituents of the desired hydrocarbon components and which are to be subsequently separated by further treatment of the absorbing medium. Thus, where there is present a gas or vapor mixture containing liquefiable constituents suitable as components of a final product whose recovery is desired and a distillate comprising essentially constituents suitable as components of the final product but also containing undesirable lighter or unstable constituents, the desired liquefiable constituents present in the gas or vapor mixture may be recovered by the practice of the process without the necessity of the additional independent stabilizing operation required in methods heretofore practiced, the said liquefiable constituents in the gas or vapor mixture being absorbed by the distillate containing the light undesirable gases prior to the subjection of the distillate to its stabilizing treatment. Hence, the stabilization of the said distillate is availed of to stabilize the desired liquefiable constituents recovered from the light gases or vapors containing them. In other words, the same operation which is employed to stabilize the distillate is availed of to effect the simultaneous removal of those lighter undesirable constituents of high vapor pressure absorbed during absorption of the desired liquefiable constituents.

The principal object of the present invention, therefore, is an effective and economical method for recovering the desired liquefiable constituents entrained in or carried by a gas or vapor mixture.

The invention will be further described in connection with the accompanying drawing, in which—

Figure 1 is a diagrammatic view of apparatus capable of carrying out the process of the invention.

Figure 2 is a side elevation, partly in section,

of the cooler in which the absorption operation is effected.

In carrying out the process of the invention in the apparatus illustrated, the natural gas or casinghead gas containing the gasoline constituents to be recovered is delivered by a pipe line 5 to a suitable compresser 6 where the mixture is compressed. The mixture, which is more or less heated during its compression is then delivered by a pipe line 7 to one end of a cooler 8 (shown in detail in Figure 2), the cooler being supplied with the desired cooling medium which enters by way of pipe 9 and leaves the cooler by way of the outlet connection 10. At the same time, the gasoline distillate which contains the undesirable constituents in an unstable form is delivered by a pipe line 11 to the cooler 8, it being preferred that the pipes 7 and 11 which deliver the compressed gas or vapor mixture and the gasoline distillate respectively be connected to the same end of the cooler. The distillate may be delivered to the cooler 8 from a suitable source of supply such as a storage tank 12, a pump 13 preferably being availed of to insure this. The absorbing medium or distillate which is delivered to the cooler 8 and which has been referred to, by way of example as a gasoline distillate, may not only be a pressure or straight run distillate but may also be a natural light oil.

In the cooler 8, the compressed gas mixture is cooled and at the same time brought into intimate contact with the gasoline distillate and absorption by the latter of the desired liquefiable constituents present in the compressed gas mixture is effected. Although a small part of the undesirable and unstable lighter gases in the mixture may also be absorbed during this operation, such unstable gases are substantially similar to those already contained in the gasoline distillate.

The distillate containing the absorbed liquefiable constituents originally present in the compressed gas or vapor mixtures together with the unabsorbed gases and vapors leaves the cooler 8 at the opposite end and is delivered to a vapor separator 14 where the unabsorbed gases and vapors are separated from the distillate, the said gases and vapors being discharged through a pipe connection 15 for delivery to a suitable point of disposal.

It will be apparent, at this point, that the distillate in the separator 14 contains, in addition to the light unstable hydrocarbons present in it prior to its use an absorbing medium in the cooler 7, the desired liquefiable constituents suitable as gasoline and originally present in the gas mixture. The distillate also may contain a small part of the undesirable and unstable constituents originally present in the gas mixture but absorbed during the absorption of the desired liquefiable constituents. It is necessary, therefore, in order to condition the distillate to meet required standards that it be subjected to a stabilizing treatment during which the light undesirable constituents of high vapor pressure originally present in the distillate as well as those originally present in the gas or vapor mixture are separated from the distillate thereby leaving gasoline, in the present example, as the final product. The stabilization of the distillate may be accomplished in any type of apparatus desired. The apparatus by which this is accomplished, as illustrated, includes a rectifier or bubble tower 15*a* and the distillate in the separator 14 is withdrawn by a pump 16 and delivered by a pipe line 17 to the said rectifier, there being a plurality of valved connections 18 communicating with the pipe line 17 and by which the distillate may be caused to enter the rectifier at the desired height. The pump 16 is provided with means 16*a* for maintaining a constant flow of distillate to the rectifier. It will be noted that a heat exchanger 19, which will be later referred to is included in the pipe line 17.

The rectifier is of conventional construction and at its bottom is in communication with a drum 20. The distillate upon reaching the bottom of the rectifier leaves the same through the pipe connection 21 and enters the drum 20 where it is heated to a temperature sufficient to vaporize the undesirable constituents of high vapor pressure. The heating of the distillate in the drum 20 may be accomplished by a suitable nest of tubes indicated conventionally at 22, the said tubes being in communication with inlet and outlet pipes 23 and 24 by which the heating medium may be circulated through them.

The vapors or gases in the drum 20 leave the latter through the outlet connection 25 which leads back to the rectifier. The hot vapors or gases, therefore, rise through the descending distillate entering the rectifier through a valved connection 18 thereby preliminarily heating the incoming distillate. During this action, any vaporized desirable constituents are again absorbed and returned to the bottom of the rectifier. The uncondensed vapors or gases which reach the top of the rectifier and which are desirable as constituents of the final product are condensed and returned to the top of the rectifier. The uncondensed vapors or gases which reach the top of the rectifier and which constitute the undesirable constituents of high vapor pressure leave the rectifier through a pipe connection 26 and are then passed through a condenser 27 where a part thereof is condensed. This condensate together with the uncondensed gases or vapors is then delivered to a vapor separator 28 where the uncondensed gases or vapors escape through a pipe connection 29. The condenser 27 is provided with inlet and outlet connections 30, and 31 respectively by which the cooling medium may be circulated through it. The pipe connection 31 includes a valve 32 which is suitably connected to a float control mechanism 33, whereby the circulation of the cooling medium through the condenser may be automatically controlled so as to regulate the condensation of the gases leaving the rectifier.

The cool condensate from the vapor separator 28 is withdrawn by a pump 34 and delivered through a pipe line 35 to the top of the rectifier where it contacts with the ascending gases to scrub them in accordance with present practice. The pump 34 is provided with means 34*a* for maintaining a constant flow of the condensate to the rectifier.

The unvaporized portion of the distillate which constitutes the final product and which is free of the light constituents of high vapor pressure leaves the drum 20 through the outlet pipe line 36 and then passes through the heat exchanger 19 where a part of its heat is taken up by the cool distillate passing through the said exchanger on its way to the rectifier. The partially cooled final product is then preferably passed through coolers 37 where its temperature is reduced to the degree desired and from the said coolers the final products, gasoline in the present instance, is delivered by a pipe 38 to a point of disposal. The coolers 37 are supplied with a suitable cool-

ing medium by a pipe connection 37*a*, the said medium leaving the last cooler in the series through a pipe connection 37*b*. The pipe 38 includes a valve 39 which is suitably connected to a float control mechanism 40 whereby the rate of flow of the final product is automatically regulated to maintain a substantially constant level of the distillate in the drum 20.

From the foregoing, it will be apparent that by utilizing a distillate having undesirable constituents similar to those which will be absorbed during the absorption of the desirable constituents present in the gas or vapor mixture, all of the undesirable constituents of high vapor pressure, that is to say those originally present in the distillate and those originally present in the gas, but which were absorbed during the absorption of the desirable constituents present in the gas, may be separated from the distillate in a single stabilizing operation. The process, therefore, has the advantages that a maximum yield may be obtained and a reduction in the cost of production insured.

The gases or vapors which contain the desirable liquefiable constituents and which are to be treated in accordance with the present invention may be gases or vapors produced during the production of the distillate which is utilized to recover the desirable constituents or the gases or vapors may be derived from an entirely different source than the said distillate as will be the case, for example, where natural gas is treated.

While the absorbing medium is referred to in the specification and claims as a distillate, it is to be understood that this is intended to include not only cracked and straight run distillates but also natural occurring light oils, the only requirement necessary in the case of the light oils being that they have substantially the same characteristics as the distillates to which reference has been made, that is to say, that they consist essentially of constituents suitable as a final product but which also include undesirable constituents of high vapor pressure which are an unsuitable constituent of the final product.

I claim as my invention:

1. The process of recovering liquefiable constituents present in a vapor mixture and suitable as components of a final product which consists in compressing the vapor mixture, contacting the said mixture with a distillate which comprises essentially constituents suitable as components of the final product, the contacting of the vapor mixture and the distillate taking place while the two flow concurrently through a contacting zone, cooling indirectly and with an extraneous medium said vapor mixture and said distillate during said contacting operation, conducting the vapor mixture and distillate to a separate zone after the contacting operation and separating the unabsorbed vapors in said last mentioned zone.

2. The process of recovering liquefiable constituents present in a vapor mixture and suitable as components of a final product which consists in compressing the vapor mixture, contacting the said mixture with a distillate which comprises essentially constituents suitable as components of the final product but which in addition also contains undesirable constituents of high vapor pressure, the contacting of the vapor mixture and the distillate taking place while the two flow concurrently through a contacting zone, cooling indirectly and with an extraneous medium said vapor mixture and said distillate during said contacting operation, conducting the vapor mixture and distillate to a separate zone after the contacting operation, separating the unabsorbed vapors in said last mentioned zone and then heating the remaining distillate to vaporize off those undesirable constituents of high vapor pressure originally present in the distillate and also those constituents of high vapor pressure originally present in the vapor mixture but which are absorbed during the absorption of the desirable liquefiable constituents.

3. The process of recovering desirable liquefiable constituents present in a vapor mixture and suitable as components of gasoline which consists in compressing the vapor mixture, contacting the compressed vapor mixture with a distillate which is essentially gasoline, the contacting of the vapor mixture and the distillate taking place while the two flow concurrently through a contacting zone, cooling indirectly and with an extraneous medium said vapor mixture and said distillate during said contacting operation, conducting the vapor mixture and distillate to a separate zone after the contacting operation and separating the unabsorbed vapors in said last mentioned zone.

4. The process of recovering desirable liquefiable constituents present in a vapor mixture and suitable as components of gasoline which consists in compressing the vapor mixture, contacting the compressed vapor mixture with a distillate which is essentially gasoline but which in addition also contains undesirable constituents of high vapor pressure, the contacting of the vapor mixture and the distillate taking place while the two flow concurrently through a contacting zone, cooling indirectly and with an extraneous medium said vapor mixture and said distillate during said contacting operation, conducting the vapor mixture and distillate to a separate zone after the contacting operation, separating the unabsorbed vapors in said last mentioned zone and then heating the distillate to vaporize off those undesirable constituents of high vapor pressure originally present in the distillate and also those constituents of high vapor pressure originally present in the vapor mixture but which are absorbed during the absorption of the desirable liquefiable constituents.

5. The process of recovering liquefiable constituents present in a vapor mixture and suitable as components of a final product which consists in compressing the vapor mixture, contacting the said mixture with a distillate which comprises essentially constituents suitable as components of the final product, the contacting of the vapor mixture and the distillate taking place while the two flow through a contacting zone and without separation of the unabsorbed vapors, cooling indirectly and with an extraneous medium said vapor mixture and said distillate during said contacting operation, conducting the vapor mixture and distillate to a second zone after the contacting operation and separating the unabsorbed vapors in said second zone.

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