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RECOVERING GASOLINE

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Fig. 1.

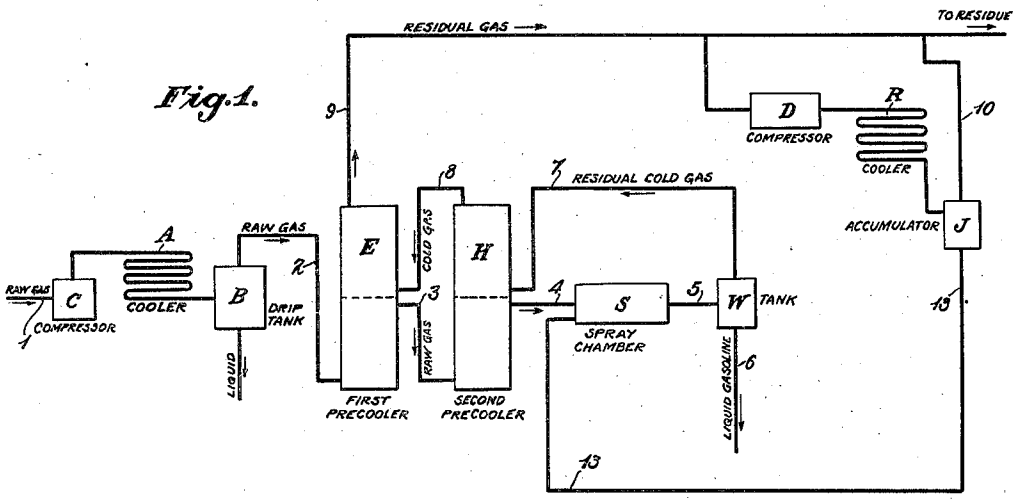
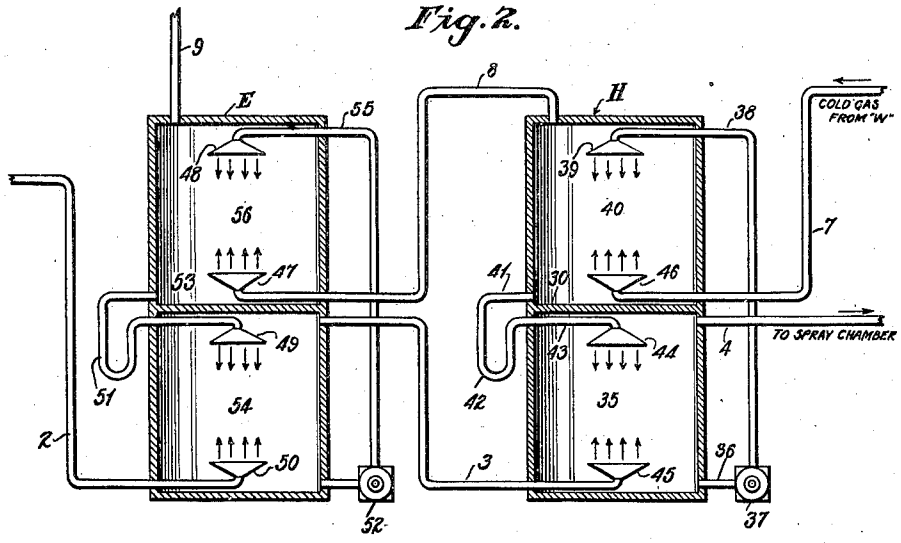


Fig. 2.



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RECOVERING GASOLINE.

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This invention relates to processes of recovering gasoline, and more especially to a method of recovering gasoline from casinghead or natural gas by cooling and refrigeration wherein higher boiling fractions contained in casinghead or natural gas are condensed and separated from the lower boiling fractions; and it comprises a process wherein natural or casinghead gas is first contacted in the gaseous state with cooling liquids previously cooled by contact with cold gas subsequently formed in the process and the then precooled gas brought into intimate contact in a suitable chamber with liquefied lower boiling fractions of the casinghead gas, whereby the liquefied lower boiling fractions are caused to evaporate in such a manner that the gas undergoing treatment is further chilled and the desired higher boiling fractions liquefied and separated from the gases in contact therewith, and the said gases conducted back into the cooling medium to chill the same; it further comprises liquefying a part of these cooling gases for the purposes of refrigerating the incoming natural gas; it further comprises a new method of chilling vapors containing gasoline for the purpose of liquefying the gasoline by contacting said vapors with a suitable cooling medium; and it further comprises as a new organization of apparatus elements a heat exchanger particularly adapted to precool gasoline vapors prior to the liquefaction of the desirable constituents thereof; all as more fully hereinafter set forth and as claimed.

In the recovery of gasoline from natural gas and casinghead gas, a wide variety of processes have been proposed and are in use, utilizing pressure, chilling and scrubbing in various ways. All these processes produce what is known as a wild gasoline, that is, a gasoline containing very volatile components which must be weathered out in making commercial gasoline. In weathering, however, there is a loss of desirable, less volatile products which accompany vapors of the very volatile components. It is the object of the present invention to produce in a simple way a gasoline requiring less weathering; and to accomplish this with a minimum plant equipment.

Wet natural gas contains in addition to methane and ethane, which are permanent gases for the present purposes, a wide variety of vapors of condensible hydrocarbons; these ranging from propane up through the butanes, the pentanes, the hexanes, etc. On condensation, these vapors give liquids of decreasing volatility in the order given. In the terminology of the art, volatile oils are called light oil and this nomenclature will be adopted here, the very volatile oils being termed light oils and the less volatile oils, the heavy oils; it being understood, however, that these heavy oils produced in the present process are of the nature of gasoline.

In the present invention, natural gas coming from any suitable source is usually, but not always, put under some degree of pressure by a pump if the line pressure be deemed not sufficient. In this stage of operation, the gas may, indeed, be at ordinary or atmospheric pressure, although I find it better to work under at least a few pounds extra pressure. After compression, the gas is cooled in an ordinary way. Any condensate which may be produced at this point is removed from the system. The gas is now further cooled in a novel type of precooler by bringing the gas into contact with a liquid cooling medium such as calcium chloride solution, or suitable solution which will not freeze at temperatures used, which cooling medium has been cooled to a sufficiently low temperature by cold gas produced further along in the process.

After the temperature of the raw gas has been lowered to between 0° F. and —50° F. by contact with cold calcium chloride solution it is then passed into intimate contact with liquid gasoline which gasoline has been chilled to about —70° F. or lower by cold gas also subsequently produced, the temperatures depending upon requirements. After the raw gas has been "precooled" by these two cooling mediums, it is then conducted into a spray chamber wherein it is brought into contact with a quantity of liquefied lower boiling fractions of the natural gas obtained in the process in a later stage. These lower boiling fractions undergo self-evaporation while in contact with the raw gas, with the result that the temperature of the raw gas is lowered to such an extent that the desired higher boiling fractions are liquefied. These higher boiling fractions are then separated from the residual gas. The residual gas which has a very low temperature, which may be about —70° F., is conducted into contact with the

gasoline previously mentioned as a cooling medium for the incoming raw gas thereby lowering the temperature of the gasoline. The residual gas is then conducted into contact with the calcium chloride solution used to precool the gas in the first precooler stage. After having fulfilled its function of cooling the calcium chloride solution the now somewhat warmed residual gas is conducted out of the system, a part thereof however being recompressed and chilled and the liquefied portions thereof conducted back into the system, brought into contact with incoming precooled raw gas, permitted to undergo self-evaporation, the raw gas thus cooled to a condensing temperature, and the cycle repeated.

In the accompanying illustration I have shown more or less diagrammatically certain embodiments of my invention. In this showing,

Figure 1 is a flow sheet diagram indicating the course of the raw gas and the cooling medium in the system; and

Figure 2 shows in detail the construction of the heat exchanger.

Referring more particularly to Figure 1, raw gas enters the system at 1, and is compressed in compressor C which may be of ordinary construction. If the gas is already under a suitable pressure it need not be compressed at this stage. If it is not, the compressed gas is cooled by an ordinary water cooling device A whereby the heat of compression is extracted from it. Leaving A the gas is conducted to drip tank B wherein such constituents as have liquefied are separated and withdrawn from the system. The gas leaving B is conducted through line 2 to the lower part of the first precooler E wherein it is brought into contact with a countercurrent shower of a chilled liquid cooling medium such as calcium chloride solution. Passing from E the gas is conducted through line 3 into the second precooler H wherein the gas passes upward through a downcoming shower of extremely cold gasoline. The gas now very much lowered in temperature passes by means of line 4 into the "spray chamber" S wherein it is brought into contact with low boiling liquids undergoing self-evaporation. From the spray chamber the gaseous mixture passes by line 5 into a second accumulator tank W in which the liquefied portion of the gaseous mixture is separated from the residual gas and conducted to a suitable storage tank (not shown) by line 6. The residual gas leaving the top of W by line 7 is conducted back to the second precooler H wherein it is brought into contact with gasoline in order to chill the same and make it suitable as a cooling medium for the raw gas.

The precooler H (see Figure 2) is constructed in the form of a tank divided at its mid portion by partition 30 thereby separating completely the upper half of the tank from the lower. The lower half of the tank 35 is provided with an outlet 36 leading to a pump 37 (shown diagrammatically) which pumps the cooling medium, in this case gasoline, into the upper half of the precooler designated as 40. The cooling medium is conducted into the upper half of the precooler 40 by line 38 which terminates within the precooler portion 40 and at the top thereof in a spray device of ordinary construction 39. The upper half of the precooler 40, is provided at its lower extremity with an outlet 41 connected with a liquid seal 42. The other end of the liquid seal passes into the lower half of the precooler 35 at the upper extremity thereof by line 43 and terminates in a spray device 44. The raw gas entering the precooler H by line 3 is "sprayed" upwardly into contact with the downcoming gasoline from 44 by spray device 45. The operation of the second precooler H is as follows: Cold gas leaving the accumulator tank W is conducted by line 7 into the upper half 40 of the precooler and "sprayed" upwardly by spray device 46. This cold gas meets a downcoming stream of gasoline coming from 39 and cools the same. The now chilled gasoline passes by 41 through the liquid seal 42 and into the lower half 35 of the precooler, is sprayed by means of 44 into the upcoming stream of raw gas, thereby cooling the same. The cooling medium is withdrawn from the lower half 35 of the cooler and pumped by pump 37 back into the upper half 40 wherein it is once more cooled for reuse by incoming cold gas from the accumulator tank W. The cold gas which has sufficed to chill the cooling medium, gasoline, is withdrawn from the upper half 40 of the precooler H and is conducted by line 8 into the first precooler wherein calcium chloride solution or some non-freezing medium is used as the cooling medium.

The first precooler E is identical in its structural features with the precooler H, it being provided with spray devices 47, 48, 49 and 50, and liquid seal 51 and a pump 52, and is also divided at its mid portion by a partition 53. Calcium chloride solution is circulated from the lower half 54 of the precooler E by means of pump 52 and line 55 into the upper half of the precooler 56 wherein it is sprayed through 48 into contact with gas coming from the upper half 40 of precooler H by line 8. This gas, which is a few degrees below 0° F. is sprayed upwardly through 47 into a downcoming stream of calcium chloride from 48 whereby the calcium chloride solution is chilled to a temperature between 0° F. and —50° F. The now cooled calcium chloride solution is conducted into the lower half 54 of the pre-

cooler through liquid seal 51 and spray device 49 and then acts to cool incoming raw gas from line 2 and spray device 50. The calcium chloride solution after it has absorbed heat from the raw gas is then pumped by 52 through line 55 back into the upper half 56 of the precooler where it is again brought into contact with further quantities of cold gas and is again chilled. The cold gas, which consists of most of the lower boiling fractions in the natural or casinghead gas, after it has acted to lower the temperatures of the calcium chloride solution is conducted out of the upper half 56 of the precooler E by line 9 to a storage tank (not shown). A part, however, of this gas is passed by line 10 (Fig. 1) into a compressor D wherein it is compressed and subsequently cooled in a watercooler R and then passed to an accumulator tank J. The liquefied portions are withdrawn from J by line 13 and conducted back into the spray chamber S wherein the liquefied portions undergo self-evaporation and act to cool the incoming precooled raw gas to a liquefying temperature. The residual gas is passed from J by line 10 back to line 9 and is conducted out of the system.

In the first precooler E, a cooling medium which does not freeze above a temperature of about 0° F. must be used. I have found calcium chloride solutions particularly adapted for my purpose although I do not wish to be restricted solely to the use of that cooling medium since it is obvious that many other cooling mediums may be suitable. In the precooler H, I advantageously use gasoline and the temperature in the precooler H varies between the temperature of the incoming raw gas through line 3 and the temperature of the incoming cold gas through line 7. It is necessary that a cooling medium in H be one which stands a very low temperature, say down to —70° F. or lower and at the same time does not volatilize to an appreciable degree. I prefer not to use calcium chloride solution in the second precooler H because calcium chloride solution ordinarily cannot stand the extremely low temperatures which are found in the second precooler. Gasoline could not be used as a cooling medium in the first precooler because too much of the gasoline would be volatilized at the temperatures maintained therein.

It will be seen that the process is a cyclic one, raw gas being cooled, parts thereof liquefied, and the residual cold gas used to cool the liquid cooling medium with which the raw gas is precooled. By utilizing the cold lean gas to maintain the cooling medium at an effective temperature and then bringing the raw gas into actual intimate contact with the said cooling medium, I obtain an almost theoretically efficient exchange of heat.

What I claim is:—

1. In the recovery of gasoline by the refrigeration of natural or casinghead gas the step which comprises contacting the vapors of gas to be cooled with a solution of a cooling medium cooled by cold gas subsequently obtained from the natural gas in a later stage of the operation.

2. The process of recovering gasoline from natural gas by refrigeration, which process comprises passing the gas in a countercurrent relation to a downward flow of a cooling medium whereby the gas is precooled to a temperature between 0° F. and —50° F., passing the gas in contact with a downward flow of a second cooling medium whereby the gas is further cooled, passing the gas into intimate contact with lower boiling liquid undergoing self-evaporation, separating and withdrawing condensed liquid from the resulting gaseous mixture, passing the residual gas into countercurrent contact with the second cooling medium whereby the same is cooled, subsequently passing the residual gas into contact with the first cooling medium whereby the same is cooled, liquefying at least a part of the residual gas and conducting said liquefied portions into the system and into contact with the precooled raw gas, permitting the liquefied portion to undergo self-evaporation whereby the raw gas is chilled to a liquefying temperature and then separating the desired liquefied constituents from the gas.

In testimony whereof, I have hereunto affixed my signature.

FRED E. HOSMER.