

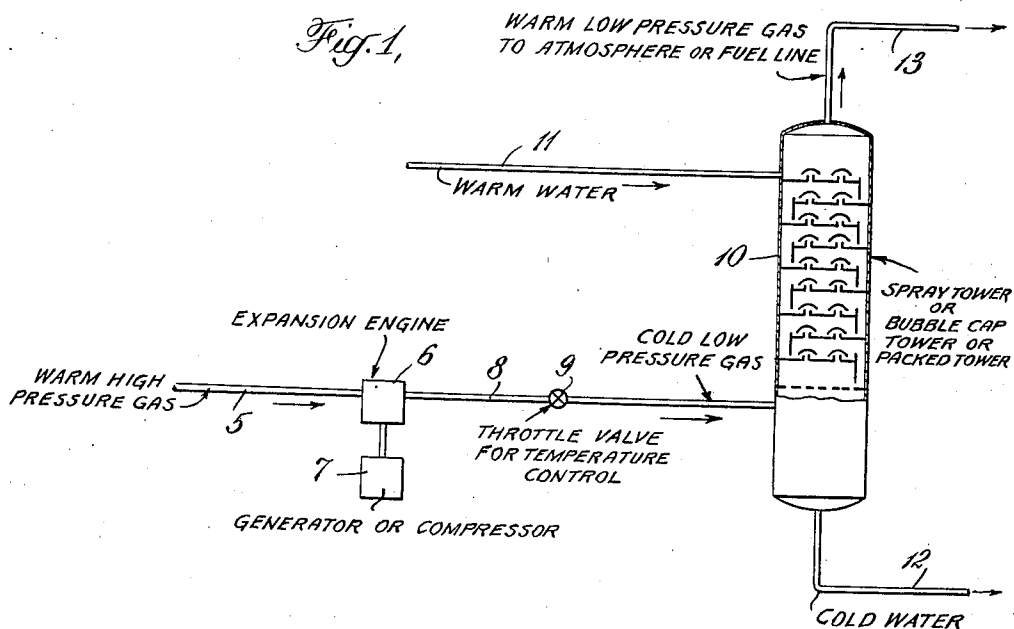
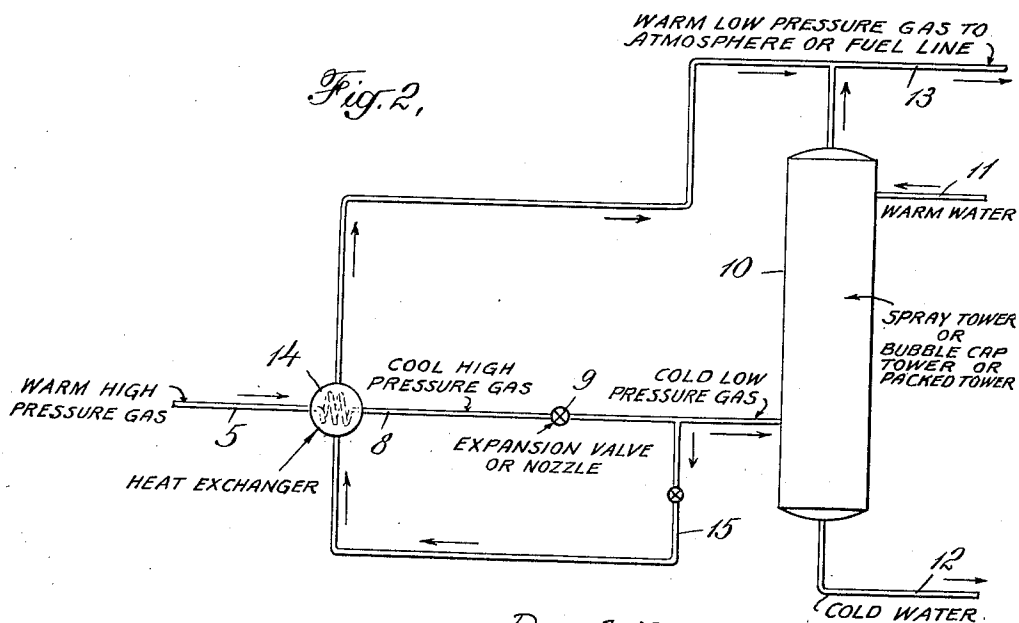
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D. S. MELLETT ET AL
METHOD OF GAS UTILIZATION

2,316,744

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Fig. 3,

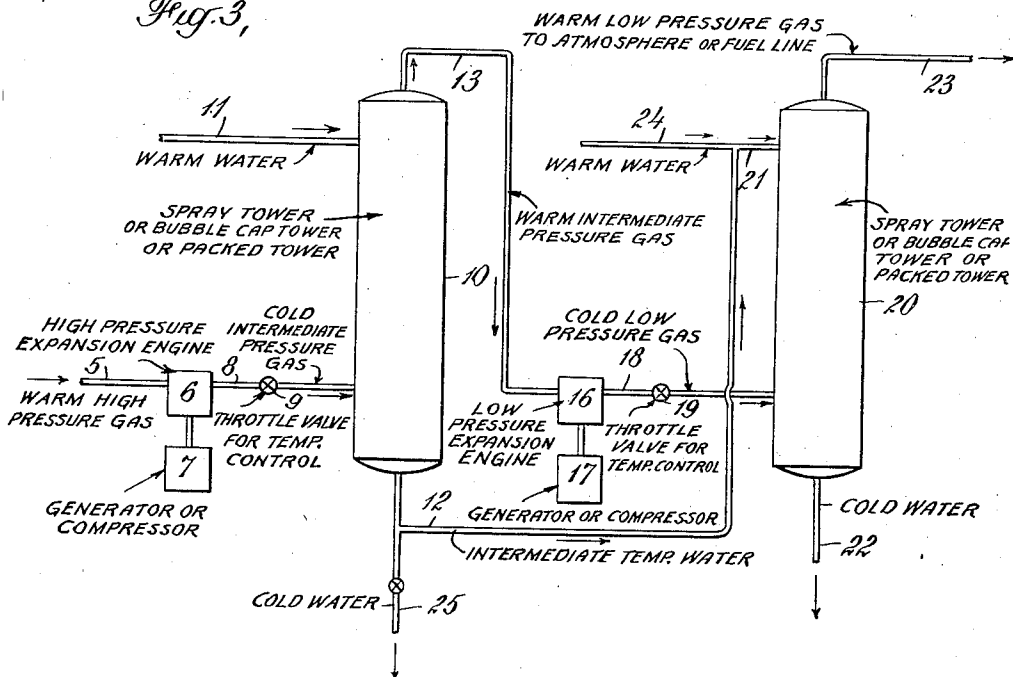
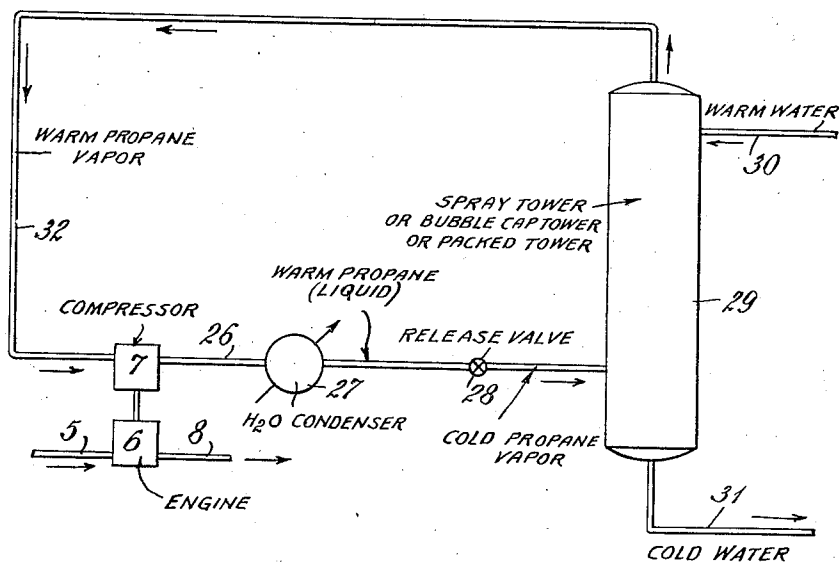


Fig. 4,



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METHOD OF GAS UTILIZATION

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4 Claims. (Cl. 62-175.5)

This invention is directed to a method for producing refrigerated or cooled water for oil refinery uses, and more particularly to a method for such purposes utilizing the energy stored in gaseous petroleum fractions normally available in substantial quantities at petroleum refineries.

Oil refineries do a very considerable amount of heat extraction. While by far the greater portion of the heat extraction deals with heat at relatively high temperature levels, where heat in outgoing process products can be given up to incoming process charges in heat exchanging equipment, there remains a relatively quite large amount of low temperature level heat extraction, and practically the whole of this low level heat is extracted by cooling with water in heat exchange relationship. With even a moderately sized refinery, the amount of cooling water circulated is enormous. Obviously the water so used must be cooled and recirculated. The usual methods of cooling are by cooling ponds, spray ponds, and water cooling towers. The disadvantages of these older processes are the limitation of cold water temperature, loss of water, and cost of operation. The water temperature obtainable by these methods is limited by atmospheric conditions, i. e., by the temperature and humidity of the air. Further, in atmospheric towers, operation depends on wind velocity, in forced draft towers the power demand is appreciable, and in any of these methods the water loss may range from 5 to 25 per cent. For many refinery operations, the establishment of temperature levels below the reach of water so cooled is necessary, and evaporative water coolers are used, for these, the lower the water temperature desired, the higher is the vacuum that must be maintained. Consequently for very low temperatures, the cost of steam for vacuum jobs is high, and, of course, a high pressure steam supply must be available. It may be mentioned that the vacuum cooling system is also limited by the temperature of the water available for condensing. The higher the condensing water temperature, the higher will be the steam requirement for any desired cold water temperature.

Of course, refrigerative methods in which some material, such as ammonia or carbon dioxide is compressed, cooled, and evaporated in a closed system are available. These processes are expensive at best and the cost of operation mounts rapidly as the desired temperature level is lowered. Additionally these processes in the usual

forms are handled as indirect heat exchange systems. Due to these characteristics, the use of such processes is uniformly restricted to specialized service jobs, such as wax chilling and the like.

This invention has for its major object the provision of cooling capacity of comparatively low cost, both from the installation and operation standpoints, of great flexibility, and particularly adaptable to refinery operations with a minimum of difficulty. Another object is the provision of such a process utilizing energy stored in gaseous petroleum products normally in existence in almost all refineries, which has never before been so used.

Any modern refinery has many sources of petroleum gases at elevated pressures, such as the dry gases from absorbers, stabilizers, debutanizers, depropanizers, and similar effluent gases from many forms of operations from which gases are withdrawn at pressures higher than atmospheric. The normal final disposition of these gases is a use as fuel or an open flare, both at quite low pressures. The necessary reduction of the exit pressures to waste or fuel pressure levels represents a very considerable amount of energy which may be made available for cooling duties. So far as is known, this possibility has heretofore been completely overlooked.

How this energy may be effectively utilized for this and for other purposes will be readily understood by reference to the attached drawings.

The four figures of these drawings show, in diagram form, various aspects of the process of securing low temperature cooling fluids herein set forth.

In Figure 1 there is shown a simple and preferred form of the process of energy utilization. In this diagram, warm, high pressure gas, exhausted from refinery processing, such as, for example, from a usual type of debutanizing or stabilization operation, on cracked gasoline, or the like, at a pressure of from about 35 to 400 pounds or so, and a temperature of from about 70° to 120° is delivered through pipe 5, and is passed through expansion engine 6, wherein it is expanded, doing work against the engine, and being cooled in the process. Useful work may be recovered, if desired, from engine 6 by utilizing it to drive a generator, compressor or other device 7. To properly control the engine, and to permit further controlled reduction of the pressure upon the gas, the gas leaving the engine 6 through pipe 8 is passed through pressure reduction valve 9

where its pressure is reduced to atmospheric or to the relatively low pressure held on the usual low pressure fuel supply pipe. The gas is further cooled in this adiabatic expansion. The expanded gas is then immediately passed to and through tower 10 wherein it is contacted with water which is introduced by pipe 11 and removed by pipe 12. This tower, for good contact, is preferably a bubble tray type of tower, or filled with a packing material such as raschig rings, or coke, although, in some circumstances, good results may be secured with an open tower into which the warm water is so sprayed as to assure good contact with the gases. The gases, after contact, depart through pipe 13.

This process of producing cool water is considerably more capable than any now in use for the correction of temperature of refinery cooling waters, and may be used for the production of water of hitherto unusual low temperatures. For example, with the reduction of gas at 100° F. and 35# per square inch gauge pressure to normal fuel supply line pressure of near atmospheric levels, it is relatively easy to reduce water to near its freezing point. This is beyond the capability of cooling towers or vacuum-cooling systems, and the energy source is one that has not heretofore been utilized in any way. And the low temperature waters can be used to great advantage in increasing the efficiency of existing processes over what has been attainable heretofore. For example, this low temperature water can be used to great advantage in chilling lean oil for absorbers, and in condensers for debutanizers, stabilizers, and the like. It is a virtual necessity for the production and recovery of low-boiling point materials, such as ethane and ethylene.

Figure 2 illustrates another application of the process. In this case the operation of the tower is the same as that described above. The method of chilling the gas, however, is similar to that used in the production of liquid air. The high pressure gas is expanded through a valve or nozzle 9, cooling by the Joule-Thompson effect. A portion of the cold low pressure gas is passed by pipe 15 through a heat exchanger 14 against the entering high pressure gas cooling the latter while being warmed itself. The remainder of the cold gas passes into the tower and cools the water by direct contact, as described. The temperature of the gas entering the tower is controlled by varying the quantity of gas released through the heat exchanger. This process will not produce as much refrigeration as those illustrated in Figures 1 and 3 since no work is taken out of the gas. Nor is any power recovered. However, the installation cost for this process would be considerably less than for those previously described, and consequently, it might be preferred in some situations.

In cases when the initial pressure of the gas is so high that expansion in a single stage would produce temperatures low enough to bring about icing or gas hydrate formation, the process may be carried out in two or more stages as indicated in Figure 3. In this figure, the functions of items 5, 6, 7, 8, 9, 10, 11, 12, 13 are the same as in Figure 1, except that the pressure reduction in these items is only partial, the gas in pipe 13 passing to another engine 16, attached to another energy user 17, through pipe 18, through final pressure reduction valve 19 and into tower 20. the warm water supply for which at 21 may be

made up entirely of cooled water from pipe 12, or entirely of warm water from pipe 24, or a mixture, with cooled water leaving at 22, and gas leaving to final disposition at 23. Intermediate cooled water may be withdrawn, if desired at 25.

As a measure of the magnitude of the refrigeration capacity existent in the usual refinery, and heretofore wholly unused, it may be remarked that in one small refinery equipped with a high pressure gas recovery system, there is available in the effluent gases power equivalent to 730 theoretical horsepower. Assuming an overall efficiency of 50%, this power is equivalent to 1840 tons of refrigeration, or 22,000,000 B. t. u. per 15 hour.

A very efficient utilization of the energy so available may be made by using the operation diagrammed in Figure 4, wherein the engine 6, corresponding to the expansion engine 6 of Figure 1, driven by high pressure refinery gas from pipe 5, drives a compressor 7, as in Figure 1, which compressor 7 is utilized for the compression of a recycled refrigerant gas, conveniently propane or a mixture of light petroleum gases, such as refinery gas. The compressed gas flowing through pipe 26 is liquefied by cooling water in condensor-exchanger 27, and is expanded through valve 28 to pass through contact tower 29 to cool water introduced thereto by 30 and withdrawn by 31, the gas being returned to reuse by pipe 32.

We claim:

1. A method for the utilization of high pressure refinery gases to produce cooled fluids for heat extraction uses in refinery processing comprising partially expanding said gases to reduce the temperature thereof, and passing the cooled gases in direct physical contact with cooling fluid of higher temperature than said cooled gases, and subsequently expanding said gases to near atmospheric pressure, and again passing said gases in direct physical contact with cooling fluid of higher temperature than said gases as passed in contact therewith.

2. A method for the utilization of high pressure refinery gases to produce cooled fluids for refinery processing use comprising expanding said gases while extracting work therefrom to reduce the temperature thereof, passing said cooled gases in direct physical contact with a fluid to be cooled of higher temperature than said cooled gases, utilizing the work extracted from said gases to compress a refrigerant gas held in a compressing - cooling - expanding - compressing cycle, and contacting the refrigerant gas, after its expansion, in direct physical contact with a second portion of fluid to be cooled of higher temperature than said refrigerant gas after its expansion.

3. A method for cooling fluids for heat extraction uses comprising expanding high pressure refinery gases to reduce the temperature thereof, and passing the so-cooled gases in direct physical contact with a fluid of higher temperature to reduce the temperature of said fluid.

4. A method for cooling fluids for heat extraction uses comprising expanding high pressure refinery gases and extracting work therefrom to reduce the temperature thereof, and passing the so-cooled gases in direct physical contact with a fluid of higher temperature to reduce the temperature of said fluid.

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