

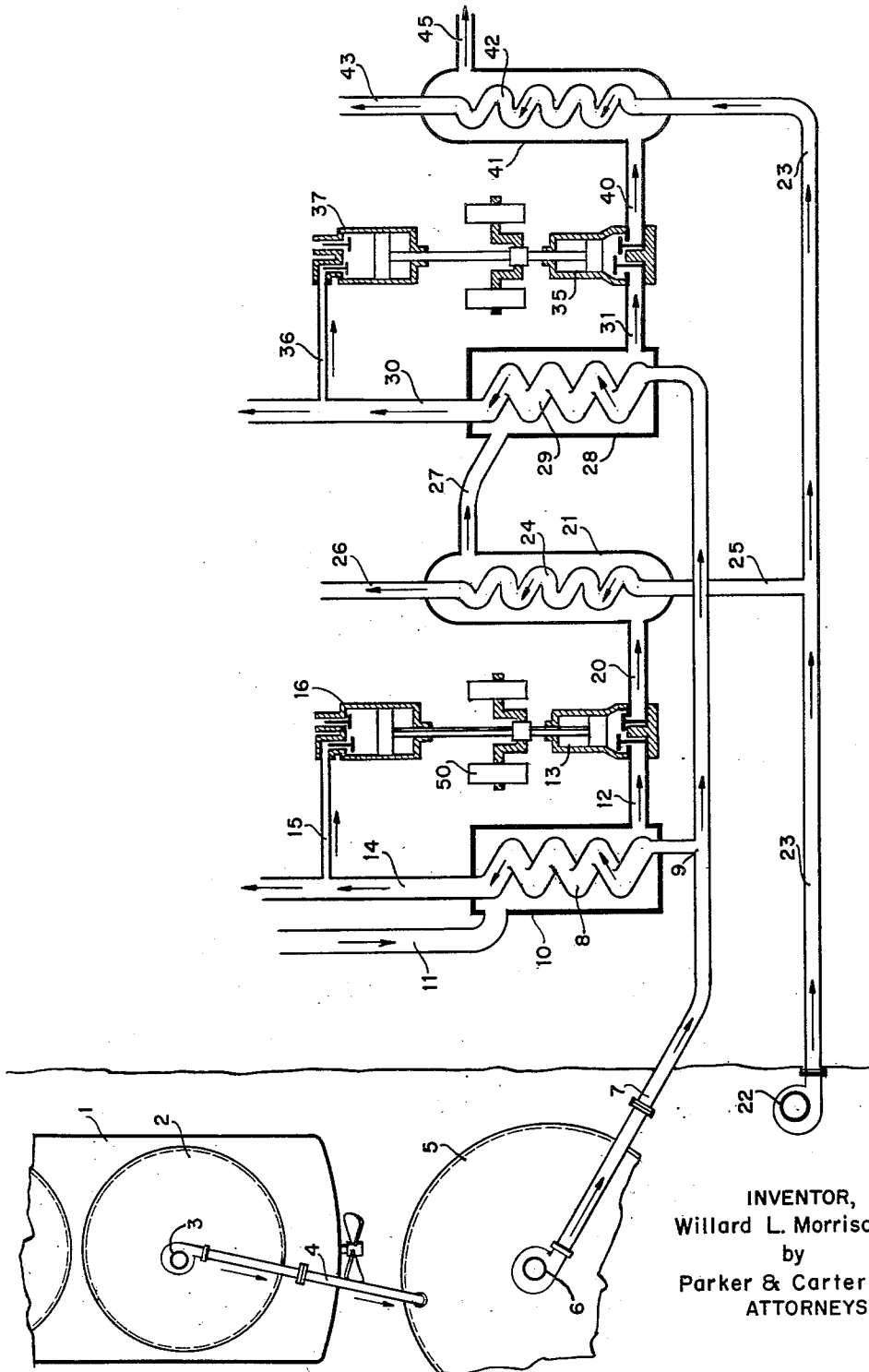
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METHOD AND APPARATUS FOR REDUCING POWER NEEDED FOR COMPRESSION

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METHOD AND APPARATUS FOR REDUCING POWER NEEDED FOR COMPRESSION

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This invention relates to processes involving the compression of various gaseous materials and has for one object to provide a method for reducing the power necessary to compress said gaseous materials.

Another object is to provide an apparatus effective to reduce the power necessary to compress gaseous materials.

Another object is to provide a method of cooling gaseous materials which are to be compressed prior to such compression in order to reduce the power necessary to compress said gaseous materials to a desired pressure.

Another object is to provide a method of cooling gaseous materials prior to their compression in order to reduce the power necessary for such compression wherein the cooling medium may be utilized, also to produce the power required for such compression.

Other objects will appear from time to time in the course of the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawing wherein the single figure comprising the drawing is a top plan view in cross section.

Like parts are indicated by like characters throughout the specification and drawings.

Referring to the drawing, 1 is a barge or similar carrier which may be tied up at a dock or similarly located alongside a plant wherein gaseous materials are processed, the process involving at one or more stages the compression of such gaseous materials. The carrier 1 may have one or more containers or tanks such as that illustrated at 2. Any suitable pumping means such as the pump generally shown at 3 may be employed to transfer a supply of liquefied natural gas from the containers 2, for example, through the piping or conduit 4 to a reservoir 5. Similarly a pumping means 6 may be employed to transfer the liquefied natural gas from the reservoir 5 through pipe 7. A coil 8 may be connected to the pipe 7 as indicated at 9 and may be enclosed within a heat exchange chamber 10. A conduit 11 may be employed to convey the gaseous materials which are to be compressed, to the chamber 10, for heat exchange contact with coil 8. A conduit 12 is connected to the heat exchange chamber 10 to convey the gaseous material which have been cooled therein from the chamber 10 to a compressor mechanism 13. The coil 8 has an outlet pipe 14 leading from the chamber 10. A branch conduit 15 is connected at one end to the pipe 14 and at its opposite end to an internal combustion engine which is powered by gas vaporized and warmed by heat exchange in coil 8, illustrated diagrammatically at 16.

It will be realized that the pipe 11 is connected to a source of supply of gaseous materials and that the pipe 14 may be connected to a variety of mechanisms and may in fact be so connected as to direct the natural gas which has been vaporized by heat exchange in the chamber 10 to a point of use in the process of the plant in which the gaseous materials are treated. Since the elements to which the pipes 11 and 14 may be connected do not form any

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part of the present invention they are not illustrated or further discussed herein.

An outlet conduit 20 leads from the compressor 13 and conducts the gaseous materials compressed therein to a second heat exchange chamber 21. A water pump 22 is effective to direct water under pressure through a water pipe 23. A coil 24 is positioned within the heat exchange chamber 21 and is connected, at one end to the branch conduit 25 leading from pipe 23 and at its opposite end to a water discharge pipe 26 extending from the chamber 21. An outlet pipe 27 is connected to the chamber 21 to conduct the gaseous materials which have been cooled within the chamber 21 by the water passing through the coil 24, to a third heat exchange chamber 28 which contains the coil 29. The coil 29 is connected at one end to the liquid natural gas supply pipe 7 and at its opposite end to an outlet conduit 30. An outlet pipe 31 is connected to the chamber 28 to convey the gas cooled therein by the liquid natural gas flowing through the coil 29 to a second compressor 35. A branch conduit 36 is connected to the pipe 30 to convey the natural gas vaporized and warmed by heat exchange, to an internal combustion engine illustrated at 37. The pipe 30 may be connected to a suitable mechanism as described above with relation to pipe 14.

40 is a discharge conduit leading from compressor 35 to conduct the gaseous materials compressed therein to a fourth heat exchange chamber 41 through which extends the coil 42 which is connected at one end to the water supply pipe 23 and at its opposite end to the water discharge pipe 43. 45 is an outlet conduit connected to the chamber 41 to convey the gaseous materials cooled therein by heat exchange with the water passing through the coil 42. The outlet pipe 45 may be connected to a variety of mechanisms employed in the processing plant or, if desired, it may be connected to a fifth heat exchange chamber similar to the chamber 28. It will be realized that the mechanism illustrated diagrammatically at 8—20 may be repeated at any desired number of points without departing from the nature and scope of the invention.

50 illustrates fly-wheels employed with the compressors 13, 35.

The use and operation of this invention are as follows:

A method is provided for reducing the power necessary to compress gaseous materials which involves the concept of cooling the gases prior to such compression by the use of liquefied natural gas as a refrigerant passed in heat exchange relationship with such gaseous materials immediately prior to compression thereof.

The liquefied methane which is supplied in tonnage quantities at a temperature of -258° F. within the containers 2 and reservoir 5 is pumped through the heat exchange coil 8. The gaseous materials entering the heat exchange chamber 10 are thus cooled as they pass about the coil 8 and the liquefied natural gas is vaporized. The cooled gaseous materials are conveyed from the chamber 10 to a compressor 13 by the conduit 12. A portion of the vaporized natural gas flowing from the coil 8 through the pipe 14 is bled off and directed into the internal combustion engine 16 where it serves as a fuel to provide the power necessary to operate the compressor 13. Thus, by liquefying natural gas and supplying it in quantity, the refrigerant effect is utilized to cool gaseous materials about to be compressed and to use also at least a portion of the natural gas in gaseous phase resulting from such cooling as a fuel to provide the necessary compression power.

As natural gas is often used as one of the raw materials in certain processing plants and since only a portion of the natural gas vaporized in the chamber 10 is necessary to provide the amount of power needed for compressing

the gaseous materials which have been cooled within the chamber 10, the remaining vaporized natural gas may be used as raw material in the process within the plant, or may be diverted to other use in or out of the plant.

The gaseous materials compressed by the compressor 13 flow outward therefrom through the outlet conduit 20, having been raised in temperature by compression. Under certain circumstances it may be found advisable to produce an initial cooling of such compressed gases to an intermediate lower temperature. This may be accomplished by the use of a heat-exchange mechanism employing a coil through which water is pumped. As illustrated, the water in which the barge 1 is floated may be conveniently utilized. The gaseous materials leaving the water cooled heat exchanger 21 through the conduit 27 may be directed into the compressing plant or may be again cooled by means corresponding to those already described.

It will be understood that the compressor outlet 20 could be, under certain circumstances, connected directly to the heat exchange chamber 28 wherein the gases which were heated to some extent by the compressor 13 would be again cooled before entering a second compressor 35.

It is known that the horsepower required to compress gases per unit mass varies directly as the inlet absolute temperature from the same initial pressure to the same final pressure. While various means have been employed to cool said gases prior to compression, I have found that natural gas liquefied at about -258° F. may be utilized effectively to cool said gases prior to compression and this use of natural gas is productive of particularly advantageous results in that the natural gas, when supplied in large quantities in liquefied form at or about -258° F. may be utilized first, as an effective coolant for gaseous materials in a processing plant, then as a fuel to power the compression mechanism, and thirdly, as a raw material usable in the process within the plant. Also any surplus of natural gas in gaseous phase resulting from the use of liquefied natural gas as a coolant may be utilized as a fuel to economically and effectively power other mechanisms within the plant.

While I have illustrated my invention as using the gas as fuel in internal combustion engines, it will be obvious that the gas might be used just as well as fuel for any other means of generating the necessary power.

I have referred to the vaporization of the liquefied gas by heat exchange as it passes through the coils 8 and 29. Such gasification will take place if the pressure in those coils is substantially at atmospheric because liquefied methane or natural gas boils at approximately -258° F. On the other hand, if by control of the exhaust pressure through the pipes 14 and 30 and by operation of the pump 6, the pressure in the coils 8 and 29 is maintained above atmospheric, then the boiling point of the liquefied methane will be above -258° F.

I claim:

1. In the method of raising the temperature of a stream of methane from about minus 258° F. to substantially atmospheric temperature while simultaneously substantially compressing a stream of a second gas, the steps which comprise: (a) in a first step passing the cold methane in heat exchange with the second gas to substantially reduce its temperature and increase its density, (b) in a second stage compressing the said second gas effluent from said first stage, (c) in a third stage water cooling the second gas effluent from said second stage, (d) in a fourth stage passing a further stream of cold methane in heat exchange relation with said second gas effluent from said third stage, (e) in a fifth stage compressing the second gas effluent from said fourth stage, and (f) in a sixth stage water cooling to substantially atmospheric temperature the second gas effluent from said fifth stage.

2. The method of substantially raising the temperature of a stream of a first gas from a temperature substantially below atmospheric to substantially atmospheric temperature while simultaneously compressing a second gas to a substantially elevated pressure which comprises in progressive stages compressing said second gas stream, passing the stream of said second gas entering each compressor in heat exchange relation with separate portions of said first gas, and water cooling the stream of said second gas as it leaves each of said compressors, and subsequently utilizing said heated-up first gas as a fuel.

3. The method of claim 1 characterized further in that a portion of the methane stream after heat exchange with said second stream is converted into power for operation of compression means.

4. The apparatus for substantially raising the temperature of a stream of a first gas from a temperature substantially below atmospheric to substantially atmospheric temperature while simultaneously compressing a second gas to a substantially elevated pressure which comprises the combination of a plurality of heat exchangers, means to convey said second gas stream sequentially through said heat exchangers, means of conveying different portions respectively of the stream of said first gas through said heat exchangers, means for compressing said second gas stream after it has passed through one of said heat exchangers and means for conveying water in heat exchange relation with said stream of said second gas as it leaves at least one of said compressors.

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