

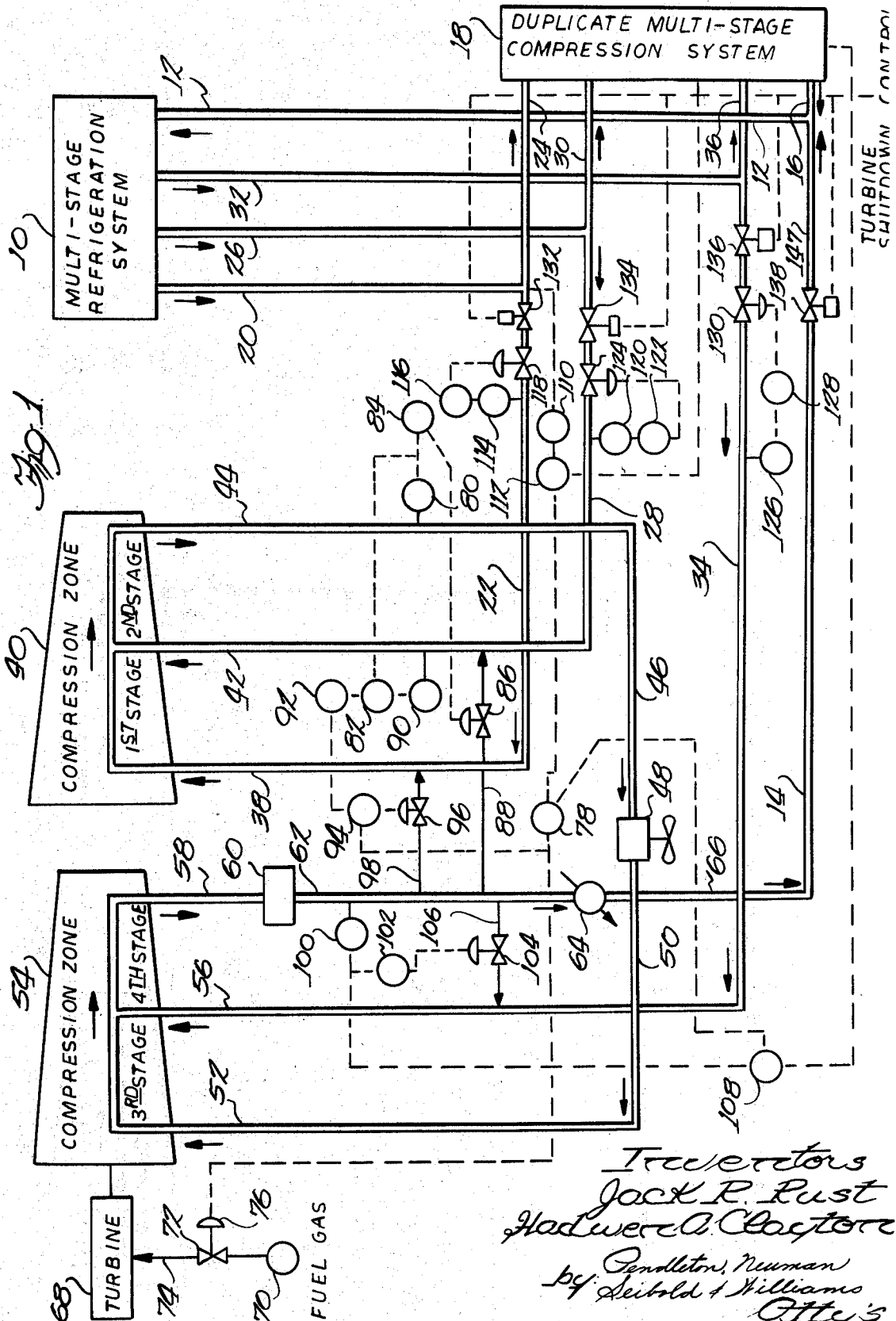
Sept. 8, 1970

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METHOD OF CONTROLLING PARALLEL-OPERATING
REFRIGERATION COMPRESSORS

3,527,059

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2 Sheets-Sheet 1



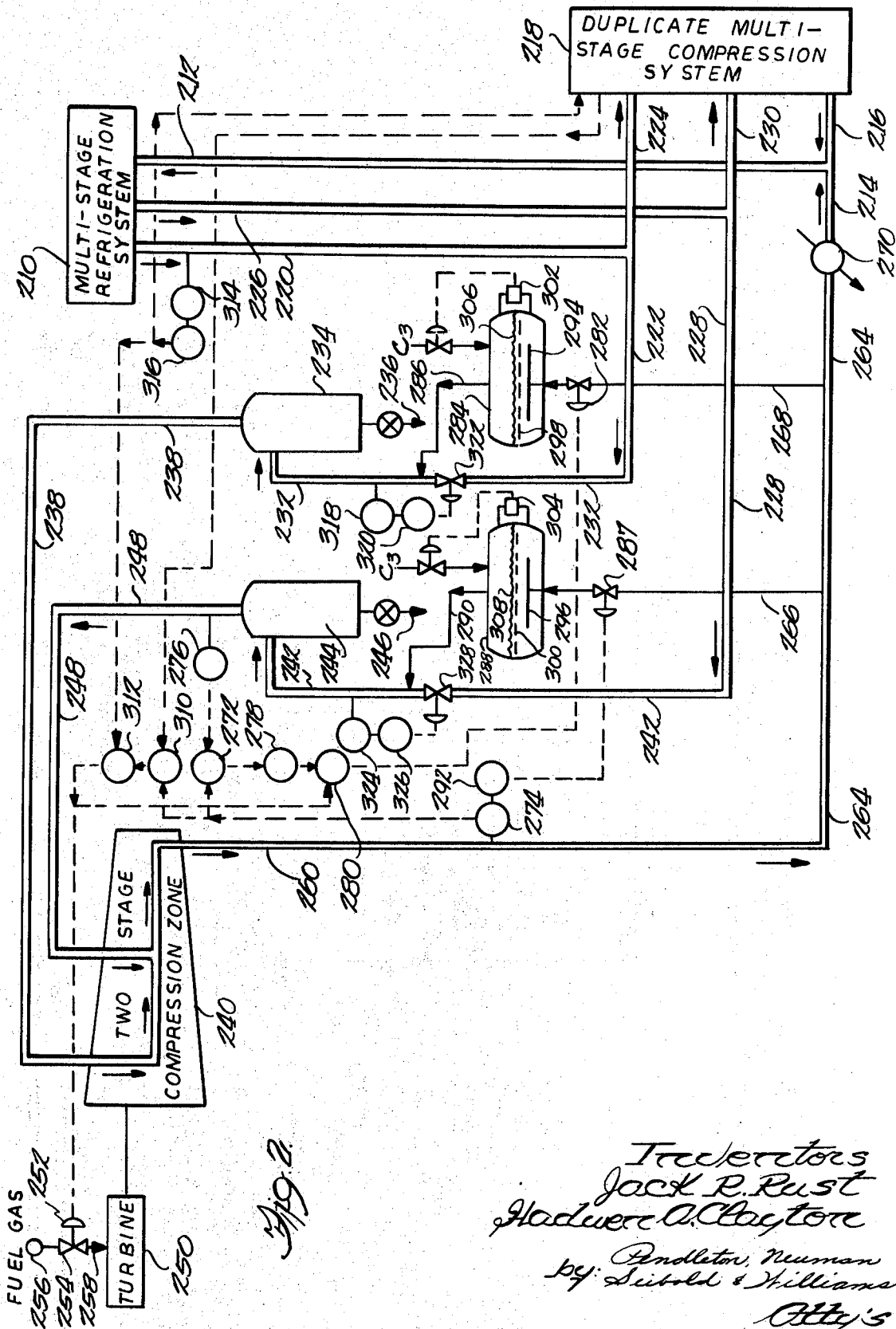
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METHOD OF CONTROLLING PARALLEL-OPERATING REFRIGERATION COMPRESSORS

Jack R. Rust and Hadwen A. Clayton, Bartlesville, Okla., assignors to Phillips Petroleum Company, a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

A method of balancing the operation of a plurality of turbine-powered multi-stage refrigeration compressors which operate in parallel to supply refrigerant to a single multi-stage refrigeration system comprises interrelated control steps which interact to achieve the desired balanced operation. The control steps include recycling a portion of the compressed gaseous refrigerant from the final stage to the earlier stages of each compressor so that all stages operate at least about 80% of their normal capacity and excessive surging is avoided. Recycle to the first stage also may be used to maintain suction pressure above a predetermined minimum. The speed of the turbine prime movers is also controlled to achieve the desired common suction pressure to the first stage of compression and substantially equal flow rates from the final stages of compression of each compressor. Recycled gaseous refrigerant may be contacted with liquid refrigerant to cool and saturate the recycled vapors.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to a novel method of controlling and balancing the operation of a plurality of turbine-powered multi-stage refrigeration compressors which operate in parallel to supply refrigerant to a multi-stage refrigeration system. More specifically, it relates to a method of controlling the operation of such compressors so that the load and refrigerant flow are balanced among the various compressors in the system and so that each compressor stage is efficiently operated at or near its normal capacity whereby undesired surging is avoided.

For convenience herein, the invention will be described with particular reference to several embodiments employing either methane or propane as the refrigerant. It should be understood, however, that the invention is not limited thereto. It can be embodied in the form of methods for controlling the operation of other parallel-operating multi-stage refrigeration compressors or the operation of the same or other compressors employing any of a number of other well-known refrigerants, e.g., ethane, ethylene, or the like. Any necessary modifications of the specific embodiments sets forth herein to adapt the method to other installations using the same or different refrigerants or combinations thereof will be apparent to those skilled in the art in the light of the present disclosure.

The term "parallel" as used herein refers to compressor systems wherein two or more turbine-powered, multi-stage refrigerant compressors are interconnected to a common multi-stage refrigeration installation. The liquefied refrigerant from each of the compressors is combined to form a common refrigerant charge to the refrigeration installation. The gaseous refrigerant stream from each stage of the refrigeration installation is in turn divided, preferably substantially equally, among each of the multi-stage compressors for recompression.

Description of the prior art

The control of a plurality of parallel-operating multi-stage refrigeration compressors presents a number of problems which heretofore have not been coped with adequately by methods of the prior art. For example, turbine-powered, multi-stage compressors should be controlled so that each stage is operated at or near normal capacity, e.g., at least about 80% of normal capacity. The load on each compressor operating in parallel and the refrigerant flow therefrom should also be substantially equally divided so as to balance the operation. The refrigerant entering each of the various stages of compression, particularly any recycled refrigerant, should be in gaseous form and yet should be at as low a temperature as possible to achieve high compression efficiency. The suction pressure to the first stage should also be maintained at or above minimum levels for proper operation.

Prior art techniques for coping with these problems have in large measure been deficient in one way or another or non-existent. For example, in some instances there has been no positive control over the load levels of each stage of compression to assure at least near-normal capacity operation, a balanced loading, and freedom from excessive surging. Attempts to adjust loadings require accurate measurement of flow rates but the low pressures and large pressure drops, particularly in the first stage of compression, preclude conventional prior-art measuring techniques.

The prior art has also failed to suggest an adequate method of controlling the relative flow rates among the respective compressors themselves. As a result, unbalanced compressor operation could be encountered. The lack of positive control over the condition of the refrigerant entering the various stages of compression, e.g., the temperature of recycled refrigerant, the suction pressure to the first stage, could also lead to lowered compression efficiencies and erratic operation.

It is therefore a general object of the present invention to cope with these and related problems associated with parallel-operating refrigerant compressors which the prior art has failed to solve. It is a specific object to provide a method of controlling the operation of such compressor systems so as to balance the load on, and the flow from, each compressor and control the load on each stage of each compressor. It is another specific object of the present invention to control the load on each stage of such compressors so as to assure operations at or near normal capacity, e.g., about 80% or more.

It is another object to measure the flow rate to the low compression stage of each compressor accurately for flow control purposes. It is another specific object of the present invention to control the temperature of compressed refrigerant gases which are recycled to earlier stages of compression. It is still another specific object to control the common suction pressure of all compressors in the system. It is a still further object to balance the flow rates of compressed gaseous refrigerant from the final stages of compression of each compressor so as to substantially equalize the same. These and other objects of the present invention will become apparent as a detailed description thereof proceeds.

SUMMARY OF THE INVENTION

In brief, these objects are achieved in particular embodiments by a method involving interrelated controls which interact to balance the load and refrigerant flow among the several compressors in the system, maintain the loading on each stage of each compressor above the desired minimum level so as to avoid excessive surging.

ing, and otherwise maximize compressor efficiency and assure smoothness of operation. In one aspect, the method comprises recycling a portion of the compressed gaseous refrigerant from the final stage of compression to both the first stage and second stage compression zone of each compressor in the system. The amount of recycle is sufficient to maintain at least the desired minimum loading on each stage, e.g., at least about 80% of normal capacity. Another aspect of the method comprises regulating the speed of the turbine prime movers, preferably by controlling the fuel supply thereto, in response to the common suction pressure to the first compression zones. The speed is preferably also regulated in response to the flow rates of compressed gaseous refrigerant from each of said compressors so as to equalize said flow rates.

The amount of recycle (which may be zero) from the final stage of compression to the first stage compression zone to achieve at least the desired minimum loading on the first stage is controlled by maintaining at least a predetermined minimum difference between the flows of refrigerant gases exteriorly entering the second stage compression zone and leaving such zone. The amount of such recycle is made responsive to such difference in flows because it is a more accurate measure of the flow through the low pressure first stage to the second stage, as will be apparent from the detailed description of the specific embodiments shown in the drawings. Compressed gaseous refrigerant from the final stage of compression may also be recycled to the first stage compression zone (even though at least the minimum flow rates are already present) to maintain at least a predetermined minimum suction pressure.

The amount of compressed gaseous refrigerant recycled from the final stage of compression to the second stage compression zone is that quantity (which may be zero) which will maintain at least a predetermined minimum refrigerant flow rate from said second stage compression zone. If there are more than two stages of compression, it is contemplated herein that compressed gaseous refrigerant from the final stage of compression will be recycled to each of the additional stages in sufficient amount to maintain at least the desired near-capacity loading of each such compression zone.

In a specific embodiment of the present method, compression efficiency is enhanced by careful control of the temperature of the recycled gases. The temperature is preferably adjusted by cooling so as to approximate the temperature of the main stream gases entering the compression zone. This embodiment particularly lends itself to compression systems wherein the refrigerant has a relatively high boiling point. Thus, for example, hot propane vapors are recycled through direct-contact propane coolers, from which saturated vapors emerge, for admixture with the mainstream and further compression.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more clearly understood from the following detailed description of several embodiments, read in conjunction with accompanying drawings, wherein:

FIG. 1 is a flow diagram illustrating the present invention as applied to the control of two parallel compressors, each having four stages of compression and using methane as the refrigerant, only one of the two substantially identical compressors being shown in detail in the interest of simplicity and drawing economy; and

FIG. 2 is a flow diagram illustrating the present invention as applied to the control of two parallel compressors, each having two stages of compression and using propane as the refrigerant, only one of the two substantially identical compressors being shown in the interest of simplicity and drawing economy.

DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1

Referring to FIG. 1, a multi-stage refrigeration system 10 receives liquefied methane via line 12 from the outlet line 14 of the schematically illustrated three-stage refrigeration system shown and also from line 16 of a duplicate multi-stage compression system not shown. This duplicate compression is represented in FIG. 1 as block 18. While methane is the refrigerant used in this specific embodiment, other refrigerants such as ethylene could be employed in this embodiment without substantial change, except possibly adjustments in the setting of various controls.

After expansion in the multi-stage refrigeration system 10, relatively-low-pressure gaseous methane leaves via line 20 and is returned to the two substantially identical compression systems via lines 22 and 24 respectively. Similarly, intermediate-pressure gaseous methane leaves refrigeration system 10 via line 26 and is returned to the two compressors via lines 28 and 30 respectively. Relatively-high-pressure gaseous methane leaves multi-stage refrigeration system 10 via line 32 and is returned for recompression to the two compressors via lines 34 and 36 respectively.

In the compressor shown, low-pressure gaseous methane from line 22 is charged via line 38 to the first stage of two-stage compression zone 40. The compressed gaseous methane then joins with the intermediate pressure methane from lines 28 and 42 (including any recycled methane, as hereinafter discussed) for further compression in the second stage of compression zone 40 and exits therefrom via line 44. The gaseous methane then flows via line 46, cooler 48 and lines 50 and 52 for third-stage compression in compression zone 54. The compressed gaseous methane from the third stage joins with that from lines 34 and 56 (including any recycled methane, as hereinafter discussed) for the fourth-stage compression in compression zone 54.

The hot compressed gaseous methane leaves compression zone 54 via line 58, cooler 60 and line 62 and enters heat exchanger 64 wherein sufficient heat is withdrawn to liquefy the gaseous methane. From heat exchanger 64 the liquefied methane flows via lines 66 and 14 to line 12 where it is admixed with the liquefied methane from compression system 18 and returns to refrigeration system 10.

The four stages of compression in compression zones 40 and 54 are powered by turbine drive means 68, which employs fuel gas from source 70 via valve 72 and line 74. While the details are not shown, the speed of turbine 68 is governor-regulated. The governor controls valve 72 so as to adjust the fuel gas input. For simplicity, the governor and the control for the fuel valve is symbolically indicated by valve control 76, which receives control signals from load balancing bias relay 78, as hereinafter discussed.

As aforementioned, to prevent compressor surging, each stage should operate at or above a predetermined percent of normal capacity, e.g., at least about 80% of the normal capacity. Thus, whenever the flow rate to any stage incipiently decreases below the predetermined minimum level, a portion of the compressed gaseous refrigerant from the final or fourth stage of compression zone 54, after being partially cooled in cooler 60, is recycled thereto to maintain the desired minimum flow rate.

The rate of flow of gaseous methane to the first stage of compression is difficult to measure because of the large volume of gas at very low pressure in line 38. Thus, the use of a conventional flow-measuring orifice with accompanying substantial pressure drop is precluded. Instead, the present invention contemplates that the gaseous flow in line 38 be determined by measuring the flow in line 44 and subtracting from that the flow in line 42, the difference being the flow in line 38. Since the gaseous

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methane in lines 42 and 44 has already been compressed, conventional flow measuring techniques are feasible.

Accordingly, flow transmitter 80 transmits a signal that is related to the flow of gas through line 44 (and thus through the second and third stages) to relay 82 and also to flow controller 84. If the flow of methane in line 44 is less than the predetermined minimum desired flow for the second and third stages, flow controller 84 will cause valve 86 to open and allow compressed gaseous methane to flow from line 62 through line 88 into line 42. This, of course, increases the flow in line 44 also.

Flow transmitter 90, connected to line 42, transmits a signal related to the flow of methane through line 42 to relay 82. With flow inputs from flow transmitters 80 and 90, relay 82 transmits a signal to flow controller 92 that is related to the difference in flows in lines 44 and 42. Flow controller 92 in turn transmits a related signal to relay 94. When the difference in the methane flow through lines 44 and 42 becomes less than the predetermined minimum value, relay 94 causes valve 96 to open and allow sufficient methane to flow from line 62 through line 98 into line 38 to restore the desired difference. An analysis of the interrelated controls on the recycle streams to lines 38 and 42 makes it apparent that the loads on the first, second and third stages are thus effectively controlled so as to maintain at least the predetermined minimum percentage of the normal capacity.

The load on the fourth stage of compression in compression zone 54 is similarly controlled. Thus, flow transmitter 100 sends a signal which is related to the flow in line 62 (before any recycle is withdrawn therefrom) to flow controller 102. Thus, should the flow of compressed methane through line 62 fall below that of a predetermined minimum, flow controller 102 will cause valve 104 to open and allow a portion of the compressed gaseous methane to flow from line 62 through line 106 into line 56. Thus, the load on the fourth stage of compression is also effectively controlled above a predetermined minimum.

The flow signal from flow transmitter 100 is also transmitted to flow controller 108. Flow controller 108 in turn receives another signal from the equivalent flow transmitter in the other compressor 18. Thus, should the signal received by flow controller 108 from flow transmitter 100 decrease below that received from the like flow transmitter in compressor 18, flow controller 108 will transmit a signal to load balancing bias relay 78. This will cause relay 78 to signal an increase in the setting on the governor-value control 76 of turbine 68 whereby valve 72 is adjusted so as to supply a higher rate of fuel gas to turbine 68. This causes turbine 68 to speed up the compressors and equalize the flow rate through line 62 and the equivalent line in compression system 18, both flows being measured prior to the withdrawal of any recycle methane via lines 88, 98 and 106 and their equivalents in compressor system 18. Similarly, if the signal received by flow controller 108 from flow transmitter 100 increases over that received from the like flow transmitter of compression system 18, flow controller 108 sends a signal to load balancing bias relay 78 whereby turbine 68 is slowed down, again to balance the loads.

Another aspect of the interrelated control system is pressure transmitter 110 which is responsive to the suction pressure in lines 20, 22 and 24. Pressure controller 112 which receives a signal from pressure transmitter 110 relays a signal to load balancing bias relay 78 and to the equivalent relay in compressor 18 whereby signals are sent to the respective turbines to adjust the speed thereof so as to maintain the suction pressure in lines 20, 22 and 24 substantially constant. Suction pressure is also controlled by sending a like signal from relay 78 to relay 94 whereby, if suction pressure gets too low, valve 96 may be opened to introduce high pressure gaseous methane from line 62 via line 98 into line 38. Similar action may occur in the equivalent lines of compressor

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18, whereby the common suction pressure is maintained above minimum desired levels.

Pressure controller 112 transmits signals to actuate valve 72 and a similar valve on the parallel compression system not shown to maintain a constant pressure in line 24. Controller 108 transmits a signal, that is related to the ratio of the rates of flow transmitted by transmitter 100 and a similar transmitter on the parallel system, to vary the signal from controller 112 to motor 76 of valve 72 to actuate valve 72 to maintain an equal rate of flow of fluid from the fourth stage of each compressor.

Pressure transmitter 114, pressure controller 116 and valve 118 prevent the pressure in line 22 from becoming too high. Similarly, pressure transmitter 120, pressure controller 122 and valve 124 prevent pressure in line 28 from becoming too high. Likewise, pressure transmitter 126, pressure controller 128 and valve 130 prevent the pressure in line 34 from becoming too high. Solenoid operated valves 132, 134, 136 and 138 in lines 22, 28, 34 and 14, respectively, are used to rapidly shut off the methane flow to and from the compression zones 40 and 54 in case of a turbine shutdown.

While the method of the present invention contemplates recycling and other interrelated adjustments to assure a balanced and efficient operation, it should be recognized that under normal operating conditions no recycling or other operating adjustments should be necessary. Thus, for example, the normal operation contemplates only the methane flow pattern shown in heavy lines in FIG. 1. It is only when operations depart from the normal that the method of the present invention comes into play to assure the desired corrective action.

It is apparent from the above description that the objects of the present invention have been achieved in connection with the system of FIG. 1. The inventive method is likewise applicable to other systems and other refrigerants as will become apparent from a consideration of the system of FIG. 2 wherein only two stages of compression are employed in each compressor and the refrigerant is propane.

Figure 2

Referring to FIG. 2, the multi-stage refrigeration system 210 receives liquefied propane via line 212 from the outlet line 214 of the schematically illustrated two-stage refrigeration system shown and also from line 216 of a duplicate multi-stage refrigeration system not shown. This duplicate system is represented in FIG. 2 (as was the equivalent in FIG. 1) as a schematic block 218.

After expansion in the multi-stage refrigeration system 210, low pressure gaseous propane leaves via line 220 and is returned to the two substantially identical compression systems via lines 222 and 224, respectively. Similarly, higher pressure gaseous propane leaves refrigeration system 210 via line 226 and is returned to the two compressors via lines 228 and 230, respectively.

The low pressure propane in line 222 passes via line 232 into knockout drum 234, from which liquid components are removed via line 236. The vapors from drum 234 pass through line 238 into the first stage or low pressure stage of compression zone 240.

Similarly, the higher pressure propane gas from line 228 passes via line 242 into knockout drum 244, from which liquid components are removed via line 246. The vapors from drum 244 pass through line 248 and into the second stage or high pressure stage of compression zone 240 to join the vapors from line 238 which have already been partially compressed.

Compression zone 240 is powered by turbine 250, the speed of which is governor-controlled. The governor and related valve control are symbolically indicated by valve control 252 which adjusts valve 254 and the fuel gas from source 256 and line 258. This turbine speed control system is substantially identical to that already described in connection with the embodiment of FIG. 1.

All of the hot compressed propane vapors from com-

pressor 240 pass at high pressure through line 260 into line 264 except for any portion thereof which may be recycled via lines 266 and 268, as hereinafter described. The hot compressed gaseous propane in line 264 is liquefied in heat exchanger 270. It is then charged to the refrigeration system 210 via lines 214 and 212, along with the liquefied propane from line 216 of the duplicate compression system 218.

As in the embodiment of FIG. 1, the flow of propane vapors to the first and second stages of compression zone 240 are controlled in accordance with the method of the present invention so as to approximate at least 80% of the normal capacity of each stage so as to minimize any surging problems. This is accomplished by determining the flows in lines 238 and 260 and adjusting these flows by introducing recycled propane to lines 232 and 242 if the flows are less than the desired flow rates.

Again, however, it is difficult to measure the flow rate in line 238 by conventional orifice techniques because of the large volumes of low pressure propane gas involved. Thus, as in FIG. 1, the flow in line 238 is determined by measuring the flow in line 260 and subtracting the flow in line 248.

Accordingly, relay 272 receives flow measurement signals from flow transmitters 274 in line 260 and 276 in line 248. Relay 272 subtracts the two flows and transmits a signal to flow controller 278 which is related to the difference. Flow controller 278 transmits a signal to selector relay 280 which causes relay 280 to actuate valve 282, if required, to maintain a rate of flow of propane through line 238 above that of a predetermined minimum, such as 80% of the capacity of the compressor. Valve 282 in line 268 permits hot compressed gaseous propane from line 264 to be recycled via line 268, cooler-vessel 284 and line 286 to line 232.

The flow rate in line 248 to the second stage of compression zone 240 is controlled at or above the desired minimum level by adjusting valve 287 in line 266 so as to recycle hot compressed propane via line 266, cooler-vessel 288 and line 290 into line 242. Valve 287 is controlled by means of flow controller 292 which receives a flow signal transmitted by flow transmitter 274.

Any recycled gaseous propane is cooled via cooler-vessels 284 or 288. The temperature is lowered to the saturation point, thus approximating the temperature of the vapors passing out of knockout drums 234 or 244. If the recycled gases were not cooled, compressor efficiency could be decreased.

Vessels 284 and 288 comprise spargers or propane distributors 294 and 296 adjacent the bottom, perforated plates 298 and 300 thereabove but below the liquid level of propane, and liquid level controllers 302 and 304. Since the hot recycled propane vapors thus thoroughly contact the liquid propane 306 and 308, the recycled propane leaves vessels 284 and 288 as saturated vapor.

The flow signal from flow transmitter 274 is also transmitted to flow controller 310, which is common to both compression systems. Flow controller 310 also receives another signal from the equivalent flow transmitter in the duplicate parallel compression system 218. If a comparison of the two signals shows that the flow rates in line 260 and the equivalent line in the duplicate compression system 218 are not substantially the same, flow controller 310 sends a signal to load balancing bias relay 312 whereby the fuel rate to the turbine 250 is adjusted so as to equalize the flow rates through line 260 and its equivalent line in compression system 218.

Pressure transmitter 314 is responsive to the suction pressure in line 220 and thus in lines 222 and 224. Pressure controller 316 receives a signal from pressure transmitter 314 and relays it to load balancing bias relay 312 and also to the equivalent relay in the duplicate parallel compression system 218. The load balancing bias relay in each system transmits signals to the respective turbine

controls to adjust the speed thereof so as to maintain the suction pressure in line 220 substantially constant.

Suction pressure may also be controlled by sending a like signal from load balancing bias relay 312 to selector relay 280, whereby valve 282 may be opened to introduce high pressure gaseous propane into line 232. Similar control action may occur in the equivalent lines of compression system 218, whereby the common suction pressure is maintained above minimum level.

Pressure transmitter 318, pressure controller 320 and valve 322 prevent the pressure in line 232 from becoming too high. Similarly, pressure transmitter 324, pressure controller 326 and valve 328 prevent the pressure in line 242 from exceeding desired limits. While not shown in FIG. 2, the system may also contain solenoid operated valves to rapidly close the flow of gas to and from the compression zone in the case of a turbine shutdown.

It is apparent from the above description that the objects of the present invention have been achieved in connection with the system of FIG. 2. While in many respects the system of FIG. 2 is simpler than that of FIG. 1, it is more elaborate at least in connection with the control of the recycle propane streams to assure they are saturated. It should be understood, of course, that the inventive control method described herein is common to both systems.

While only certain embodiments have been illustrated, many alternative modifications will be apparent from the above description to those skilled in the art. These and other alternatives are considered within the spirit and scope of the present invention, and coverage thereof is intended by this application.

Having described the invention, what is claimed is:

1. The method of balancing the operation of a plurality of parallel-operating refrigeration compressors, each comprising at least a first stage compression zone for relatively low pressure gaseous refrigerant from a refrigeration zone and a second stage compression zone for higher pressure gaseous refrigerant from said refrigeration zone and from said first stage, both of said stages being powered by a turbine prime mover, which method comprises:

- (a) recycling a portion of the compressed gaseous refrigerant from the final stage of compression in each of said plurality of compressors to the first stage thereof in sufficient quantity to maintain at least a predetermined refrigerant flow rate in said first stage compression zone;
- (b) recycling a portion of the compressed gaseous refrigerant from the final stage of compression in each of said plurality of compressors to the second stage compression zone thereof in sufficient quantity to maintain at least a predetermined minimum refrigerant flow rate in said second stage compression zone; and
- (c) regulating the speed of the turbine prime movers of each of said compressors in response to the flow rates of compressed gaseous refrigerant from the final stage of compression in each of said compressors so as to substantially equalize said flow rates.

2. The method of claim 1 wherein the amount of recycle to the first stage compression zone is determined by maintaining at least a predetermined minimum difference between the refrigerant flows entering the second stage compression zone from said refrigeration zone and leaving the second stage compression zone.

3. The method of claim 1 wherein the speed of the turbine prime movers of each of said compressors is also regulated in response to the common suction pressure to the first compression zones thereof so as to maintain at least a predetermined minimum suction pressure.

4. The method of claim 1 wherein a portion of compressed gaseous refrigerant from the final stage of compression in each of said plurality of compressors is re-

cycled to the respective inlets of the first stage compression zones in sufficient quantity to maintain at least a predetermined minimum suction pressure.

5. The method of claim 1 wherein the compressed recycled gaseous refrigerant is contacted with liquefied refrigerant whereby the recycle stream is substantially cooled and saturated prior to entering the compression zone.

6. The method of claim 1 wherein the refrigerant is methane.

7. The method of claim 1 wherein the refrigerant is ethylene.

8. The method of claim 1 wherein the refrigerant is propane.

9. The method of balancing the operation of a plurality of parallel-operating refrigeration compressors, each comprising at least a first stage compression zone for relatively low pressure refrigerant from a refrigeration zone and a second stage compression zone for higher pressure gaseous refrigerant from said refrigeration zone and from said first stage, both of said stages being powered by a turbine prime mover, which method comprises:

(a) recycling a portion of the compressed gaseous refrigerant from the final stage of compression in each of said plurality of compressors to the first stage compression zone thereof in sufficient quantity to maintain at least a predetermined minimum difference between the refrigerant flows entering the second stage compression zone from said refrigeration zone and leaving the second stage compression zone thereof;

(b) recycling a portion of the compressed gaseous refrigerant from the final stage of compression in each of said plurality of compressors to the second stage

compression zone thereof in sufficient quantity to maintain at least a predetermined minimum refrigerant flow in said second stage compression zone;

(c) recycling a portion of the compressed gaseous refrigerant from the final stage of compression in each of said plurality of compressors to the inlet of said first stage compression zone in sufficient quantity to maintain at least a predetermined minimum suction pressure; and

(d) regulating the speed of the turbine prime movers of each of said compressors in response to the common suction pressure to the first stage compression zones thereof to maintain at least a predetermined minimum suction pressure and also in response to the flows of compressed gaseous refrigerant from the final stage of compression in each of said compressors so as to substantially equalize said flows.

10. The method of claim 9 wherein the refrigerant is methane.

11. The method of claim 9 including the step of contacting the compressed gaseous recycled refrigerant with liquid refrigerant so as to cool and saturate the same.

12. The method of claim 11 wherein the refrigerant is propane.

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