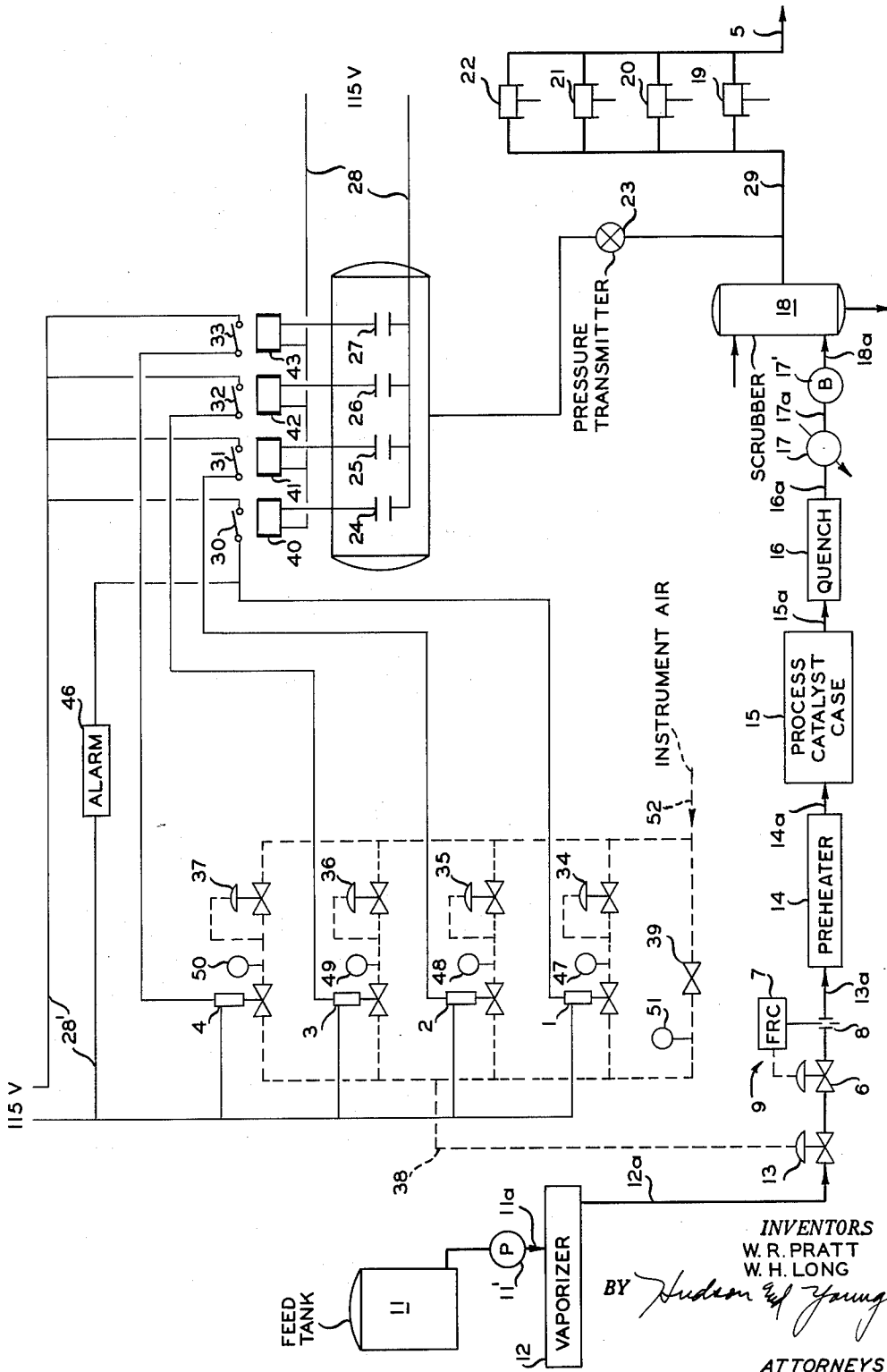


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REGULATION OF PARALLEL OPERATION
OF RECIPROCATING COMPRESSORS
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INVENTORS
W. R. PRATT
W. H. LONG
BY *Hudson & Young*
ATTORNEYS

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3,205,279 REGULATION OF PARALLEL OPERATION OF RECIPROCATING COMPRESSORS

William R. Pratt and William H. Long, Borger, Tex.,
assignors to Phillips Petroleum Company, a corporation
of Delaware

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This invention relates to control of operation of reciprocating compressors. In one aspect, it relates to the control of operation of reciprocating compressors where a plurality of compressors are operated in parallel and at full load in such a manner as to eliminate stalling due to overload.

A problem typical of many light hydrocarbon chemical processing plants employing a multiplicity of engine driven reciprocating compressors is loading the compressors to keep the compressing operation and also the processing plant operation as efficient as possible. To use a larger number of compressor-engine units than necessary is a waste of capital and unduly increases operating and maintenance costs. Thus, by providing compressor control means by which the operating engine-compressor units are operated at substantially capacity, capital investment, operating and other costs are minimized. However, when operating such engine-compressor units at or near capacity, increased material passing to the compressors results in an overload which causes the engine loaded nearest to capacity to stall or stop. When one compressor of several operating in parallel stops, the other compressors are then definitely overloaded thus causing a more or less chain reaction stalling of all of the compressors. Such a compressor overload condition results in an upset in plant processing and a loss in product production when the compressed gas is feed gas to a processing plant or when the gas for compression is the low pressure effluent from a processing plant.

Broadly speaking, according to this invention, we provide automatic means for reducing the rate of flow of gas passed to a plurality of compressors operating in parallel when the gas pressure has increased from the normal feed suction pressure to a predetermined pressure. This increase in gas pressure to the plurality of compressors is such as to cause overloading of a compressor and its ultimate stalling.

Such overloading of compressors operating in parallel on effluent gas from a process is sometimes the result of irregularity in process control whereby effluent gases leave the process at higher than normal pressures. In another instance, one or more of the compressors which operate in parallel when taken from operation for repair or maintenance causes an overload on the remaining compressors. Regardless of the cause of the overloading of the compressors, this process eliminates stalling of the compressors in operation due to increased pressure of gas passing to the compressors for compression.

An object of this invention is to provide apparatus for elimination of stalling of one or more reciprocating compressors operating in parallel and at full load upon inadvertent increase of suction gas pressure above normal suction pressure. Another object of this invention is to provide automatic control to eliminate stalling by overloading of reciprocating compressors operating in parallel wherein the stalling is caused by an increase in pressure in the suction header to the compressor. Still another object of this invention is to provide such automatic control to eliminate stalling and to provide equipment to allow manual remedy of the cause of the compressor overloading. Still other objects and advantages of this invention will be realized upon reading the following descrip-

tion which taken with the attached drawing forms a part of this specification.

The drawing illustrates in diagrammatic form an arrangement of apparatus parts for carrying out this invention.

In the drawing, reference numeral 11 identifies a tank in which liquid feed material is stored for processing in the hereinafter mentioned equipment. From tank 11, the material is pumped by a pump 11' through a conduit 11a to a vaporizer 12. The feed liquid is vaporized in vaporizer 12 and the vapor is passed on through pipe 12a, motor valves 13, and 6, orifice plate 8 and through pipe 13a to a preheater 14. This preheater 14 heats the vaporized feed to a predetermined reaction temperature. This preheated material passes on through pipe 14a to a catalyst case 15 in which is provided a catalyst suitable for the conversion of the feed to the desired product. Effluent from the catalyst cast 15 passes through a pipe 15a to a quench vessel 16 from which effluent passes through pipe 16a to a heat exchanger 17. This heat exchanger 17 usually is a cooler and from this cooler the cooled material passes on through a pipe 17a to a blower 17'. This blower 17' is mainly for the purpose of transfer of material rather than to increase the pressure thereon. From the blower or pump 17', the material passes on through pipe 18a into a scrubber or liquid knockout vessel 18 in which any liquid rising from blower 17' is separated so that liquid will not enter compressors 19, 20, 21 and 22. From the scrubber, the effluent gases pass on through pipe 29 as a suction header to a plurality of compressors 19, 20, 21 and 22 which are set up to operate in parallel. The discharge header 5 removes from the compressors the compressed gases for such disposal as desired. A pressure transmitter 23 transmits a signal to pressure switches 24, 25, 26 and 27 in response to a pressure signal in header 29. The pressure switches 24, 25, 26 and 27 complete circuits of electrical current from source 28 through respective latching relays 40, 41, 42 and 43 which in turn close switches 30, 31, 32 and 33, respectively, thereby closing circuits through a source of electromotive force 28'. Switch 30 is adapted to close a circuit through a solenoid valve 1 in a bypass conduit between pipe 52 and pipe 38. Pipe 52 leads instrument air from a source, not shown, to this apparatus. The bypass conduit containing solenoid valve 1 is also provided with a pressure gauge 47 and a pressure regulator 34. A parallel bypass conduit is provided with a solenoid valve 2, a pressure gauge 48, and a pressure regulator 35. A third bypass conduit is provided with a solenoid valve 3, a pressure gauge 49, and a pressure regulator 36. And, a fourth bypass conduit is provided with a solenoid operated valve 4, a pressure gauge 50, and a pressure regulator 37. Still another bypass conduit connects instrument air source 52 with tube 38 and this additional bypass is provided with a pressure gauge 51 and a manually operable valve 39. An electrical circuit connecting switch 30, the solenoid of solenoid valve 1, to source 28' is provided with an alarm 46 which is intended to sound whenever switch 30 is closed.

The motor valve 6 is a portion of a rate of flow controller assembly 9 which also contains a flow recorder controller 7 and an orifice plate assembly 8 as illustrated. The motor valve 13 and the motor valve 6 are normally open pneumatically operated diaphragm valves. In the operation of this process, controls are employed to reduce the supply of gas fed to the compressors, which are normally operating at full load, in order to prevent overloading and stalling of these compressors. When the compressors, as illustrated in the drawing, take suction on the effluent gas from a process, it is inadvisable in many instances to throttle the gas in the suction header to the compressors in order to prevent the overloading because

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such throttling of gas to the compressors causes pressure in the process to increase thus upsetting the operation of the process. For example, if a valve were installed in pipe 29 just ahead of the several compressors, upon throttling such a valve, gas pressure is increased and pressure is increased at all upstream points. When such a process includes catalytic operation and the like, it is not advisable to increase pressure therein to values higher than intended operational pressures. Thus, to promote safety we find that upon reducing rate of flow of feed to the process by throttling valve 13, the pressure of the gas in pipe 29 to be compressed is reduced properly for the purpose of our invention, that is, to prevent overloading and stalling of one or more of the compressors. The rate of flow controller assembly 9 is provided at its particular location for the purpose of maintaining a predetermined rate of flow of feed material to the process. When this rate of flow controller is regulating the rate of feed to the process, the motor valve 13 is fully opened thereby easily passing the process feed at its normal rate as regulated by flow controller 9. During any compressor overload time, throttle valve 13 throttles the rate of flow of feed to the process overriding the rate of flow controller 9. In this case, flow controller 9 maintains motor valve 6 open but the rate of flow of fluid through this valve is less than normal because of the throttling effect of the overriding motor valve 13.

In the operation of the system as illustrated in the drawing and for purposes of explanation and illustration, liquid feed, such as butylenes, is fed from feed tank 11 into vaporizer 12 in which the liquid is vaporized to gas. The gaseous feed then flows through control throttle valve 13, rate of flow controller valve 6 and into preheater 14 in which the material is heated to a proper and predetermined conversion temperature. This heated feed material then enters the catalyst case provided with a catalyst suitable for the conversion of butylenes to butadiene, the effluent from this conversion operation then being quenched in the quench vessel 16 to prevent further and undesired reaction. A catalyst suitable for such a conversion contains ferric oxide, potassium carbonate and chromic oxide. The conversion in the presence of this catalyst is carried out at a temperature from about 1050° to 1300° F. at pressures around 1 atmosphere. This catalyst and its use in the dehydrogenation of 2-butene (butylene) to butadiene is fully described in U.S. Patent 2,866,790. Quenched material is cooled in a cooler or heat exchanger 17 and liquid formed therein is separated in vessel 18. From scrubber 18, the effluent passes through the suction header 29 to the several compressors which compress the gas to some slight extent and exhaust same through the pressure header 5 to such disposal as desired. If one of the compressors, for example, compressor 22, must be removed from the system because of mechanical failure or if a process upset occurs in which the effluent gas from scrubber 18 leaves the scrubber at a pressure higher than the predetermined suction pressure for the compressors, then the apparatus of this system comes into operation. The pressure transmitter 23 senses this increase in pressure and transmits a pressure signal to, for example, pressure switch 24. The signal to pressure switch 24 closes the switch and energizes relay 40 which in turn closes switch 30 thereby energizing the solenoid of solenoid valve 1 and opening this valve. A pressure regulator 34 in this instance is intended to admit instrument air at a pressure of 11½ pounds per square inch through the valve, through the solenoid valve and through pipe 38 to the upper side of the diaphragm of motor valve 13. In this particular instance, the normal operating gas pressure in suction header 29 is about ½ pound per square inch gauge (p.s.i.g.) and the pressure switch 24 was actuated in response to a pressure of 1.2 p.s.i.g. in the suction header 29. This 11½ pounds (gauge) instrument air pressure passing pressure regulator 34 to the top side of the diaphragm, throttles this valve to reduce the rate of

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flow of charge to the process to such an extent that the pressure of 1.2 pounds in the suction header 29 is reduced to the normal pressure of approximately ½ pound per square inch gauge and such that the compressors on compression duty are not overloaded.

If pressure in suction header 29 increases to about 1.4 p.s.i.g., the pressure transmitter actuates pressure switch 25 to cause closing of switch 31 and opening of solenoid valve 2 thereby admitting instrument air from conduit 52 through pressure regulator 35 at a pressure of about 12¾ p.s.i.g. to close or throttle further the normally opened throttle valve 13. Likewise, if pressure in header 29 increases to about 1.6 p.s.i.g., the pressure switch 26 actuates relay 42, closing switch 32 which in turn opens solenoid valve 3, thereby allowing instrument air at a pressure of about 13½ p.s.i.g. to pass through pressure regulator 36 and through conduit 38 to still further throttle valve 13. And, finally, as illustrated in the drawing, if pressure in header 29 reaches 1.8 p.s.i.g., the pressure switch 27 causes closing of switch 33 and opening of solenoid valve 4 to allow instrument air at pressure of 15½ p.s.i.g. to pass through conduit 30 to still further throttle valve 13.

When one or more of the solenoid valves 1, 2, 3 or 4 are open and throttle valve 13 has throttled the feed to the process the pressure of the effluent gas of the process in header 29 is reduced. When the cause of the initial pressure build-up has been remedied, manually operable valve 39 is opened to admit instrument air at the pressure existing in conduit 38 to the diaphragm of valve 13 and then the one or more latching relays 40, 41, 42 or 43 are deactivated or unlatched manually so as to open the one or more switches 30, 31, 32 or 33 and to close solenoid valves 1, 2, 3 or 4 to put the system under the control of manual valve 39. With the process operating on reduced throughput as a result of instrument air passing through manually operable valve 39 to throttle valve 13, then the manually operable valve is slowly closed and the process operation is observed as the flow rate of feed to the process through throttle valve 13 slowly increases in proportion to the closing of valve 39. Furthermore, pressure in the suction header 29 is also observed so that it will not increase to such a pressure as will cause the pressure switch 24 to actuate again switch 30 for restricting flow to the system. Finally, with manually operable valve 39 fully closed, the normally open throttle valve 13 is then fully opened and the flow of charge feed to the process is regulated by the rate of flow control assembly 9 and the system is again in normal operation.

The alarm 46 is intended to warn an operator when the pressure in suction header 29 increases to such an extent as to actuate pressure switch 24 with the closing of switch 30. When switch 30 is closed, the circuit to the alarm 46 is also closed and the alarm sounds.

If a compressor must be shut in, as for repairs, pressure in header 29 increases and pressure switch 24 actuates relay 40 to close switch 30 thereby opening solenoid valve 1 to admit instrument air at 11½ p.s.i.g. to the diaphragm of valve 13 and reducing the flow of feed to the process to such an extent that pressure in the header returns to normal, for example, ½ p.s.i.g. When the compressor is repaired and placed in operation pressure in header is reduced to a value below the above-mentioned ½ p.s.i.g. Manual valve 39 is then opened to admit instrument air at 11½ p.s.i.g. to pipe 38 and relay 40 is manually deactivated or unlatched thereby closing the solenoid valve 1 and placing the system in operation by way of the manual valve 39. This manual valve is then slowly closed allowing diaphragm valve 13 to open slowly thereby slowly increasing flow of feed to the process with the result that pressure in header 29 slowly reaches its normal value of the above-mentioned ½ p.s.i.g.

During the time of reduced flow of feed to the process, the process has to be regulated for this reduced feed as regards temperature, etc.; also, when all compressors are

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placed in operation, the process must be regulated and adjusted as manual valve 39 is closed in order to maintain proper conversion or process conditions.

The instruments employed in this invention are a pressure transmitter 23, pressure switches 24, 25, 26 and 27, latching relays 40, 41, 42 and 43, switches 30, 31, 32 and 33, solenoid valves 1, 2, 3, and 4 and the pressure regulators 34, 35, 36 and 37. While other instruments and control apparatus are employed such as throttle valve 13 and throttle valve 6, such apparatus is very common and is available from substantially any instrument supply house. The construction, operation, and installation of such other equipment is well understood by those skilled in the art. The above-mentioned apparatus components are available from at least a major portion of the instrument supply houses. However, if desired, such instruments can be obtained from Foxboro Instrument Company, Foxboro, Massachusetts.

In Table I are given the pressures in terms of pounds per square inch gauge at those process points in the system illustrated in the accompanying drawing when dehydrogenating butylenes to butadiene. It is noted in this table that the desired and normally operative pressure of the suction header 29 is $\frac{1}{2}$ p.s.i.g.

TABLE I

Pressures at process points

	p.s.i.g.
11a	260
13a	220
13b	125
14a	25
15a	5
16a	$3\frac{1}{2}$
17a	$2\frac{1}{2}$
18a	7
29	$\frac{1}{2}$

In Table II are given the several pressures in the suction header in pounds per square inch gauge which actuate the several pressures switches. Also, given in this table are the instrument air pressures passed by the several regulators upon opening of the respective solenoid valves.

TABLE II

Example-intake pressures and regulator pressures

Pressure Switch No.	Responsive to Pressure, p.s.i.g.	Regulator	Pressure, p.s.i.g.
24	1.2	34	$11\frac{1}{2}$
25	1.4	35	$12\frac{1}{4}$
26	1.6	36	$13\frac{1}{2}$
27	1.8	37	$15\frac{1}{2}$

While certain embodiments of the invention have been described for illustrative purposes, the invention obviously is not limited thereto.

That which is claimed is:

1. A reciprocating compressor control system comprising, in combination, means for processing a fluid, said means for processing having an inlet and an outlet, a plurality of reciprocating compressors, a suction header leading from said outlet of said means for processing to the suction inlets of the compressors, a first conduit for passage of feed fluid under a superatmospheric first pressure to said inlet of said means for processing, said suction header being adapted to transmit vaporous fluid at a second pressure below said first pressure, said compressors being adapted to operate at substantially full capacity at said second pressure, a throttle valve in said first conduit, said throttle valve having a pneumatically operable motor, a second conduit communicating a source of pneumatic pressure fluid with said motor, a solenoid valve in said second conduit, a pressure regulator in said second conduit

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intermediate said solenoid valve and the source of pressure fluid, first means for sensing pressure in said suction header, and second means communicating said first means with the solenoid of said solenoid valve whereby said first means upon sensing pressure higher than said second pressure in said header actuates said second means thereby energizing said solenoid and opening the solenoid valve and admitting pneumatic pressure fluid to the motor of said throttle valve and thereby throttling said throttle valve and reducing pressure in said first conduit and in said header thereby eliminating overload to said compressors.

2. A reciprocating compressor control system comprising, in combination, means for processing a fluid, said means for processing having an inlet and an outlet, a plurality of reciprocating compressors, a suction header leading from said outlet of said means for processing to the suction inlets of the compressors, a first conduit for passage of feed fluid under a superatmospheric first pressure to said inlet of said means for processing, said suction header being adapted to transmit vaporous fluid at a second pressure below said first pressure, said compressors being adapted to operate at substantially full capacity at said second pressure, a throttle valve in said first conduit, said throttle valve having a pneumatically operable motor, a second conduit communicating a source of pneumatic pressure fluid with said motor, a solenoid valve in said second conduit, a pressure regulator in said second conduit intermediate said solenoid valve and the source of pressure fluid, a rate of flow controller assembly in said first conduit intermediate said throttle valve and said means for processing, first means for sensing pressure in said suction header, and second means communicating said first means with the solenoid of said solenoid valve whereby said first means upon sensing pressure higher than said second pressure in said header actuates said second means thereby energizing said solenoid valve and admitting pneumatic pressure fluid to the motor of said throttle valve and thereby throttling said throttle valve and reducing pressure in said first conduit and in said header thereby eliminating overload to said compressors.

3. A reciprocating compressor control assembly comprising in combination, means for processing a fluid, said means for processing having an inlet and an outlet, a plurality of reciprocating compressors, a suction header leading from said outlet of said means for processing to the suction inlets of said compressors, a first conduit for passage of feed fluid under a superatmospheric first pressure to said inlet of the means for processing, said compressors being adapted to operate at substantially full capacity at a suction pressure below said first pressure, a throttle valve in said first conduit, said throttle valve having a pneumatically operable motor, a second conduit communicating a source of pneumatic pressure fluid with said motor, a solenoid valve in said second conduit, a pressure regulator in said second conduit intermediate said solenoid valve and said source of pressure fluid, a bypass conduit provided with a manually operable valve, one end of said bypass conduit communicating with said second conduit intermediate said solenoid valve and said motor and the other end communicating with said second conduit intermediate said pressure regulator and said source of pressure fluid, first means for sensing pressure in said suction header, a rate of flow controller assembly in said first conduit intermediate said throttle valve and said means for processing, and second means communicating said first means with the solenoid of said solenoid valve whereby said first means upon sensing pressure higher than said second pressure in said header actuates said second means thereby energizing said solenoid and opening the solenoid valve and admitting pneumatic pressure fluid to the motor of said throttle valve and thereby throttling said throttle valve and reducing pressure in said first conduit and in said header thereby eliminating overload to said compressors.

4. A reciprocating compressor control assembly comprising, in combination, means for processing a fluid, said means for processing having an inlet and an outlet, a plurality of reciprocating compressors, a suction header leading from said outlet of said means for processing to the suction inlets of said compressors, a first conduit for passage of feed fluid under a superatmospheric first pressure to said inlet of the said means for processing, said compressors being adapted to operate at substantially full capacity at a suction pressure below said first pressure, a throttle valve in said first conduit, said throttle valve having a pneumatically operable motor, a second conduit communicating a source of pneumatic pressure fluid with said motor, said second conduit being provided with a manually operable valve, a plurality of bypass conduits provided with separate solenoid valves, one end of each bypass conduit communicating with said second conduit intermediate said manually operable valve and said motor, the other end of each bypass conduit communicating with said second conduit intermediate said manually operable valve and said source of pressure fluid, each bypass conduit having a pressure regulator intermediate the respective solenoid valve and the respective point of communication with said second conduit, the respective pressure regulators being set to pass progressively higher pressure pneumatic fluid through the respective bypass conduits, first means in communication with said suction header for sensing pressure, separate means communicating the respective solenoids of said solenoid valves with said first means, said separate means being adapted to energize successively the solenoids of solenoid valves in response to successively higher pressures sensed by said first means whereby the respective solenoid valves open to admit said progressively higher pressure pneumatic fluid to the motor of said throttle valve and said throttle valve throttles in successive stages feed fluid passing therethrough.

5. A reciprocating compressor control system comprising, in combination, means for processing a fluid, said means for processing having an inlet and an outlet, a plurality of reciprocating compressors, a suction header leading from said outlet of said means for processing to the suction inlets of the compressors, a first conduit for passage of fluid under a superatmospheric first pressure to said inlet of said means for processing, said suction header being adapted to transmit vaporous fluid at a second pressure below said superatmospheric pressure, said compressors being adapted to operate at substantially full capacity at said second pressure, a pressure transmitter in operative communication with said header, a pressure switch in operative communication with said transmitter, a latching relay in operative communication with said pressure switch, a second switch in operative communication with said relay, a normally open throttle valve in said first conduit, the throttle valve having a pneumatically operable motor, a second conduit leading from a source of pneumatic fluid under pressure to said motor, a solenoid valve in said second conduit, an electrical circuit including a source of E.M.F., said second switch, and the solenoid of said solenoid valve, a pressure regulator in said second conduit intermediate said solenoid valve and said source of pneumatic fluid, whereby upon sensing of an increase in pressure of said vaporous fluid in said suction header by said transmitter, said pressure switch actuates said relay thereby closing said second switch in response to a signal from said transmitter thereby energizing the solenoid and opening the solenoid valve and increasing pneumatic pressure on the motor of said throttle valve thereby throttling said throttle valve and reducing fluid flow therethrough and reducing pressure in said suction header thereby eliminating tendency for overloading said compressor when the pressure in said header exceeds that providing full capacity operation of said compressors.

6. A reciprocating compressor control system comprising in combination, means for processing a fluid, said means for processing having an inlet and an outlet, a plu-

ality of reciprocating compressors, a suction header leading from said outlet of said means for processing to the suction inlets of the compressors, a first conduit for passage of fluid under a superatmospheric first pressure to said inlet of said means for processing, said suction header being adapted to transmit vaporous fluid at a second pressure below said superatmospheric pressure, said compressors being adapted to operate at substantially full capacity at said second pressure, a normally open throttle valve in said first conduit, the throttle valve having a pneumatically operable motor, a second conduit provided with a manually operable valve leading from a source of pneumatic pressure fluid to said motor, a plurality of bypass conduits provided with separate solenoid valves, one end of each bypass conduit communicating with said second conduit intermediate said manually operable valve and said motor, the other end of each bypass conduit communicating with said second conduit intermediate said manually operable valve and said source of pressure fluid, each bypass conduit having a pressure regulator intermediate the respective solenoid valve and the respective point of communication with said second conduit, the respective pressure regulators being set to pass progressively higher pressure pneumatic fluid through the respective bypass conduits, a pressure transmitter in operative communication with said header, a plurality of pressure switches in operative communication with said transmitter, a separate latching relay in operative communication with each pressure switch, a separate second switch in operative communication with each latching relay, a separate electrical circuit for each of said bypass conduits including a source of E.M.F., one of the second switches and a solenoid of the respective solenoid valve, a separate second electrical circuit for each of said bypass conduits including a source of E.M.F., a pressure switch and a corresponding latching relay of the above referred to pressure switches and latching relays, each of said pressure switches being adapted to transmit a signal to the corresponding relay in response to a different pressure as sensed by said transmitter, whereby said second switches are closed and the corresponding solenoid valves are opened successively in response to said successively higher pressures thereby admitting pressure fluid to the motor of said throttle valve in successively higher pressure increments whereby the throttle valve is throttled in successive increments, thereby decreasing pressure of vaporous fluid in said suction header.

7. A method for eliminating of stalling of a reciprocating gas compressor due to overload, and normally operating to compress effluent gas of a process at substantially full compressor load under a normal operating compressor intake pressure, said gas resulting from a process in which the effluent gas issues from said process at about said normal operating pressure, said process involving steps of treating a vaporous fluid wherein pressure of the fluid in process is reduced from a charge pressure higher than said normal operating pressure comprising passing effluent gas from said process at a pressure higher than said normal operating pressure to the inlet of said compressor, compressing this gas of higher inlet pressure whereby said compressor tends to stall due to overload, sensing the increased pressure of said gas and reducing the rate of flow of vaporous fluid to said process in response to the sensed increased pressure thereby eliminating said tendency to stall.

8. A reciprocating compressor control system comprising, in combination, means for processing a fluid, said means for processing having an inlet and an outlet, a reciprocating compressor, a suction header leading from said outlet of said means for processing to the suction inlet of the compressor, a first conduit for passage of feed fluid under a superatmospheric first pressure to said inlet of said means for processing, said suction header being adapted to transmit vaporous fluid at a second pressure below said first pressure, said compressor being adapted

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to operate at substantially full capacity at said second pressure, a throttle valve in said first conduit, said throttle valve having a pneumatically operable motor, a second conduit communicating a source of pneumatic pressure fluid with said motor, a solenoid valve in said second conduit, a pressure regulator in said second conduit intermediate said solenoid valve and the source of pressure fluid, first means for sensing pressure in said suction header, and second means communicating said first means with the solenoid of said solenoid valve whereby said first means upon sensing pressure higher than said second pressure in said header actuates said second means thereby energizing said solenoid and opening the solenoid valve and admitting pneumatic pressure fluid to the motor of said throttle valve and thereby throttling said throttle

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valve and reducing pressure in said first conduit and in said header thereby eliminating overload to said compressor.

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15 ALPHONSO D. SULLIVAN, *Primary Examiner*.