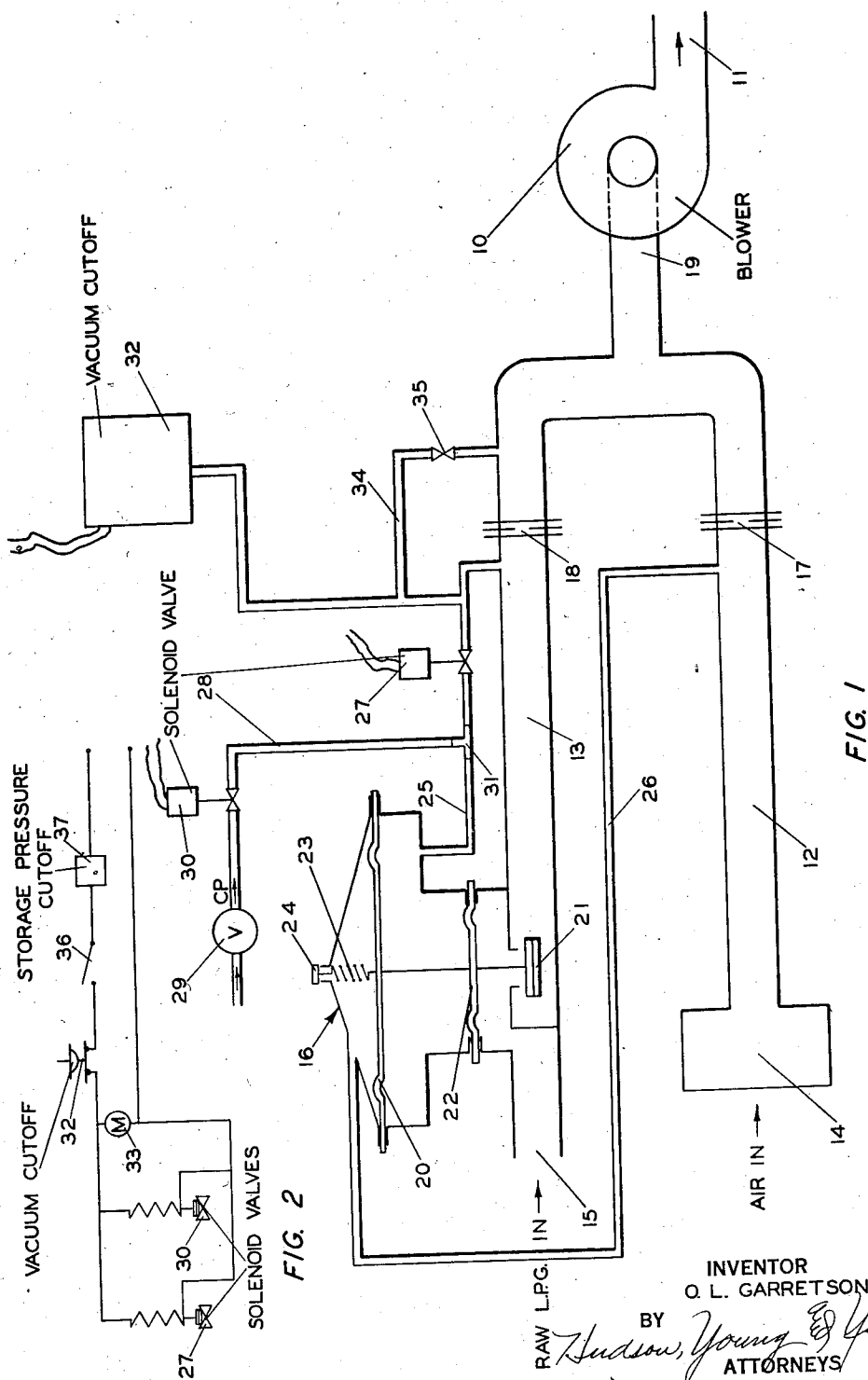


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O. L. GARRETSON
GAS PROPORTIONING SYSTEM

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GAS PROPORTIONING SYSTEM

Owen L. Garretson, Detroit, Mich., assignor to
Phillips Petroleum Company, a corporation of
Delaware

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My invention relates to a gas manufacturing plant control system.

More specifically, I herein disclose an improved control arrangement for a gas-air mixing unit which results in greater safety of operation, and also in improved performance with regard to production of a uniform air-gas ratio.

It has in recent years become common and well-known practice to use liquefied petroleum gases in air-diluted form for industrial furnace fuel, and also for distribution in mains to supply dwellings and business establishment in small communities. Gas proportioning plants for this purpose are inexpensive to erect and maintain, and are often economically justified as replacement or supplanting equipment where coke-oven or other gas manufacturing systems have previously been used. The U. S. Patent No. 2,021,271, to R. W. Thomas illustrates a complete gas manufacturing plant of the type referred to.

Several types of proportioning or gas-air machines are in everyday use, and these may be classified under two general groups. One type employs variable air and gas openings to control the proportioning, while the other type employs fixed gas and air orifices, depending upon control of the differential pressure across the fixed orifices to obtain the desired proportioning. My invention relates to the fixed orifice type of system.

My invention has for an object the provision of a positive means to prevent formation of an explosive mixture in a gas-air dilutor.

A further object is to provide improved and more positive means for shutting off the gas supply whenever the gas machine is shut down for any reason.

Another object of my improvement is to attain the above desirable characteristics by the use of standard devices which are obtainable at low cost.

It is an object to provide for incorporation of my improvements in already existing gas-air plants, without requiring extensive revision or alteration of the original piping or electrical circuits.

Other objects and advantages will be apparent from the following specification in which

Figure 1 is a schematic diagram, partly in section, of that portion of a gas-air dilutor system wherein my improvements are applied.

Figure 2 is a sample wiring diagram which illustrates the operation of certain elements contained in Figure 1.

Referring specifically to Figure 1, the numeral 10 is an impeller such as a centrifugal or com-

pressor blower, which discharges a finished gas containing air and a liquefied petroleum gas vapor in definite proportions. The discharge is carried by conduit 11 to a gas holder, a high pressure storage tank, or directly to a distribution main (not shown). The finished gas is formed by induction of air and raw gas through the intake lines 12 and 13, respectively. Air is taken into line 12 directly from the atmosphere, first passing through an air cleaner or filter 14. Raw liquefied petroleum gas vapor (hereinafter called LPG) is supplied under pressure to the inlet 15 from a storage tank or vaporizer (not shown). A zero regulator, indicated generally by numeral 16 and shown in diagrammatic section, reduces the gas pressure in line 13 substantially to atmospheric level. Proportioning of the air and gas induced or drawn into the blower 10 is obtained by the use of calibrated fixed orifices 17 and 18 in the lines 12 and 13, respectively. The mixed air and gas enter the blower through the common line 19.

The zero regulator 16 may be any one of several makes which are obtainable as standard items of manufacture. The important features of this unit are that it should have a large main diaphragm 20 separated from the valve 21 by a smaller sealing diaphragm 22. The spring 23 is a long, soft, tension spring which urges the valve 21 toward the closed position, and is provided with an adjustment screw 24. The space under the main diaphragm 20 is subjected to the pressure at the inlet of orifice 18 in line 13 through the pressure registry tube 25. The pressure (slightly subatmospheric) in line 12 before the orifice 17 is transmitted by another pressure registry tube 26 to the upper side of diaphragm 20. This is for the purpose of compensating for variation of air inlet resistance due to air filter 14.

The equipment and system so far described is old and well known in the art. In operation, running of the blower 10 imposes a suction in line 19, through orifices 17 and 18 and in lines 12 and 13. Suction registered in line 25 induces opening of the valve 21 against the spring 23 and also against the suction in line 26. It should be noted that, due to the restricting effect of valve 21, the suction imposed in lines 13 and 25 will tend to be greater than that in line 12, whose intake end is relatively unrestricted. By proper adjustment of the spring 23 and by proper selection of orifice sizes (17 and 18) the desired mixture of gas and air is obtained at the discharge 11 as long as the blower 10 continues to run. Upon shutting down the system, as when a sufficient supply

of finished gas has reached the storage holder, the spring 23 must be relied upon to close the valve 21 and the trapped pressure under diaphragm 22 has been relied upon to aid in maintaining the valve tightly closed.

In continuing with the description of those parts of the system illustrated which comprise my invention, it will be seen that a great improvement over the above is obtained. In the line 25, I provide a solenoid-actuated valve 27, which valve is open when the solenoid is energized and is otherwise spring-loaded closed. Further, I provide a pressure line 28 which is supplied with gas or air under pressure, from a source not shown. This line contains a pressure regulator 29 and a second solenoid valve 30. The line 28 joins line 25 through a T connection 31 located between valve 27 and zero regulator 16. The valve 30 is closed when the solenoid is energized, being otherwise spring-loaded open (the operation is converse to that of valve 27). Solenoid valves of the required style are available commercially at nominal cost. The pressure regulator 29 is any small regulator capable of delivering a low outlet pressure, as 5 inches water column for example. The flow capacity of this regulator is immaterial, since no flow of any consequence will occur in the line 28.

In operation, the solenoids of valves 27 and 30 are energized from the same power supply which serves the electric motor (not shown) used to drive the blower 10. While the blower motor is running, valve 27 is open, valve 30 is closed, and the system operates as before described. Upon opening of the motor power circuit when shutting down, the valves 27 and 30 are de-energized; valve 27 closes, valve 30 opens, and a positive pressure is thereby admitted under diaphragm 20 from the source controlled by regulator 29. This positive pressure provides certain and complete closure of valve 21. Since the spring 23 is no longer relied on for complete closure, the zero regulator may be adjusted more delicately. The spring 23 can be softer, and hence better suited for its primary function, which is pressure regulation.

Upon re-starting, the solenoid valves are energized by closing of the motor circuit. Valve 30 closes and 27 opens, allowing pressure under the diaphragm 20 to bleed into line 13 and thus permitting the zero regulator to open.

As a further precaution against explosion hazard, I provide a vacuum-operated switch 32. The pressure element of this switch is connected to a point in line 25 between line 13 and valve 27. This switch is set to open when the pressure in line 13 falls below a predetermined value, such as 3 inches water column vacuum, for example. The electrical circuit is a series connection in one side of the motor (or motor-starter) circuit, so that opening of the switch 32 will shut down the blower motor, and at the same time actuate valves 27 and 30 as before described.

The purpose of the above vacuum shut-off is to prevent formation of an explosive mixture in the system. The normal gas-air mixture formed by the system is well without the range of inflammability. Failure or even diminution of the gas supply at the inlet of the zero governor, however, could reduce the B. t. u. value of the mixture to an inflammable or explosive value. The vacuum shut-off, however, will be actuated in such event, since failure of the gas supply will result in formation of a subatmospheric pressure in line 13. The cutoff setting of switch 32 is selected so that

the switch will be actuated before the upper limit of explosive mixture is reached.

A modification which is of benefit in cases where the pressure downstream from the zero regulator tends to reduce excessively at high flow rates is also shown in Figure 1, wherein 34 is a by-pass line around the orifice 18, and 35 is a needle valve in the by-pass line.

In operation, this modification permits a restricted flow in the line 34, due to the differential pressure which acts across the orifice and hence exists also across the respective ends of line 34 and also across valve 35. This flow of gas through the line 34, while small in magnitude, aids in keeping the zero governor open to a greater extent than would otherwise be obtained. Hence, the characteristics of the zero governor at high flow rates can be improved or modified to suit by adjustment of valve 35. The valve is opened wider at high flow to compensate for pressure drop in line 13.

In the wiring diagram, Figure 2, it is seen how the opening of vacuum switch 32 coacts to stop the motor 33 and operate the valves 27 and 30. It is also seen how the valves 27 and 30 are actuated whether the motor is stopped by opening of switch 32, or by any other switch, such as the manual emergency cutoff 36 or the storage tank maximum pressure switch 37. These latter switches do not appear in Figure 1, but are ordinarily incorporated in all systems such as the one of which Figure 1 is a part.

For simplicity of illustration, the vacuum switch 32 (in Figure 2) has been shown as wired directly in the power circuit before the motor. It is understood that a safety starting switch would in most cases be used and that such use would be within the scope of the system here contemplated. Other obvious departures may be employed within the scope of my invention; for example the solenoid valves 27 and 30 could as well be of a low-voltage type, using transformers to reduce the voltage from 110 or 220 to 6, 12, 24, or any suitable value. My invention resides in the system disclosed, rather than in any specific mechanical structure of valves, switches, regulators, or other devices.

I claim:

1. In an air-gas proportioning machine of the blower-dilutor type, the combination of: an electrical prime mover selectively associated with a source of electrical energy for driving the said blower; a pair of fixed orifices respectively associated with an air intake and a raw gas intake of the blower; a normally closed zero regulator controlling the inlet pressure to the gas orifice and arranged to be opened by operation of the blower; a separate pressure source adapted to load the zero governor to closed position; a pair of solenoid-actuated valves selectively associated with said electrical energy source and operative to apply said pressure loading when de-energized, and pressure-actuated switching means operatively associated with the outlet of said zero regulator to de-energize said prime mover and said solenoid valves when the outlet pressure from the zero regulator attains a predetermined minimum value.
2. In an air-gas proportioning machine including a gas supply, an air supply and a blower, the combination of: an electrical prime mover selectively associated with a source of electrical energy for driving the said blower; a pair of fixed orifices respectively associated with an air intake and a raw gas intake; a zero regulator having a diaphragm controlling the inlet pressure to the gas

orifice; a first conduit placing one side of said diaphragm of the regulator in communication with the upstream side of said orifice and a second conduit placing the first conduit in restricted communication with the downstream side of said orifice.

3. In a gas proportioning system including a gas supply, an air supply, means for effecting a minimum pressure comprising an impeller and a zero governor controlling the admission of gas to the impeller, a separate source of pressure fluid connecting with the zero governor and valve means operably connected with the impeller, normally closed to prevent flow of said pressure fluid to the zero governor during operation of the impeller but opening during non-operation thereof.

4. In a gas proportioning system including a gas supply, an air supply, means for effecting a minimum pressure comprising an impeller and having an electric motor circuit, a zero governor controlling the admission of gas to the impeller, a separate source of pressure fluid connecting with the zero governor and valve means operably connected with the impeller normally closed to prevent flow of said pressure fluid to the zero governor during operation of the impeller but opening during non-operation thereof, said valve means being under control of the electric motor circuit of the impeller.

5. In a gas proportioning system including a gas supply, an air supply, means for effecting a minimum pressure comprising an impeller and a zero governor controlling the admission of gas to the impeller, a separate source of pressure fluid communicating with the zero governor, automatic means for admitting pressure from said source to the zero governor diaphragm during non-operation of the system, and automatic means for removing said pressure during operation of the system.

6. In a gas proportioning machine including a gas supply, an air supply, means for effecting a minimum pressure comprising a zero regulator and an impeller having electrical controlling means, an independent source of pressure adapted to load the zero regulator to close the same, and solenoid valve means connected with said electrical controlling means adapted to remove said pressure loading during energization of the electrical controlling means.

7. A control system for gas proportioning systems having a zero regulator governing the raw gas feed, an air supply, means for effecting a minimum pressure comprising the zero regulator and an impeller having an electrically driven prime mover, a source of independent pressure for loading the zero regulator in a closed position, valve means adapted to electrically apply or remove said pressure loading, and switching means operable by a predetermined minimum pressure in the outlet of said zero regulator to disconnect the prime mover from its source of electrical energy, whereby the prime mover is placed out of operation and the said valve means is actuated to positively close said valve regulator.

8. In an air-gas proportioning machine of the blower type, a gas supply, an air supply and a blower, the combination of: an electric prime mover for the blower associated with a source of electrical energy for driving the said blower; a pair of fixed orifices respectively associated with the air intake and the raw gas intake; a zero regulator controlling the inlet pressure to the gas orifice; a separate pressure source adapted to load the zero governor closed; a pair of solenoid actu-

ated valves associated with said electrical energy source operative to apply said pressure loading when de-energized, and operative to remove said pressure loading when energized.

9. In a gas flow line comprising a first gas conduit, a zero regulator controlling flow through said first conduit, a diaphragm actuating the zero regulator to open and close said first conduit to the flow of gas therethrough, a restricted orifice in the conduit downstream of the zero regulator, and a second conduit transmitting gas under pressure from the first conduit at a point between the zero regulator and the orifice to one side of the zero regulator diaphragm to urge the diaphragm to close said first conduit and give zero regulation, the improvement comprising a first valve in said second conduit, a source of gas under pressure, a third conduit connecting said source of gas to said second conduit at a point between said first valve and said zero regulator, a second valve in said third conduit, and means operable to open said first valve and close said second valve when the zero regulator is to control the flow in the first conduit and to open said second valve and close said first valve when the zero regulator is to be biased shut by said source of gas.

10. In a gas flow line comprising a first gas conduit, a zero regulator controlling flow through said first conduit, a diaphragm actuating the zero regulator to open and close said first conduit to the flow of gas therethrough, a restricted orifice in the conduit downstream of the zero regulator, and a second conduit transmitting gas under pressure from the first conduit at a point between the zero regulator and the orifice to one side of the zero regulator diaphragm to urge the diaphragm to close said first conduit and give zero regulation, the improvement comprising a third conduit connecting said second conduit with the first conduit downstream of said restricted orifice, and a variable restricting valve in said third conduit whereby the operation of the zero regulator is made more responsive to flow.

11. In a gas flow line comprising a first gas conduit, a zero regulator controlling flow through said first conduit, a diaphragm actuating the zero regulator to open and close said first conduit to the flow of gas therethrough, a restricted orifice in the conduit downstream of the zero regulator, and a second conduit transmitting gas under pressure from the first conduit at a point between the zero regulator and the orifice to one side of the zero regulator diaphragm to urge the diaphragm to close said first conduit and give zero regulation, the improvement comprising a gas impeller connected to said first conduit downstream of said restricted orifice, a motor driving said gas impeller, a power supply for said motor, a cut off for said power supply actuated by a predetermined minimum pressure and a third conduit connected to said second conduit and said cut off whereby upon said predetermined minimum pressure being reached in the third conduit the power supplied to said motor is cut off.

12. In a gas flow line comprising a first gas conduit, a zero regulator controlling flow through said first conduit, a diaphragm actuating the zero regulator to open and close said first conduit to the flow of gas therethrough, a restricted orifice in the conduit downstream of the zero regulator, and a second conduit transmitting gas under pressure from the first conduit at a point between the zero regulator and the orifice to one side of the zero regulator diaphragm to urge the dia-

phragm to close said first conduit and give zero regulation, the improvement comprising a first valve in said second conduit, a source of gas under pressure, a third conduit connecting said source of gas to said second conduit at a point between said first valve and said zero regulator, a second valve in said third conduit, a fourth conduit connecting said second conduit with the first conduit downstream of said restricted orifice, a variable restricting valve in said fourth conduit whereby the operation of the zero regulator is made more responsive to flow.

13. In a gas flow line comprising a first gas conduit, a zero regulator controlling flow through said first conduit, a diaphragm actuating the zero regulator to open and close said first conduit to the flow of gas therethrough, a restricted orifice in the conduit downstream of the zero regulator, and a second conduit transmitting gas under pressure from the first conduit at a point between the zero regulator and the orifice to one side of the zero regulator diaphragm to urge the diaphragm to close said first conduit and give zero regulation, the improvement comprising a first valve in said second conduit, a source of gas under pressure, a third conduit connecting said source of gas to said second conduit at a point between said first valve and said zero regulator, a second valve in said third conduit, a gas impeller connected to said first conduit downstream of said restricted orifice, an electric motor driving said gas impeller, an electric circuit supplying power for said motor, means operated by flow of electric current in said circuit to open said first valve and close said second valve and operated by failure of flow of electric current to close said first valve and open said second valve whereby the zero regulator is biased to close said first conduit when said electric circuit is open, a cut off to open said electric circuit actuated by a predetermined minimum pressure and a fourth conduit connected to said second conduit and said cut off whereby upon said predetermined minimum pressure being reached in the fourth conduit the electric circuit to the motor and said valves is opened.

14. In a gas flow line comprising a first gas conduit, a zero regulator controlling flow through said first conduit, a diaphragm actuating the zero regulator to open and close said first conduit to the flow of gas therethrough, a restricted orifice in the conduit downstream of the zero regulator, and a second conduit transmitting gas under pressure from the first conduit at a point between the zero regulator and the orifice to one side of the zero regulator diaphragm to urge the diaphragm to close said first conduit and give zero regulation, the improvement comprising a first valve in said second conduit, a source of gas under pressure, a third conduit connecting said source of gas to said second conduit at a point between said first valve and said zero regulator, a second valve in said third conduit, a gas impeller connected to said first conduit downstream of said restricted orifice, an electric motor driving said gas impeller, an electric circuit supplying power for said motor, means operated by flow of electric current in said circuit to open said first valve and close said second valve and operated by failure of flow of electric current to close said first valve and open said second valve whereby the zero regulator is biased to close said first conduit when said electric circuit is open, a cut off to open said electric circuit actuated by a predetermined minimum pressure, a fourth

conduit connected to said second conduit and said cut off whereby upon said predetermined minimum pressure being reached in the fourth conduit the electric circuit to the motor and said valves is opened, a fifth conduit connecting said second conduit with the first conduit downstream of said restricted orifice, and a variable restricting valve in said fifth conduit whereby the operation of the zero regulator is made more responsive to flow and said cut off more responsive to pressure.

15. In a gas supply system in which an inflammable gas is mixed with air, a control system for preventing the formation of explosive mixtures of gas and air comprising in combination a gas line, an air line, the gas and air lines joining to form a fuel line, an impeller in the fuel line impelling the fuel into a storage tank, a motor driving the impeller, electrically controlled means for positively closing the zero regulator independent of pressure in the gas, air and fuel lines, an electrical network including the motor windings, a source of electrical power and the electrically controlled means, and means for opening the circuit in the network comprising a switch responsive to a predetermined low pressure in the gas line, a manual switch and a switch responsive to a predetermined high pressure in the storage tank, whereby when conditions under which an explosive mixture could form exist the gas line is closed.

16. In a gas supply system in which an inflammable gas is mixed with air, a control system for preventing the formation of explosive mixtures of gas and air comprising in combination a gas line, an air line, the gas and air lines joining to form a fuel line, an impeller in the fuel line impelling the fuel, a motor driving the impeller, electrically controlled means for positively closing the zero regulator independent of pressure in the gas, air and fuel lines, an electrical network including the motor windings, a source of electrical power and the electrically controlled means, and means for opening the circuit in the network comprising a switch responsive to a predetermined low pressure in the gas line, whereby when conditions under which an explosive mixture could form exist the gas line is closed.

17. In a gas supply system in which an inflammable gas is mixed with air, a control system for preventing the formation of explosive mixtures of gas and air comprising in combination a gas line, an air line, the gas and air lines joining to form a fuel line, an impeller in the fuel line impelling the fuel, a motor driving the impeller, an electrical network including the motor windings, and a source of electrical power, and means for opening the circuit in the network comprising a switch responsive to a predetermined low pressure in the gas line.

18. In a gas supply system in which an inflammable gas is mixed with air, a control system for preventing the formation of explosive mixtures of gas and air comprising in combination a gas line, an air line, the gas and air lines joining to form a fuel line, an impeller in the fuel line impelling the fuel into a storage tank, a motor driving the impeller, an electrical network including the motor windings, and a source of electrical power, and means for opening the circuit in the network comprising a switch responsive to a predetermined low pressure in the gas line, a manual switch and a switch responsive to a predetermined high pressure in the storage tank.

OWEN L. GARRETSON.