May 15, 1934. E. G. DE CORIOLIS ET AL 1,958,913

METHOD OF AND APPARATUS FOR FORMING HOT GASES

Filed Oct. 24, 1930

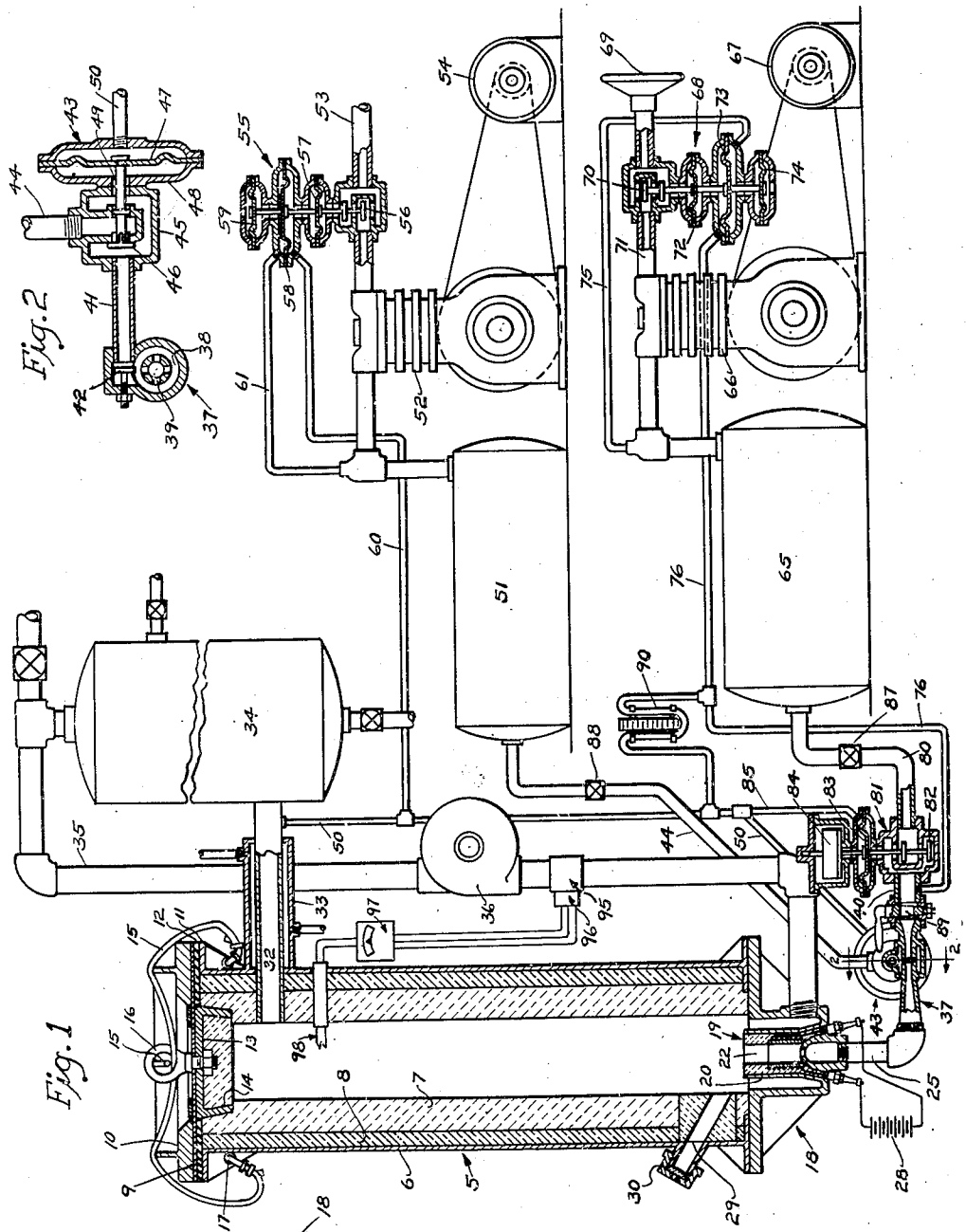


Fig. 2

Fig. 1

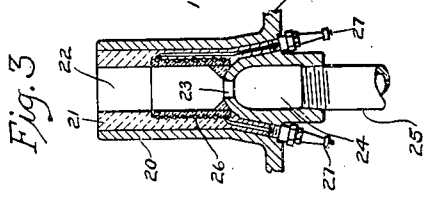


Fig. 3

INVENTORS:
ERNEST G. DE CORIOLIS
HUGH B. BARBER
BY
Charles A. Lind
ATTORNEY.

Patented May 15, 1934 1,958,913

UNITED STATES PATENT OFFICE

1,958,913

METHOD OF AND APPARATUS FOR FORMING HOT GASES

Ernest G. de Coriolis and Hugh B. Barber, Toledo, Ohio, assignors to Surface Combustion Corporation, Toledo, Ohio, a corporation of New York

Application October 24, 1930, Serial No. 490,855

17 Claims. (Cl. 158—119)

This invention relates to the generation of hot gases at any desired pressure by burning in a confined space an explosive mixture of fluid fuel, such as fuel gas, and air. More particularly, the invention relates to ways and means for forming a constant mixture of air and fluid fuel irrespective of the pressure against which the mixture is discharged; for supplying such mixture at any desired pressure, and for regulating the temperature of the resultant gaseous products of combustion.

When a gaseous mixture is formed by utilizing one of the constituents of the mixture to induce a flow of the other constituent, the proportions of the constituents in the mixture will remain constant, other factors being equal, provided the pressure against which the mixture is discharged remains constant. However, if the pressure against which the mixture is discharged varies, the proportion of the induced constituent in the mixture will also vary, the proportion being less the higher the pressure and the more the lesser the pressure. One of the objects of the present invention is therefore to provide ways and means for automatically maintaining the proportion of the induced constituent in the mixture constant irrespective of the pressure against which the mixture is discharged.

When the pressure against which a gaseous mixture is discharged varies, it follows that the pressure of the mixture must vary in the same degree in order to maintain a given differential pressure between the mixture pressure and the pressure against which the mixture is discharged, such differential pressure being necessary in order not only to insure delivery of the mixture at a velocity in excess of the rate of flame propagation through the mixture and thus to prevent back flash through the orifice from which the mixture is discharged but also to prevent the mixture from being discharged with such excessive velocity as to prevent burning of the mixture within the confines provided for it.

Another object of the invention is to provide ways and means for tempering the hot gases of combustion by admitting controlled quantities of cold spent gases to the chamber wherein the hot gases are generated.

The above and other features of the invention will more fully appear from the detailed description taken in connection with the accompanying drawing forming part of this specification where in the preferred form of the invention is fully set forth.

Referring to the drawing:

Fig. 1 is a more or less diagrammatic elevation of an appartus constituting the preferred embodiment of the invention, parts of the apparatus being in section;

Fig. 2 is an enlarged section taken on line 2—2 of Fig. 1, and

Fig. 3 is an enlarged cross section of the combustion tunnel shown in Fig. 1.

In the drawing, 5 indicates generally a cylinder or chamber adapted to withstand high internal pressure and whereinto the hot gases resulting from the burning of combustible fuel are initially discharged and confined to form a source of supply of such gases. This chamber preferably comprises a tubular steel casing 6 interiorly provided with a refractory lining 7 between which and the casing is provided a suitable heat-insulating material 8.

The cylinder is capped at one end by a safety cover adapted to blow out if and when the internal pressure becomes too great. This safety cover comprises a relatively thin metal plate 9 disposed across the outer end of the cylinder and held in place thereon by a ring 10 suitably secured to a flange 11 on the cylinder, there being interposed between the plate and the flange a gasket 12. To prevent the middle of the plate from bulging under pressure there is provided at its under side a body 13 shown as provided with an annular flange 14, the space inside of the flange being filled with refractory insulating material. The plate 9 is preferably made of copper and when the pressure within the cylinder becomes too great, the plate will shear around the periphery of the body 13, thus permitting the body 13 to blow out. Cables 15 passed through an eye bolt 16 secured to the body 13 and secured to the cylinder as at 17 prevent the body from blowing away following shearing of the plate 9 as stated.

The other end of the cylinder is closed by a head 18 wherein is positioned a burner 19 adapted for burning explosive gaseous mixtures. As shown this burner comprises a tubular member 20 formed as part of the body 18, the tube being interiorly lined with refractory material 21. At the bottom of the tunnel 22 thus formed is a jet orifice nozzle 23 forming the outlet from a chambered portion 24 of the body 18 into which portion a pipe 25 delivers an explosive gaseous mixture formed in a manner hereinafter specified. Forming part of the tunnel wall is a refractory cylinder 26 of high heat conductivity and around this cylinder is wound an electric

heating element having suitable terminals 27 adapted for connection to a suitable source of electric current as a battery 28. The purpose of the heating element is to heat a sufficient portion of the tunnel to incandescence to initially light the explosive mixture discharged from the orifice 23. 29 indicates a passage having a window 30 through which the operation of the burner may be observed.

The hot gases flow from the cylinder 5 through an outlet remote from the burner 19, this outlet being shown as a conduit 32 delivering into a retort 34 adapted to contain the material to be heat-treated. The conduit may be surrounded by a water jacket 33, the flow of water or other cooling medium through which may be automatically controlled by any suitable means not shown for cooling the hot gases to such temperature as may be required. The present invention also provides for the return to the cylinder 5 of spent heating gases from the retort 34 in order to temper the fresh hot products of combustion. To this end there is provided a conduit 35 wherein is positioned a suitable pump shown as a centrifugal pump 36 for positively forcing the spent gases into the cylinder against such pressure as may prevail therein. The spent gases are preferably introduced into the cylinder about the burner 19 as shown thereby to cool the burner parts and the head 18 and to insure thorough mixing of the spent gases with the hot gases issuing from the burner.

The amount of spent heating gases returned as aforesaid is controlled in accordance with the temperature requirements of the gases within the cylinder 5 and to this end there is provided any suitable temperature-controlled means. As shown there is provided in the conduit 35 a valve 95 adapted to be actuated by a motor 96 under the control of a pyrometer 97 the operation of which is controlled by a thermocouple 98 extending through the wall of the cylinder 5. The pump 36 may be continuously driven.

The combustible mixture, as already indicated, is an explosive mixture. The fuel utilized in forming this mixture may be any suitable fluid but the use of fuel gas is preferred. For convenience of description the combustible mixture may be referred to as an explosive gaseous mixture and it is intended by such expression to include not only gaseous fuel as such but also any other fuel adapted for use with the claimed apparatus.

The apparatus for forming and supplying the combustible mixture to the burner 19 is the outstanding feature of the present invention and will next be described.

In accordance with the present invention the explosive mixture is formed by utilizing one of the constituents of the mixture for inducing a flow of the other constituent. To insure constant proportions of air and gas in a mixture formed in that manner, it is necessary that the induced gas be delivered to the stream of the inducing gas at a pressure the same as that against which the mixture is discharged. In this connection, it should be noted that in order to insure combustion of the mixture within the confines of the combustion chamber 22 whereinto the mixture is discharged from the discharge orifice 23, the pressure of the mixture must always bear a certain definite relation to the pressure against which the mixture is discharged, that is, the pressure existing in the cylinder or chamber 5. Thus, if the pressure of the mixture is too great the mixture will be projected beyond the combustion chamber whereas if the pressure is too low the rate of flame propagation through the mixture will be in excess of the velocity of the mixture and flash-back through the discharge orifice 23 will occur.

The injector or inspirator is generally indicated at 37 and it delivers into the pipe 25 which leads to the chamber 24 ahead of the discharge orifice or nozzle 23. The inspirator comprises a Venturi tube having formed about its restricted portion a chamber 38 whereinto the medium to be induced, in the present instance the fuel gas, is delivered. The fuel gas enters the Venturi tube through a plurality of radial orifices 39 formed in the restricted portion of the tube. The air which is to serve as the inducing gas is delivered to the mouth of the tube by a conduit 40 and the fuel gas is delivered to the chamber 38 by a conduit 41. The effective discharge area of the conduit 41 is regulable by a valve 42 adjustably mounted in a wall of the chamber 38. This type of inspirator or injector is well known in the art and forms no part of the present invention.

43 indicates generally a governor interposed between the conduit 41 and a main supply line 44. This governor comprises a casing 45 wherein is mounted a balanced valve 46, the stem of which is connected to a diaphragm 47 within a case 48. The pressure which is effective at the outlet side of the valve 46 is also effective on the adjacent side of the diaphragm 47 by way of a passage 49 around the valve stem. Since the valve is balanced as regards the inlet pressure, such pressure will neither tend to open nor close the valve and consequently such opening and closing are dependent on the difference in pressures on opposite sides of the diaphragm 47. Leading from the cylinder 5 or, as shown, from the conduit 32, is a pipe 50 by means of which the pressure in the cylinder is made effective on one side of the diaphragm 47. It will therefore be appreciated that if the pressures prevailing on opposite sides of the diaphragm are equal and a suction is created in the conduit 41 the valve 46 will open and thus permit gas to flow to the inspirator.

51 indicates a tank wherein a supply of the gas to be induced is maintained under a pressure somewhat in excess of the pressure prevailing within the cylinder or chamber 5. 52 indicates a pump of any suitable type for taking the gas at any available pressure from a supply main 53 and pumping it into the tank 51 at a regulated pressure. The pump 52 is preferably continuously driven by any suitable prime mover as a motor 54.

The mechanism for governing input of gas into the tank 51 preferably comprises a governing device generally indicated at 55. This device 55 is shown as comprising a valve 56 to the stem of which are connected three diaphragms 57, 58 and 59, each mounted in its own case. The middle diaphragm 58 has the greatest effective area and one side of this diaphragm is made subject to the pressure existing in the chamber 5 by means of a pipe 60 shown as a branch extending from the pipe 50. The other side of the diaphragm 58 is made subject to the pressure existing in the tank 51 by a pipe 61. The upper side of diaphragm 58 is in open communication with the under side of the diaphragm 59 and the under side of

diaphragm 58 is in open communication with the upper side of the diaphragm 57. The under side of diaphragm 57 is open to the pressure in the supply main 53 and the upper side of diaphragm 59 is open to the atmosphere.

When the pressures effective on the opposite sides of the diaphragm 58 are equal, and pressure in the supply main 53 is effective on the under side of the diaphragm 57, the valve 56 will open, it being understood that there will always be at least a nominal pressure in the supply line 53. When the pressure in the tank 51 is about 2 lbs. per square inch in excess of the pressure prevailing in the chamber 5, the valve 56 will close due to the pressure in the tank 51 being effective on the upper side of the diaphragm 58 and the pump 52 will run idle.

As previously stated, the pressure of the gas delivered to the chamber 38 about the Venturi tube of the injector is controlled by a governing device 43 in such a manner that the gas is delivered to the injector at a pressure the same as that prevailing in the chamber 5. The excess pressure in the tank 51, therefore, not only compensates for the frictional resistance offered to the flow of the gas through the conduits leading to the governor 43 but also provides sufficient pressure to insure proper sensitivity of the governor 43.

65 indicates a tank wherein a supply of the inducing medium, namely, air in the present instance, may be stored at a pressure which is always sufficiently in excess of the pressure prevailing in the chamber 5 by a predetermined amount to enable the final mixture of air and gas to be discharged into the cylinder 5. Ordinarily a pressure about 3 lbs. per square inch in excess of the pressure prevailing in the cylinder 5 will be maintained in the tank 65 but the pressure of the air in the conduit 40 delivering to the injector will be somewhat less as will presently appear. 66 indicates a pump similar to the pump 52 and this pump is also preferably continuously driven by suitable prime mover shown as a motor 67. 68 indicates generally a governing device for regulating the pressure in the tank 65. The air to be pumped into the tank is drawn from the atmosphere as through a strainer 69. 70 indicates a valve positioned in the air conduit 71, this valve being normally open due to its own weight and the parts connected thereto. Connected to the stem of the valve 70 are three diaphragms 72, 73 and 74, each mounted in its own case. The upper side of the middle diaphragm 73 is open to the under side of the upper diaphragm 72 and its under side to the upper side of the lower diaphragm 74. If the pressures on the opposite sides of the diaphragm 73 are equal, the weight of the valve 70 will obviously hold the valve open. The under side of the diaphragm 73 is made subject to the pressure existing in the tank 65 by a pipe 75 and the upper side of said diaphragm 73 is made subject to the pressure of the air in the conduit 40 by a pipe 76. It will therefore, be seen that when the pressure in the tank 65 exceeds the presure of the air in the conduit 40 by a predetermined amount, the valve 70 will close and the pump 66 will run idle.

The governing device 68 is so adjusted that the pressure in the air tank 65 will be in excess of the pressure of the air in the conduit 40 by about 1 lb. per square inch before the valve 70 will close in order to compensate for the frictional resistance offered to the flow of the air through the conduit 80 leading to a governing device 81 and to provide for proper sensitivity of the latter.

The governing device 81 comprises a valve 82 to the stem of which is secured a diaphragm 83 and a weight 84 which tends to hold the valve 82 open so as to insure delivery of air at a predetermined pressure in excess of the pressure in cylinder 5. The under side of the diaphragm 83 is open to the pressure in the conduit 40 and consequently when the pressure on the under side of the diaphragm 83 is sufficient, the valve will close. The upper side of the diaphragm 83 is made subject to the pressure existing in the chamber 5 by a pipe 85 shown as a branch from the pipe 50 which leads from the outlet 32 of the chamber 5. It will, therefore, be seen that the valve 82 will always remain open until the pressure on the under side of the diaphragm 83 is sufficient to overcome not only the pressure prevailing on top of the diaphragm 83 but also the dead weight loading of said valve. The loading of the valve 82 will ordinarily be such as will insure a pressure at the delivery side of said valve of approximately 2 lbs. per square inch in excess of the pressure prevailing in the cylinder 5.

A differential pressure gauge 90 is connected between the pipe 50 and the pipe 76, by which the difference between the pressure in chamber 5 and the pressure of the entraining medium may be quickly and easily ascertained.

87 indicates a hand operated cut-off valve in the pipes 80 and 88 a similar valve in the pipe 44 leading from the tank 51 to the governor 43. 89 indicates any suitable valve adapted to be adjusted by hand to control the amount of air admitted to the Venturi tube and thus to control the amount of the explosive delivered into the cyinler 5.

From the foregoing description it will be seen that the proportions of air and fuel gas in the mixture will always remain constant irrespective of the pressure against which the mixture is discharged by reason of maintaining the pressure of the induced constituent always equal to the pressure against which the mixture is discharged; that the ratio of air to gas in the mixture may readily be controlled by adjusting the valve 42 in the pipe 41 between the governor 43 and injector 37; that the governing apparatus as a whole functions automatically to maintain a predetermined set of conditions, namely, the proper differential pressures between the various gases, and that the temperature of the hot gases, may be readily controlled. Ordinarily the apparatus will be so adjusted as to supply hot gasses at a pressure around 250 lbs. per square inch, but as will be readily appreciated the apparatus may be adjusted to generate the hot gas at any desired pressure whether above or below atmospheric pressure.

The operation of the apparatus may be briefly described as follows: In starting up the apparatus the pressure in cylinder 5 can be assumed to be atmospheric. The pumps 52 and 66 are simultaneously started whereupon pressure begins to build up in the tanks 51 and 65, the valves 88 and 87 being meanwhile closed. When the pressure of the air in the tank 65 is about 3 lbs. per square inch, the pressure in the gas tank will be about 2 lbs. per square inch. The valves 87 and 88 are thereupon opened. The governer 43 passes the gas from the tank 51 at the same pressure as prevails

in the cylinder 5 and the governor 81 passes the air, from the tank 65 at such pressure in excess of that prevailing in the cylinder 5 as is determined by the loading of the governor valve 82, usually about 2 lbs. per square inch. The air in passing through the injector will have some of its pressure energy changed to velocity energy with consequent reduction of pressure and the gas in the chamber 38 about the injector will therefore be induced to flow into the injector and mix with the air passing therethrough. The resultant mixture is delivered to the burner 19. As the pressure within the cylinder 5 builds up, the air and gas pressures in the tanks 65 and 51 build up correspondingly under control of the governors 55 and 68. The pressures available at the governors 43 and 81 are therefore always in excess of the pressure prevailing in the cylinder 5, said governors controlling the final gas and air pressures as already stated, each governor being under direct control of the pressure prevailing in the cylinder 5. The pressure in the cylinder 5 may therefore be built up to any desired pressure and the proportions of air and gas in the explosive gaseous mixture will always be maintained constant irrespective of the pressure against which the mixture is discharged, that is, the pressure in cylinder 5.

In case it should be desired to reduce the amount of explosive gaseous mixture delivered to the burner 19, this can be accomplished by throttling the air between the governor 81 and the injector 37 with the result that correspondingly less gas will be drawn into the injector by the air in passing therethrough. The same result can be accomplished by making lighter the weight 84, which loads the governor valve 82, or by bleeding fluid from the top of the diaphragm 83, as will be readily understood by those skilled in the art.

What is claimed is:

1. The method of delivering into a confined space for combustion therein an explosive gaseous mixture under a pressure which varies as the pressure in said space varies, which comprises supplying one of the constituents of the mixture under a pressure higher than the other to serve as an inducing gas, changing some of the pressure energy of such inducing gas to velocity energy with reduction of pressure, supplying the other constituent to the stream of the inducing gas at a point of relatively high velocity and low pressure, changing some of the velocity energy of the mixture back to pressure energy, discharging the mixture into said space through a discharge orifice, maintaining the supply pressure of the induced gas approximately equal to the pressure prevailing in said space, and varying the pressure of the inducing gas in accordance as the pressure in said space varies.

2. The method of delivering into a confined space for combustion therein an explosive gaseous mixture under a pressure which varies as the pressure in said space varies, which comprises supplying one of the constituents of the mixture under a pressure higher than the other to serve as an inducing gas, changing some of the pressure energy of such inducing gas to velocity energy with reduction of pressure, supplying the other gas to the stream of the inducing gas at a point of relatively high velocity and low pressure, changing the velocity energy of the mixture back to pressure energy, discharging the mixture into said space through a discharge orifice, maintaining the supply pressure of the induced gas substantially equal to the pressure prevailing in said space, varying the pressure of the inducing gas in accordance as the pressure in said space varies, maintaining in relative large volume a supply of the gas which is to serve as the inducing gas, and maintaining such volume of gas under a pressure which is always in excess of the pressure prevailing in said space by a predetermined amount.

3. The method of delivering into a confined space for combustion therein an explosive gaseous mixture under a pressure which varies as the pressure in said space varies, which comprises supplying one of the constituents of the mixture under a pressure higher than the other to serve as an inducing gas, changing some of the pressure energy of such inducing gas to velocity energy with reduction of pressure, supplying the other gas to the stream of the inducing gas at a point of relatively high velocity and low pressure, changing the velocity energy of the mixture back to pressure energy, discharging the mixture into said space through a discharge orifice, maintaining the supply pressure of the induced gas substantially equal to the pressure prevailing in said space, varying the pressure of the inducing gas in accordance as the pressure in said space varies, maintaining in relative large volume a supply of the gas which is to be induced, and maintaining such volume of gas at a pressure which is always in excess of the pressure prevailing in said space by a predetermined amount.

4. The method of delivering into a confined space for combustion therein an explosive gaseous mixture under a pressure which varies as the pressure in said space varies, which comprises supplying one of the constituents of the mixture under a pressure higher than the other to serve as an inducing gas, changing some of the pressure energy of such inducing gas to velocity energy with reduction of pressure, supplying the other gas to the stream of the inducing gas at a point of relatively high velocity and low pressure, changing the velocity energy of the mixture back to pressure energy, discharging the mixture into said space through a discharge orifice, maintaining the supply pressure of the induced gas substantially equal to the pressure prevailing in said space, varying the pressure of the inducing gas in accordance as the pressure in said space varies, maintaining in relative large volume a supply of the gas which is to be induced, maintaining such volume of gas at a pressure which is always in excess of the pressure prevailing in said space by a predetermined amount, maintaining in relatively large volume a supply of the gas which is to serve as the inducing gas, and maintaining the last-mentioned volume of gas at a pressure which is in excess of the pressure maintained on the volume of gas which is to be induced.

5. In apparatus for supplying to a confined space for combustion therein an explosive gaseous mixture in constant proportions irrespective of the pressure prevailing in said space, the combination of an injector device for injecting into said space one of the constituents of the mixture, an inlet connection for the induced constituent, a governing device interposed in said inlet connection and adapted to govern the pressure of the induced constituent in dependence on the

pressure against which the mixture is discharged, and means interposed in the supply line of the inducing constituent for delivering such constituent to the injector device at a pressure which is always in excess of the pressure against which the mixture is discharged by a predetermined amount.

6. In apparatus for supplying to a confined space for combustion therein an explosive gaseous mixture in constant proportions irrespective of the pressure prevailing in said space, the combination of an injector device for injecting into said space one of the constituents of the mixture, an inlet connection for the induced constituent, a governing device interposed in said inlet connection and adapted to govern the pressure of the induced constituent in dependence on the pressure against which the mixture is discharged, and means under the joint control of the pressure against which the mixture is discharged and the delivery pressure of the inducing constituent for varying the pressure of the inducing constituent effective at said injector device in accordance as the pressure against which the mixture is discharged varies.

7. In apparatus for supplying to a confined space for combustion therein an explosive gaseous mixture in constant proportions irrespective of the pressure prevailing in said space, the combination of an injector device for injecting into said space one of the constituents of the mixture, an inlet connection for the induced constituent, a governing device interposed in said inlet connection and adapted to govern the pressure of the induced constituent in dependence on the pressure against which the mixture is discharged, a normally open valve through which the fluid which is to serve as the inducing constituent must pass to reach the injector device, means subject to the pressure of such fluid and tending to close said valve when said pressure exceeds a predetermined amount, and means for making the pressure against which the mixture is discharged effective to counteract such valve closing pressure.

8. In apparatus for supplying to a confined space for combustion therein an explosive gaseous mixture in constant proportions irrespective of the pressure prevailing in said space, the combination with a device where through one of the constituents of the mixture may be passed in a manner to induce a flow of the other constituent, of supply tanks individual to each constituent, means controlled by the pressure prevailing in said space for controlling the pressure in the tank of the constituent which is to be induced, means jointly controlled by the pressure in said space and the pressure prevailing in the tank wherein the inducing constituent is contained for regulating the pressure at which the inducing constituent is suppiled to said device, said inducing constituent being supplied to said device at a pressure which is always higher than the pressure is said space by a predetermined amount, and said induced constituent being supplied to said device at a pressure which is substantially the same as the pressure prevailing in said space.

9. In apparatus for supplying to a confined space for combustion therein an explosive gaseous mixture in constant proportions irrespective of the pressure prevailing in said space, the combination with a device wherethrough one of the constituents of the mixture may be passed in a manner to induce a flow of the other constituent, of a valve through which the inducing constituent must flow to reach said device, a diaphragm connected to said valve and subject on one side to the outlet pressure of the inducing constituent and on its other side to the pressure prevailing in said space, means for loading the valve, and means controlled by the pressure in said space for delivering the induced constituent at a pressure substantially the same as that prevailing in said space.

10. In combination, a closed chamber, a burner set to discharge into said chamber, an injector for forming and delivering an explosive gaseous mixture to said burner, means controlled by the pressure prevailing in said chamber for controlling the pressure at which the induced constituent of the mixture is supplied to the injector, and means controlled by the pressure in said chamber for supplying to the injector the inducing constituent of said mixture at a predetermined pressure in excess of that prevailing in said chamber.

11. In combination, a closed chamber, a burner set to discharge into said chamber means controlled by the pressure prevailing in said chamber for supplying combustible mixture to said burner, and means controlled by the temperature of the hot gases within said chamber for delivering cooling gases into said chamber.

12. In combination, an elongated chamber, provided with a head forming a closure for one end of said chamber and having a reentrant portion on its inner side, a tubular burner projecting from the bottom of said portion in spaced relation with respect to the sides thereof, and means for delivering cooling gases around said burner.

13. In combination, an injector, a tank wherein may be maintained a source of supply of the medium to be induced, a pump for drawing said medium from a source of supply and delivering it into said tank, a valve between said source of supply and said pump, a diaphragm connected to the stem of said valve, means for making the pressure which is effective in said tank also effective on the valve-closing side of said diaphragm, a chamber in communication with the delivery side of the injector, and means for making the pressure which is effective in said chamber also effective on the valve opening side of said diaphragm.

14. In combination, an injector, a tank wherein may be maintained a source of supply of the inducing medium, a pump for drawing said medium from a source of supply and delivering it to the tank, a valve between said source of supply and said pump, a diaphragm connected to the stem of said valve, means for making the pressure which is effective in said tank also effective on the valve-closing side of said diaphragm, and means for making the pressure which is effective on said medium at the inlet to said injector also effective on the valve-opening side of said diaphragm.

15. In an apparatus for supplying to a confined space an explosive gaseous mixture in constant proportions irrespective of the pressure prevailing in said space, the combination of an injector device for injecting into said space one of the constituents of the mixture, an inlet connection for the induced constituent, a governing device interposed in said inlet connection and adapted to govern the pressure of the induced constituent in dependence on the pressure

against which the mixture is discharged, and means interposed in the supply line of the inducing constituent for delivering such constituent to the injector device at a pressure which is always in excess of the pressure against which the mixture is discharged by a predetermined amount.

16. In combination, a closed chamber, a burner set to discharge into said chamber, a retort, communicating means between said chamber and retort, means for forming and delivering an explosive gaseous mixture to said burner, and means controlled by the pressure prevailing in said communicating means for controlling the pressure of the mixture supplied to the burner.

17. In combination, a closed chamber, a burner set to discharge into said chamber, a retort, communicating means between said chamber and retort, an ejector for forming and delivering an explosive gaseous mixture to said burner, and means controlled by the pressure prevailing in said communicating means for controlling the pressure of the mixture delivered to said burner.

ERNEST G. DE CORIOLIS
HUGH B. BARBER.