

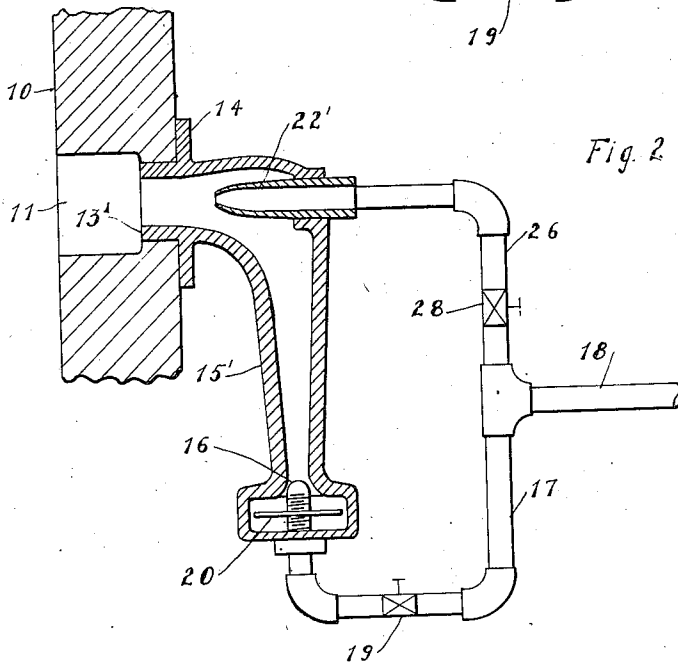
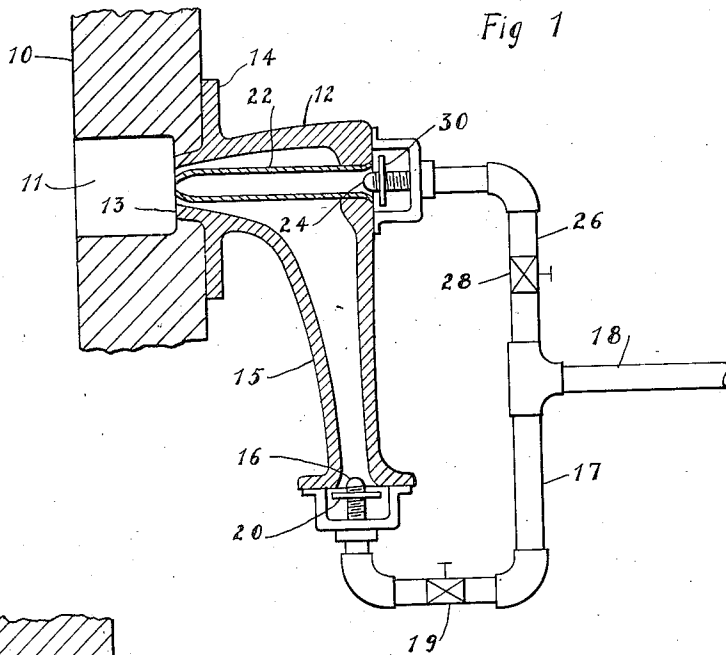
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METHOD OF BURNING EXPLOSIVE GASEOUS MIXTURES

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METHOD OF BURNING EXPLOSIVE GASEOUS MIXTURES

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This invention relates to improvements in the art of burning explosive gaseous mixtures and has for its general object to provide an improved method of and apparatus for forming such mixtures where the pressure of the fuel gas is sufficient to allow for entrainment of the full amount of air needed for combustion. Explosive mixtures will back flash and explode if the rate of supply of the mixture to the burners falls below the rate of flame propagation through the mixture. While the volume of the mixture subject to explosion may not be such as to be hazardous nevertheless the noise of the explosion is objectionable and tends to alarm the operator. Mixing tubes having a Venturi throat give high efficiencies of entrainment but on account of the objectionable explosions which occur in case of back flash, the use of Venturi throat mixers is in practical operation limited to the relatively smaller sizes. Instead of using Venturi throat mixing tubes where large volumes of explosive mixtures are to be burned a mixing tube known in the trade as a velocity burner has been developed. This velocity burner comprises essentially a straight walled tube having a flared inlet end into which a jet of gas is discharged for entraining the air required for combustion, the discharge end of the tube being somewhat restricted and the tube being only of a length to insure equalization of pressure of the mixture in the tube. Explosions due to back fire are not as noisy in velocity burners considering the capacity of the burners as in Venturi throat mixers of like or even less capacity which is one advantage in their favor. However, velocity burners are not as efficient as Venturi throat mixers, a fact which makes it a matter of great difficulty to obtain proper proportions of air and light gases such as coke oven gas.

One of the particular objects of the present invention is to provide an apparatus which will function efficiently over a wide range of operation and which may be operated in such a manner that explosion due to back flash shall be rendered unobjectional or practically eliminated.

Briefly stated the invention consists in a

novel combination of a Venturi throat mixer and a velocity burner or an ejector tube so constructed and arranged that the final explosive mixture results from admixture of gaseous bodies delivered from the two types of mixers.

Referring to the drawings forming part of this specification, Fig. 1 is a sectional view of one form of apparatus for practicing the invention and Fig. 2 is a sectional view of a modified form of the apparatus, both views showing a fragmentary section of the furnace wall through which the explosive mixture is introduced into the furnace for burning.

Only so much of a furnace as will suffice to illustrate the application of the invention has been shown, that is to say, a furnace wall provided with a combustion tunnel 11. The burner head of the apparatus is a chamber generally indicated at 12 and its discharge nozzle at 13. The burner head is secured to the furnace wall in any suitable manner as by a radial flange 14.

Discharging into the burner head is a mixer tube 15 having a Venturi throat and discharging into the entrance end or mouth of the mixer tube is a spud or nozzle 16. Gas is supplied to the spud by a branch pipe 17 leading from a main conduit 18, said branch having a valve 19 for controlling the flow of gas to the spud. The gas discharged through the spud inspirates air as it passes into the mixer and the parts are so proportioned that the amount of air so inspirated will form with the gas a mixture which is too lean to burn. An air shutter 20 is shown as provided in front of the entrance to the mixer tube. This shutter, however, will ordinarily only be used to close off the air flow when starting the burner in order that a pure gas or a rich gas-air mixture may be present in the tube when lighting up. In regular operation, adjustment of the air shutter will not be necessary because of the fact that the parts controlling the air gas ratio, that is to say, the size of the spud 16, the size of the Venturi throat of the mixer tube 15 and the size of the burner nozzle will be so proportioned as

to permit the formation of the desired lean mixture of air and gas.

The means for supplying the additional amount of fuel required to be added to the lean mixture in order to form an explosive mixture for burning in the combustion tunnel 11 will now be described. Referring to Fig. 1 there is provided in the burner head chamber 12 a tube 22 which may for convenience be termed an ejector tube. This tube is shown as provided with a flaring mouth and with a somewhat restricted outlet. The length of the tube may be such that its outlet terminates substantially flush with the burner nozzle 13 but it may be shorter and still function properly. The outer diameter of the tube should be such that a proper size annular space is formed between the burner nozzle 13 and the adjacent end of the tube in order that the mixture formed in the mixer tube 15 may pass out through the burner nozzle under the entraining action of a stream of fuel gas or a mixture of fuel gas and air passed through the ejector tube. Discharging into the ejector tube is a spud 24 which is supplied with gas by a branch pipe 26 leading from the main supply conduit 18, a valve 28 being provided in the branch pipe for controlling the supply of gas to the spud. The spud 24 discharges into the ejector tube in a manner to allow air to be entrained by the jet of gas discharged from the spud. The amount of air so entrained will be less than is required to form an explosive mixture in the ejector tube and more particularly will be such that upon admixture of the mixture formed in the mixer tube 15 and the mixture formed in the ejector tube an explosive mixture will be formed. An air shutter 30 is provided in front of the mouth of the ejector tube but under ordinary conditions of operation such shutter need not be used because the ejector tube and its spud will be so proportioned with respect to each other that for any given fuel gas a proper mixture will be formed, that is to say, a mixture which is so rich in fuel gas as to be non-explosive. The air shutter 30 therefore finds its principal use in preventing or regulating the entrainment of air in lighting up the burner.

In Fig. 2 I have shown the ejector tube as comprising a nozzled plain tube 22' into which gas is delivered directly from the branch pipe 26. This view also shows the tube as terminating considerably short of the burner nozzle 13'. In view of the fact that pure gas is discharged from the ejector tube 22', it is desirable to position its discharge end back from the burner nozzle in order that admixture of the pure gas and the lean mixture formed in the mixer tube 15' may take place in close proximity to the outlet of the burner nozzle.

The mode of operation of the apparatus

may be briefly described as follows: The gas in the main supply conduit 18 is divided into two flow paths 17 and 26, these streams becoming confluent in close proximity to the burner nozzle 13. The gas discharged into the Venturi-throat mixer tube 15 (15') entrains enough air to render the mixture non-explosively lean with resultant reduction in pressure head. The gas discharged into the ejector tube 22 (Fig. 1) entrains some air but not enough to make the mixture explosive, the amount of air so entrained being, however, such as will make the resultant admixture of the two separately formed mixtures explosive.

The gaseous mixture formed in the ejector tube 22 will of course be under a greater pressure head than the mixture formed in the mixer tube 15 and consequently the mixture discharged from the ejector tube will entrain the other mixture thus forming an explosive mixture in close proximity to the outlet end of the burner nozzle. The explosive mixture burns in the combustion chamber 11 as will now be understood.

The mode of operation of the apparatus shown in Fig. 2 is the same in principle as that described in connection with Fig. 1, the only difference being that pure fuel gas instead of a diluted gas is discharged from the ejector tube 22'. It will now be seen that the described apparatus permits the formation of an explosive gaseous mixture by means of two streams which eventually become confluent, the velocity energy of at least one of said streams being utilized to entrain air in advance of the point of confluence of said streams, the amount of air so entrained being in such amount as to form a non-explosive lean mixture of fuel gas and air, the other stream being utilized for entraining the non-explosive gaseous mixture thus formed, the resultant admixture being an explosive mixture.

While the invention finds its most important use in connection with the forming of explosive gaseous mixtures from fuel gas of light specific gravity such as coke oven gas, it is not limited to such use as will be readily apparent to those skilled in the art.

What is claimed is:

1. A method of mixing fuel gas and air in given proportions comprising directing two streams of gas along flow paths which eventually become confluent, utilizing at least one of said streams for entraining air in advance of the point of confluence of said streams, and utilizing the other stream for entraining the gaseous mixture formed as aforesaid.

2. A method of mixing fuel gas and air in given proportions comprising dividing a stream of fuel gas into two branches, directing said branches into flow paths which eventually become confluent, utilizing at least one of said streams for entraining air in advance

of the confluence of said streams, and utilizing the other stream for entraining the gaseous mixture formed as aforesaid.

3. A method of forming and burning explosive gaseous mixtures in a manner to prevent explosion and backfire comprising supplying to a chamber opening on a zone of combustion a non-explosive lean mixture of gaseous fuel and air, inducing a flow of said lean mixture from said chamber toward the combustion zone by a stream of fuel gas sufficiently rich to be non-explosive but which upon intermingling with the lean mixture forms an explosive mixture and burning the resultant mixture in the combustion zone.

4. A method of forming and burning explosive gaseous mixtures comprising directing two streams of one of the constituents of said mixture along flow paths which eventually discharge into a common chamber, utilizing one of said streams for entraining in advance of said chamber such volumes of the other constituent as will form therewith a mixture which is not explosive but which when finally mixed with the other stream will form therewith an explosive mixture, directing said other stream toward said chamber in a manner to entrain the non-explosive mixture whereby the resultant mixture will be explosive within said chamber, and burning the resultant mixture within said chamber.

5. A method of mixing fuel gas and air and burning the mixture comprising directing two streams of gas along flow paths which eventually discharge into a combustion chamber, utilizing at least one of said streams for entraining air in advance of said chamber, utilizing the other stream for entraining the gaseous mixture formed as aforesaid, and burning the resultant mixture in said chamber.

6. A method of supplying an explosive mixture of fuel gas and combustion supporting gas in approximately constant proportion to a combustion chamber, comprising supplying one of the gases under a higher pressure 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 some of the velocity energy of the mixture back to pressure energy, the induced and inducing gases forming said mixture being in such proportions as will make a non-explosive mixture, and causing said mixture to flow into said chamber by the inducing action of a jet of gas of such composition as will render the resultant mixture explosive upon reaching said chamber.

7. A method of supplying an explosive mixture of fuel gas and combustion supporting gas in approximately constant proportion to a combustion chamber, comprising

supplying one of the gases under a higher pressure 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 some of the velocity energy of the mixture back to pressure energy, the relative volumes of said gases lacking those proportions required for a substantially correct mixture, and causing said mixture to flow into said chamber by the inducing action of a stream of that gas which the mixture lacks to make a correct mixture, whereby the resultant mixture will be explosive.

In testimony whereof I affix my signature.
WILLIAM M. HEPBURN.

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