Jan. 27, 1953 C. J. DORF 2,626,860

BACKFIRE ARRESTER

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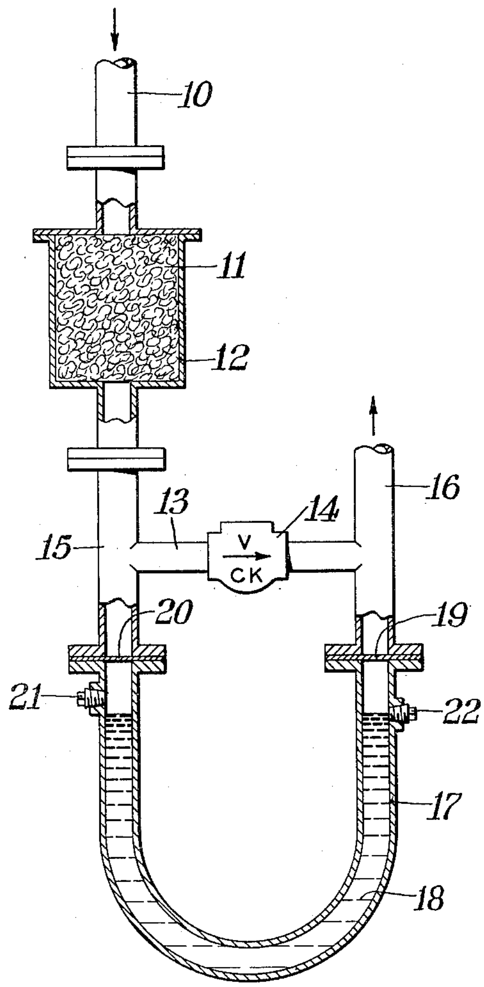

Fig. 1

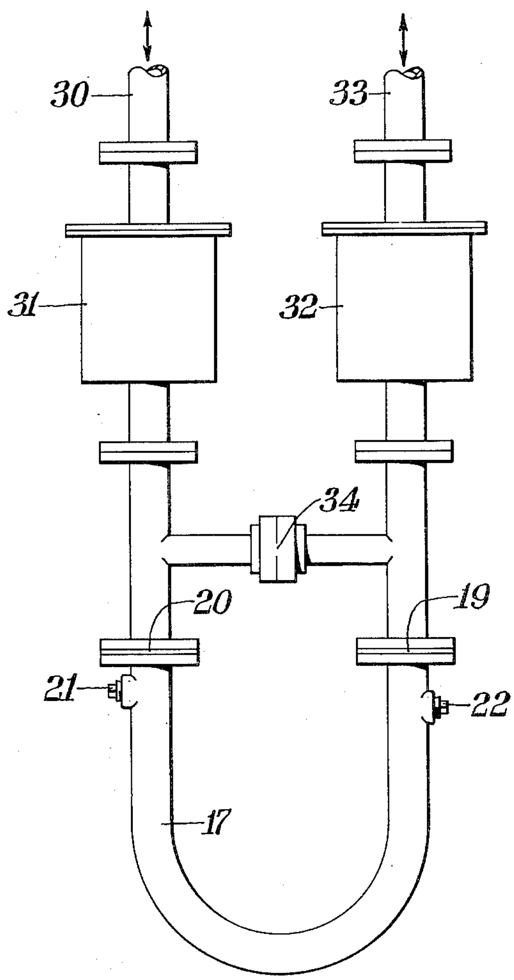

Fig. 2.

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BACKFIRE ARRESTER

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11 Claims. (Cl. 48—192)

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This invention relates to a method of and an apparatus for quenching a backfire of combustion or decomposition of fuel gas.

Heretofore, suitable apparatus comprising for instance an Alundum cartridge placed between fine mesh metal screens has been proposed for extinguishing a backfire in a fuel gas, such as acetylene under pressure not exceeding about 300 pounds per square inch. Such apparatus has not been found effective to extinguish backfire in this fuel gas at higher pressures.

An object of the present invention is the provision of a better means of extinguishing a backfire in compressed fuel gas. Another object is to permit the use, with safety, of acetylene at pressures higher than 300 pounds per square inch. A further object is to maintain a porous backfire extinguisher at a low temperature at which it is most effective. Still another object is to attain the foregoing advantages without a large pressure drop through the porous material.

According to this invention a porous mass is placed in a fuel gas stream, a supply of cooling liquid is maintained adjacent to the porous mass but out of the stream, and in prompt response to a backfire on the downstream side of the porous mass the said liquid is brought into contact with the porous mass.

More specifically, a body of cooling liquid is maintained in a container or a U tube the legs of which are connected at spaced points to a gas passage or conduit downstream of a porous mass. The impact of backfire first strikes the liquid surface in the leg farther downstream, thus forcing the liquid out of the other leg into contact with the porous mass. Preferably, a constriction is placed in the conduit between the legs of the U tube to improve the ejection of cooling liquid. When it is desired to avoid contact of the gas, e. g. dry acetylene, with the cooling liquid, e. g. water, prior to the backfire, a frangible diaphragm may be placed in each leg of the U tube.

Referring to the drawings:

Fig. 1 shows one embodiment of this invention, partly in section;

Fig. 2 is a modified construction embodying the invention and adapted to suppress a backfire which may occur in either pipe connected thereto.

As shown in Fig. 1, a supply pipe 10 carries a fuel gas such as acetylene under about 400 to 425 pounds per square inch to a usual porous material 11 used for the suppression of backfire. The porous material 11 is mounted in any appropriate enclosing casing 12, such as that illustrated as a removable portion having the flanged connec-

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tions. The outlet pipe 13 contains a constriction 14 which is in the form of an ordinary adjustable valve or appropriate check valve or a fixed constriction located between the upstream side 15 and its downstream side 16.

In shunt with the outlet pipe 13 containing the constriction 14 is a container 17 having therein water or other suitable cooling liquid 18. Frangible disks 19 and 20 prevent the liquid from being evaporated into the gas stream during normal operation of the apparatus.

When a backfire flame travels back the outlet pipe on the downstream side 16 of the constriction, the rapidly travelling pressure wave is delayed momentarily by the constriction 14, with the result that the pressure breaks the disk 19, putting pressure on the water and causing the disk 20 to break and the water to rise in the outlet pipe on the upstream side 15 of the constriction into contact with the porous material 11, where the water cools the porous material and prevents such material from becoming heated enough to decompose the fuel gas. Maintaining the porous material cool insures that the backfire will not pass through the material 11. After the disks 19 and 20 have been broken by a backfire they are replaced and the container 17 again filled with cooling liquid through a filling plug 21 or 22.

The embodiment illustrated in Fig. 2 comprises a pipe 30 adapted to function as either an inlet or an outlet pipe to the housing 31 for porous material of the type and construction shown in Fig. 1 for the enclosure 12 containing the porous material. A similar housing 32 for porous material is connected to the pipe 33, which is also either an inlet or an outlet pipe. Between the enclosures is a constriction 34 in the passage for the gas during normal operation. The frangible disks 19 and 20 are mounted at each side of the container 17 containing cooling liquid, e. g. water.

When a backfire occurs in either line 30 or 33 and passes through one of the porous materials within the housings 31 or 32, the pressure is built up on one side of the constriction 34, rupturing the frangible disks 19, 20 and forcing cooling liquid into that one of the porous material through which the backfire flame has not already penetrated.

Many types of refractory or non-refractory porous material have been found suitable such as Alundum, aluminum wool, glass wool, steel wool, and lead wool. Stainless steel wool is preferred because of its high strength and corrosion resistance. Ordinarily, water is preferred in warm climates where there is little danger of freezing. In colder climates aqueous ethylene glycol solution or other appropriate anti-freeze material may be added. The frangible disks are constructed to rupture at a pressure which is only slightly above that incurred during normal operation. Without the cooling liquid to reduce the temperature of the porous material, it was found that the porous material would get hot enough to allow a backflash or sustained decomposition or sustained burning to pass in as short a period of time as from 15 seconds to three minutes.

Using a spark to set off the backfire, a pressure of 400 to 425 pounds per square inch, with a flow of 125 to 2250 cubic feet per hour of acetylene, the present invention was found to have successfully arrested a backfire in 35 tests using stainless steel wool as the porous material. This porous mass had a porosity of substantially 74% and a pressure drop of 10 to 12 pounds per square inch across it under a flow of 2250 cubic feet per hour. The upper limit of flow rate for which this invention is adapted is not known. The range of porosity for the porous mass cannot be stated except to say that it is difficult to pack a metal wool with less than about 67% porosity. Pressure drop across the porous material 11 is a function of the flow rate and increases as the result of flow increases, decreasing as the flow rate decreases. The decomposition temperature of acetylene is said to be 1175° F. at atmospheric pressure and 1004° F. at 15 pounds per square inch. The decomposition temperature at 400 pounds per square inch is not known, but it is probably lower than the decomposition temperature at 300 pounds per square inch. A backfire occurring in an acetylene pipe where no oxygen is present is undoubtedly due to decomposition producing a pressure wave similar to the explosive combustion of the acetylene in the presence of oxygen.

Approximately 5 cubic inches of water or other cooling liquid are used in cooling the porous material. The stainless steel wool weighs about a pound and a quarter and is compressed in a space approximately 3⅜ inches in diameter by 2$\frac{7}{16}$ inches long, disks 19 and 20 are cadmium plated brass between .002 and .005 of an inch thick. The constriction in one form is a ¼ inch diameter hole in a transverse wall across a piece of pipe having an inside diameter of about ⅞ inch. It is possible that the change in direction of the rapidly travelling pressure wave may suffice to delay such wave long enough to break disk 19 in advance of disk 20 without recourse to a constriction.

Among the advantages of this invention may be mentioned the increased safety in quenching backfire under higher pressures of acetylene than have heretofore been practicable. Of course the present invention is adapted for other well-known fuel gases than acetylene. It is estimated the instantaneous detonation pressure wave may be as high as 60,000 pounds per square inch moving at supersonic velocity so that the porous material should be adapted to stand such momentary pressure. In event the porous material becomes coated and dirty it may be easily removed and new cartridge of such material replaced by disconnecting the enclosing housings at the flanged couplings illustrated. The porous materials mentioned offer less resistance to gas flow than the Alundum in the old type arrester. This means less pressure drop in the present arrester.

The cooling liquid cools the porous material quickly, before the heat of decomposition has

penetrated to the full depth of the porous material 11. The ejection of cooling liquid onto porous material 11 is in response to a backfire pressure wave. Since the cooling liquid is normally out of contact with the fuel gas, there is no loss in pressure from the gas having to bubble through the liquid normally. Neither is the gas contaminated normally from contact with the water. The cooling liquid does not clog the pores of the material 11, but effectively cools that material due to its latent heat of vaporization and low enough surface tension to allow penetration of the porous mass. After arresting a backfire the major and unvaporized portion of water is free to run back into its U tube for use again after the disks 19 and 20 are replaced. By the term "porous mass" type of arrester is meant one in which a backfire wave is broken up into many small parts and each such part is cooled by repeated contact with pore walls as the backfire is bent through numerous tortuous paths through the mass, and such term does not include the single thickness of wire screen or gauze, which is incapable of stopping a backfire wave of substantial intensity, such as one resulting from the decomposition of acetylene under pressure.

What is claimed is:

1. The combination with a fuel gas passage, of porous material therein of a type adapted to assist in quenching a backfire flame, a supply pipe leading to said material, an outlet pipe leading from said material, a constriction in said outlet pipe, an elongated liquid container having an end connected with said outlet pipe on each side of said constriction, and a frangible disk between said container and the outlet pipe on the down-stream side of said constriction, whereby any backfire surge of pressure is delayed by said constriction to rupture said disk and force liquid which may be placed in said container into contact with said porous material.

2. Apparatus according to claim 1 in which said porous material is duplicated on each side of said constriction.

3. Apparatus according to claim 1 in which a second frangible disk is provided between said container and a portion of the outlet pipe between said constriction and said porous material.

4. Apparatus according to claim 3 in which said container is a U tube shunted by the portion of said outlet pipe containing said constriction.

5. In an apparatus for arresting a backfire, said apparatus including a gas passage, a backfire arrester of the dry type having a porous mass within an enclosing casing and located in said passage, the combination therewith of an improvement for cooling said arrester promptly after it has been heated by a backfire without the necessity for a cooling liquid clogging the pores of said mass or causing an additional drop in pressure from passing a gas through a body of cooling liquid, said improvement comprising a container adapted to hold a cooling liquid of smaller amount than is required to fill said casing and the pores in said mass, and located adjacent the downstream side of said casing, a connection from said container to said passage downstream from said casing to receive the force of a backfire traveling up said passage to said casing and to transmit that force at least in part to a liquid in said container, a second connection from said container through which a cooling liquid may be directed toward said casing whereby after said liquid has received a thrust of impact from a backfire through said first connec-

tion it will be moved through said second connection into contact with said porous mass for cooling the downstream face thereof, and a frangible disc in at least one of said connections to gas-tightly separate one side of a liquid in the container from said porous mass in said passage, said disc being only slightly stronger than enough to withstand the pressure of gas in said passage and being capable of being ruptured by the impact of backfire.

6. An apparatus according to claim 5 in which said passage upstream from its junction with said first connection and downstream from said casing is bent and contains a constriction for delaying the passage of a backfire therethrough to insure a liquid in said container receiving a substantial impact from a backfire.

7. Apparatus according to claim 5 in which a frangible disc is placed on each side of said container to seal the cooling liquid from normal contact with gas in said passage.

8. An apparatus according to claim 5 in which said container is a U tube from which said connections lead to said gas passage, said passage being provided with a constriction intermediate the junction of said connections therewith and having a substantially 90° change in direction adjacent the junction of each connection, and a frangible disc in each connection to separate any liquid in said container from gas normally flowing in said passage.

9. Apparatus according to claim 5 in which said porous mass is a metal wool having a porosity of about 74% and not substantially less than 67%.

10. A method of liquid cooling a backfire arrester of the type having a porous mass within an enclosing casing through which is a path for a gas capable of supporting a backfire, said method comprising the steps of forcing a cooling liquid into the path of the gas and into said casing in contact with a downstream face of said porous mass by the impelling force of a backfire upon said liquid after said downstream face has been heated by a backfire, the amount of said liquid being less than that which would clog a majority of the pores of said mass, and said downstream face of the porous mass being normally free from contact with said cooling liquid.

11. In a method of safeguarding the flow of fuel gas through a passage comprising arresting a backfire through said passage by its impingement upon a porous mass, the combination therewith of the improvement enabling higher pressures to be used with safety whereby more voilent backfires may be arrested without a loss of pressure during normal flow of gas incident to such flow of gas having to be passed through a liquid, said improvement including forcing a liquid into said gas passage and into contact with at least the downstream face of said porous mass in response to pressure of a backfire in said passage and after said downstream face of said porous mass has been heated by a backfire, and cooling at least said downstream face of the porous mass by an amount of said liquid adequate to reduce the temperature of at least the downstream face of said mass which has been heated by its arrest of the backfire without said liquid filling the pores of said mass.

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