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MEANS FOR LIMITING TEMPERATURE RISE DUE TO ABRUPT ALTERATION OF THE FLOW RATE OF GAS UNDER HIGH PRESSURE THROUGH A CONDUIT

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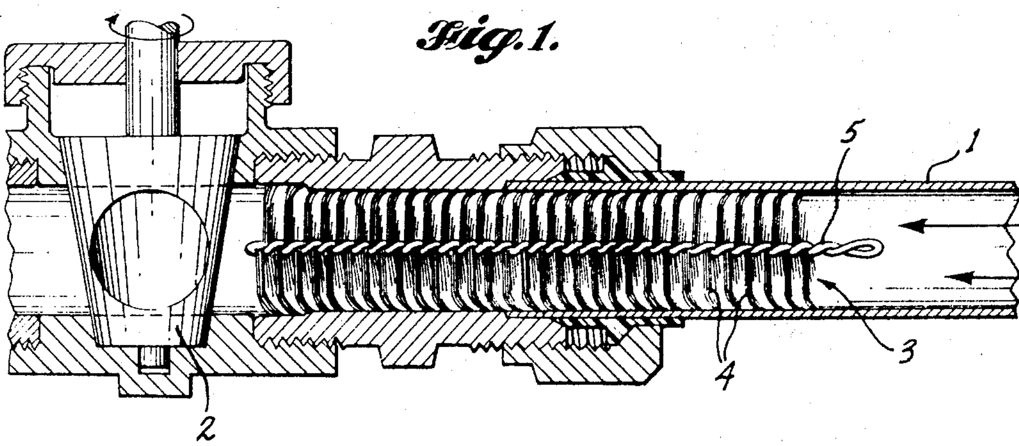
Fig. 1.



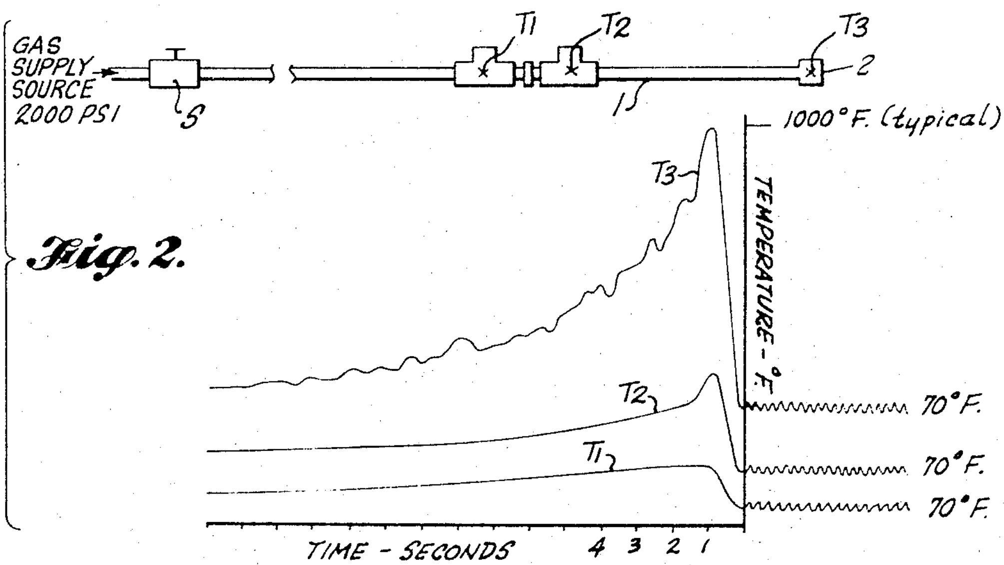


Fig. 2.

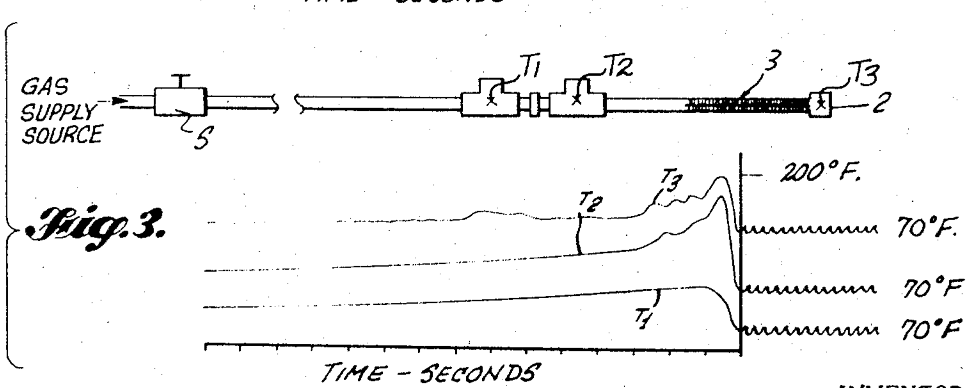


Fig. 3.

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MEANS FOR LIMITING TEMPERATURE RISE DUE TO ABRUPT ALTERATION OF THE FLOW RATE OF GAS UNDER HIGH PRESSURE THROUGH A CONDUIT

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ABSTRACT OF THE DISCLOSURE

A metallic wire brush is positioned in a flow line conducting a gas which is either combustible or capable of supporting combustion. This brush is mounted closely adjacent a point of blockage, e.g., a valve, upstream in said flow line and is in heat transfer contact with the walls of said flow line. The brush functions to dissipate any shock wave and its attendant heat of compression which will be developed when any sudden pressure surges occur upstream of said point of blockage.

BACKGROUND OF THE INVENTION

Previous system design concepts have been based on the use of a slow opening shut-off valve to control the rate of pressurization, thereby providing time sufficient for heat dissipation. The available valves have not been 100% effective, hence the currently recommended practice also depends upon operating procedures to assure slow pressurization for temperature control. Such procedures, it has been found, are not always followed. Moreover, due to improper field maintenance, it has not been possible to eliminate completely contaminants within the system. Fires have occurred, as a result, causing severe damage, and sometimes disasters and loss of life. The present invention provides positive assurance against excessive temperature build-up.

A search has been made, and the best search references found are the following: Jordan, 2,191,990; Mason, 2,468,454; Bourne, 2,297,046; Pearce et al., 1,891,008; Limpert, 2,310,970; Gillespie, 2,528,303; Young, 2,864,-405; Gunter, 2,424,612; Buttner, 2,323,895; (German) 812,847.

DESCRIPTION OF THE INVENTION

FIGURE 1 shows, in axial section, a typical installation.

FIGURE 2 is a diagram of temperature-time relations in a test involving a system without the use of the present invention, and FIGURE 3 is a similar diagram for a test involving the same system using this invention.

A conduit is represented at **1**, such as a main supply line for oxygen. That conduit would normally be of metal hence would constitute a heat-absorptive heat sink, especially with fittings of thicker or more massive materials. The oxygen, in a typical installation, would be at say 2000 p.s.i.g., flowing from a source at the right in FIGURE 2, or at the left in FIGURES 1 and 3, towards a point of blockage, such as the valve at **2**. T1, T2 and T3 indicate thermocouple locations. This valve **2** may be considered as closed, and the conduit at no appreciable pressure because of closure of another valve (not shown in FIGURE 1 but at the right, and at S at the left in FIGURES 2 and 3) downstream from the source. Now if the valve corresponding to S be opened abruptly, the gas temperature rises by adiabatic compression. The highest temperatures will occur at the downstream dead end of

the line or point of blockage at valve **2** where the gas is subjected to the highest compression ratio. Also, if high pressure ratios exist across pressure fronts in the conduit, shock waves may precede the pressure front. Such a shock wave will result in a very high velocity, high pressure-high temperature impulse which heats the gas locally as it travels, and can also heat solids or liquids (contaminants within the conduit, for example, that may be combustible) upon which the shock wave impinges, by impact heating. FIGURE 2 shows the result of an actual test, in which the temperature at T3 builds up, in approximately one second, from 70° F. to the vicinity of 1000° F. in a system wherein the present invention is not used. Temperatures at T2 and at T1 are less, although still high.

According to the present invention a pervious plug is installed within the conduit, as near as is practicable to the point of blockage (the valve **2**), this plug having the characteristic that it will dissipate a short wave and is heat-absorptive, and being installed in such manner that it is in good heat-transfer relation to a heat sink, which can be the conduit and its fittings. The pervious plug, preferably, is in the form of a wire brush **3**, of closely spaced helically arranged bristles **4** upon a wire core **5**. This wire brush should be of heat-treatable material, so that it may have sufficient spring tension or resilience to maintain itself in place when installed; sufficiently larger in diameter (preferably 10%) than the internal diameter of the conduit **1**, that it will maintain its position by reason of that spring tension, even under the impact of a shock wave. It should also be corrosion-resistant, to combat the effects of moisture or any other contaminant in the gas, and preferably is of high tensile strength. Although various metals can be made to serve, it is preferred to make the bristles primarily of copper; a chromium-copper alloy is eminently suitable.

The length of the brush in relation to the length of the conduit wherein it is installed is important. The longer the brush is, the greater is the dissipation of the shock wave, and the less is the value to which the temperature rises. We have found that the optimum length of the brush **3** should be at least 5% of the length of the conduit **1**. Such factors will vary with parameters such as the length and diameter of the conduit between the source and the dead end **2**, the expected pressurization rate and compression ratio, and the ignition point of the expected contaminant. Such a brush should be installed in the main conduit and in each branch thereof, at the point of blockage in each.

As will be clear, pressure entering from a source at the left (FIGURES 2 and 3) and abruptly blocked at the valve **2** will produce an accompanying shock wave which will build up temperature to a maximum at T3, and to lesser values at T2 and T1 in a very short period. The temperature at T3 in FIGURE 2 (without the use of the present invention) reaches the vicinity of 1000° F. in about one second—a temperature high enough to be dangerous, especially if a contaminant such as oil or dust be present. By using the previous plug of this invention, as FIGURE 3 shows, the build-up of temperature is much lower, because the successive bristles dissipate the shock wave, and absorb and dissipate the head to hold the maximum temperature to a safe value.

The spacing of the brush from the point of blockage is important. It should be located as close as possible to that point, for it is there that the compression ratio becomes a maximum. A spacing of the brush by as little as an inch from the point of blockage has been found to allow a much higher temperature build-up than if it is located immediately in advance of the point of blockage.

While a brush of lesser heat conductivity might decelerate the pressure front and its shock wave, such a brush would lack the capacity to conduct heat to its heat sink, and this is one of the highly desirable characteristics of such a device. The pervious plug, of which the brush is one example, might be in the form of a series of perforate disks, but the brush form is simple to make and to install, and by flexing the tips of the bristles it readily supports itself and maintains its position, and it interposes many successive barriers to the pressure front.

The process of this invention comprises interposing a pervious plug upstream from the point of blockage or dead end of the conduit, especially a plug of heat-absorbent and heat-conductive material, disposed in heat transfer relation to a heat sink.

What is claimed is:

1. In a system of the type for conveying a high pressure gas which is combustible or will support combustion above a predetermined temperature, and including a source of said gas,

a conduit connected to said source,

valve means in said conduit which may be opened suddenly to pressurize the conduit downstream of said valve means, and other means downstream of said valve means forming, at least temporarily, a point of blockage in the conduit, said conduit being of substantially uniform cross sectional area throughout its length between said valve means and said point of blockage whereby a shock wave may be created incidental to the sudden pressurization to build up temperature of the gas at the point of blockage which exceeds said predetermined temperature, the improvement comprising:

a pervious metal plug means in said conduit extending from a point closely adjacent said point of blockage in a direction toward said valve means, said pervious metal plug means being in heat transfer contact with said conduit and of a length sufficient to dissipate said shock wave and the heat of compression caused thereby to maintain the temperature of said gas below said predetermined temperature wherein said plug means is of a length at least 5% of the length

of the conduit between said point of blockage and said valve means.

2. In a system of the type for conveying a high pressure gas which is combustible or will support combustion above a predetermined temperature, and including a source of said gas,

a conduit connected to said source,

valve means in said conduit which may be opened surdenly to pressurize the conduit downstream of said valve means, and other means downstream of said valve means forming, at least temporarily, a point of blockage in the conduit whereby a shock wave may be created incidental to the sudden pressurization to build up temperature of the gas at the point of blockage which exceeds said predetermined temperature, the improvement comprising:

a pervious metal plug means in said conduit extending from a point closely adjacent said point of blockage in a direction toward said valve means, said pervious metal plug means being in heat transfer contact with said conduit and of a length sufficient to dissipate said shock wave and the heat of compression caused thereby to maintain the temperature of said gas below said predetermined temperature, said plug being a wire brush.

3. In the system as defined in claim **2** wherein said brush is of a length at least 5% of the length of the conduit between said point of blockage and said valve means.

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138—42; 251—127