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MANIFOLD SYSTEM FOR AUTOMATICALLY VENTING AND IGNITING
COMBUSTIBLE GAS ESCAPING FROM HIGH-PRESSURE
COMPRESSED-GAS CONTAINERS
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Fig. 1.

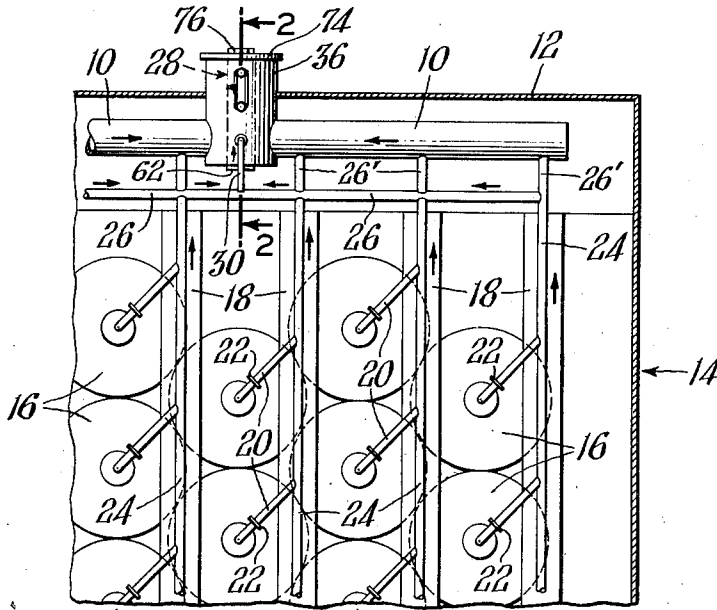


Fig. 2.

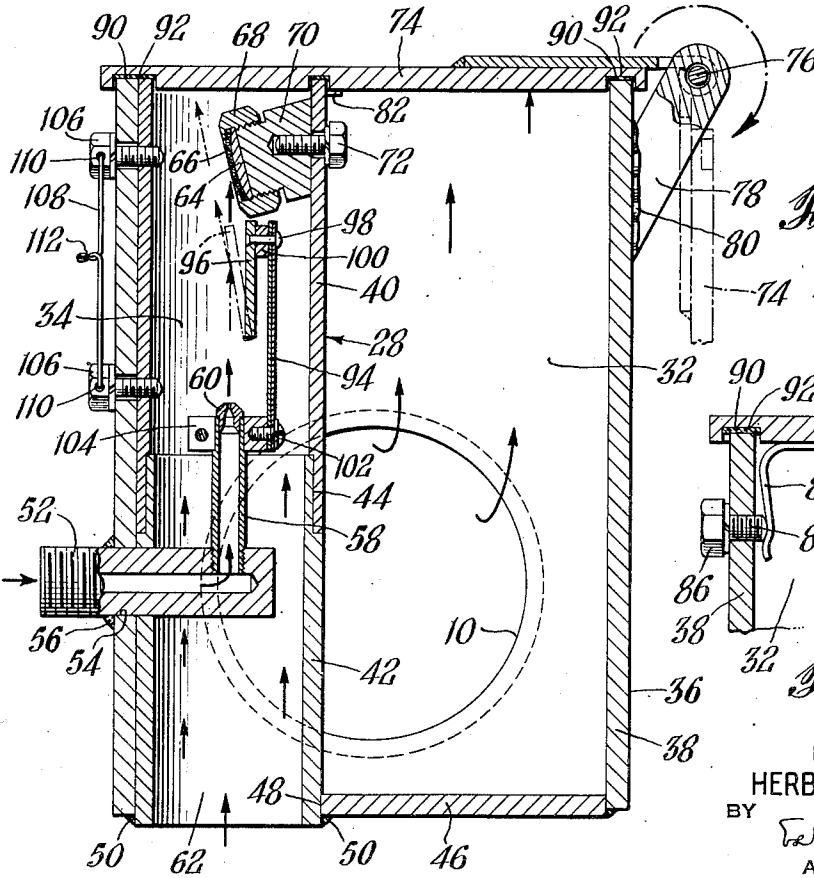


Fig. 3.

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MANIFOLD SYSTEM FOR AUTOMATICALLY VENTING AND IGNITING COMBUSTIBLE GAS ESCAPING FROM HIGH-PRESSURE COMPRESSED-GAS CONTAINERS

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14 Claims. (Cl. 220-88)

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This invention relates to the handling of combustible gases having a wide range of explosive mixtures with air, and more particularly to a repetitive pilot-type catalytic gas-igniter manifold system for automatically venting and igniting hydrogen gas escaping from one or more high-pressure compressed-gas containers thereof.

The shipment of hydrogen gas in high-pressure containers or cylinders has been restricted by the Interstate Commerce Commission because of the lack of a suitable device for igniting any gas that may be automatically released by the safety device associated with each container to relieve excessive gas pressure in such container. Igniters for this purpose have been proposed in the past, but have been found to be undependable in their operation. In general, such igniters made use of some catalytic material which was placed directly in the path of the escaping hydrogen from each container. The large variation in flow conditions as well as the neglect in providing for adequate air at the point of ignition was probably responsible for the poor operation of such igniters. Furthermore, the catalytic material was consumed by the resulting flame in each case.

According to the Interstate Commerce Commission Regulations, Part 2, entitled "Test of Explosives and Other Dangerous Articles," section 303 (q), Note 7, when large amounts of hydrogen are shipped in railroad cars a means of preventing excessive pressures in these cylinders must be employed. In addition, this note states that an approved ignition device must be used that will instantly ignite any hydrogen discharged through the safety devices. Though not specifically stated in the regulations, the ignition device should be capable of igniting the hydrogen as it escapes from each of the cylinders in an I. C. C.—107A tank car. Thus, it should be able to repeatedly ignite hydrogen without destruction of the catalyst. In spite of previous attempts, as far as is known, none has successfully satisfied the previously mentioned regulation.

The main object of this invention is to provide a novel manifold system for safely venting and igniting hydrogen gas escaping from one or more high-pressure compressed-gas cylinders especially during shipment thereof, which successfully satisfies all of such regulations. Another object is to provide an improved pilot-type catalytic gas-igniter for this purpose which is simple and economical in construction, and safe, effective and efficient in repetitive operation.

A manifold system is provided for manifold-

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ing the individual vent lines from each one of all of the safety devices of a plurality of compressed-gas cylinders to one common outlet or vent. An auxiliary manifold connected upstream of this outlet conducts some of the fuel gas to a metering orifice or gas tip in a pilot igniter. The gas tip directs a stream of hydrogen against a conventional ignition catalyst such as palladium on asbestos. Parallel to the path of the stream from the gas tip is disposed a heat-responsive element which, when it becomes sufficiently heated by the resulting pilot flame of ignited hydrogen, moves a flame deflector into the path of the flame and deflects such pilot flame away from the catalyst. This flame deflecting mechanism prevents the high temperature flame from impinging directly against the catalyst and catalyst holder, which would damage or destroy them.

The pilot igniter is located in a separate chamber inside a housing constituting the vent from the main manifold. The vent is normally covered by a hinged spring-clipped cover which is blown open when the gas pressure builds up in the vent as a result of high-pressure gas released into the manifold system. The pilot igniter has a separate air inlet constructed in such a way that the cover, when closed, restricts the gas from escaping through the air inlet.

In the drawing:

Fig. 1 is a fragmentary view mainly in end elevation of a protective system exemplifying the invention as applied in a railroad car filled with a bank of compressed hydrogen gas containers;

Fig. 2 is an enlarged cross-sectional view of the main gas vent and the improved igniter associated therewith taken on line 2-2 of Fig. 1; and

Fig. 3 is a fragmentary view in section of a detail of the vent and igniter housing illustrating a cover latch.

As shown in Fig. 1, the manifold system includes a horizontal main manifold 10 located, in this case, directly below the roof 12 of a railroad box car 14 adapted for the shipment of high-pressure containers or cylinders 16 of hydrogen gas. The gas containers 16 are stacked between uprights 18 and their individual safety vents 20, which contain pressure-responsive devices such as bursting discs 22, are coupled by suitable pipe connections to vertical headers or pipes 24. The headers 24 are connected near their upper ends to a horizontal auxiliary manifold 26 which communicates with the main manifold 10 through a number of connecting pipes 26'. The auxiliary manifold 26 is also connected to a pilot-type

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catalytic gas igniter 28 by a single central pipe 30. The pilot igniter 28 is operatively associated with a common gas vent 32 in the main manifold 10, so that any gas which is discharged therefrom is always ignited by the pilot igniter 28.

As shown in Fig. 2 the vent 32 is provided with a separate pilot-igniter chamber 34 located inside of a housing 36. A vertical metal pipe 38, six inches in diameter, has been found satisfactory for the wall of such housing for a railroad box car cylinder system; while a pair of metal pipe sections 40 and 42, two inches in diameter, and separably jointed at 44 have been found satisfactory for the wall of the pilot-igniter chamber 34. The pipes 40 and 42 are arranged as shown in Fig. 2, along one side of the housing 36. The bottom of the housing 36 is closed by a panel 46 which is cut-out at 48 to fit around the pipe 42 near the lower edge thereof, and secured to the pipes by welds 50.

When a bursting disc 22 ruptures, the high-pressure hydrogen gas thereby released in the system passes through a vent or outlet pipe 20 and an upright header 24 into the main horizontal gas manifold 10, part of the gas, however, first passing through the auxiliary gas manifold 26. This auxiliary manifold 26 conducts gas to the pilot gas supply pipe 30. The hydrogen gas then flows from the supply pipe 30 into a substantially horizontal gas fitting 52 that is mounted in a suitable opening 54 in the wall of the housing 36, where the pipes 38 and 42 adjoin each other, and is secured by a weld 56. An upright orifice tube 58 is screwed into the fitting 52 for receiving the gas supplied to the fitting 52.

Thereafter, the hydrogen gas passes through a restricting orifice or gas tip 60 and is discharged upwardly in a vertical stream or jet in the chamber 34. Air is aspirated through the vertical pipe 42 from an opening 62 in the bottom of the housing 36 by said stream of hydrogen gas from the tip 60. Hydrogen and air mix before they reach a catalyst 64 (e. g., 10 per cent palladium-on-asbestos). The catalyst 64 is held in place by a wire screen 66 which, in turn, is secured by a retaining cap 68 that screws on a catalyst holder 70. Contact of the hydrogen-air mixture with the catalyst 64 causes ignition of this mixture. The entire catalyst holder 70 is held in place on the inner wall of the chamber 34 by a retaining screw 72, the holder 70 being shaped so as to support the face of the catalyst 64 at a slight inclination toward the tip 60, and directly above the latter.

When a bursting disc 22 opens, the resulting high-pressure "build-up" of hydrogen gas in the otherwise closed manifold system blows open a common vent valve or cover 74 about a hinge 76, the latter forming a portion of a support 78 which is externally fastened to the housing 36 by a weld 80. Normally, however, the cover 74 is releasably held in closed position by two spring latches or clips 82 (one of which is shown in Fig. 3) engaging studs 84 provided by screws 86 in the wall 38 of the vent 32. In addition, a relatively gas-tight relationship is maintained between the cover 74 and the top of housing 36 by a gasket 90 which is attached in a suitable recess 92 in the cover and engages the tops of pipes 38 and 40, effectively sealing the top of the housing 36 and chamber 34.

When the cover 74 is blown open, the pilot flame ignited by the catalyst 64 in the chamber 34, in turn ignites the gas discharged to the atmosphere by vent 32. The cover 74, as it opens,

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initially deflects gas vented from chamber 32 over the outlet of chamber 34, to more quickly and effectively ignite the vented gas.

Since ignition of the air-hydrogen stream takes place at catalyst 64 and propagation of the resulting pilot flame proceeds backwards toward tip 60, heat thus produced causes a vertical heat-responsive bi-metallic element 94 to move an imperforate flame deflector plate 96 into inclined position and into the path of the flame whereby it deflects the pilot flame and hot gas away from the catalyst 64. The flame deflector plate 96 may be secured by a rivet 98 to the element 94 with a spacer 100 therebetween. A screw 102 attaches the bi-metallic element to a support 104 which is attached to orifice tube 58 by a key-slot type of connection.

The upper pipe section 40 of the pilot igniter chamber 34 is attached to the housing 36 by vertically spaced screws 106. The screws 106 are wired together by a locking device 108 composed of a length of wire the ends of which are threaded through holes 110 in the screws 106 and twisted together at 112. Thus, if for any reason, repairs need to be made, the pipe section 40 may be removed by merely releasing the device 108, removing screws 106, and lifting the upper pipe section 40 of the chamber 34 from the lower air-inlet pipe section 42 thereof.

Since the invention comprises a pilot-type igniter, only a relatively small portion of the escaping hydrogen gas is caused to flow against the catalyst 64. As is evident, air (oxygen) must be present to insure ignition of the hydrogen. This is accomplished, according to the invention, by the arrangement wherein the hydrogen stream discharged by the gas tip 60 aspirates air into the pilot igniter chamber 34, thereby causing combustible mixture of these gases to flow past the catalyst 64. Ignition occurs in approximately one to two seconds after the stream of hydrogen issues from the tip 60.

A catalyst containing 10% palladium-on-asbestos has been found to be the most satisfactory catalyst for the hydrogen igniting device illustrated.

Continuous direct impingement by a flame and hot gas will decrease the effectiveness of the catalyst. This is especially evident when the delay between subsequent ignitions is such that the catalyst becomes cooled. To overcome this disadvantage, the flame deflector plate 96 mounted on the bi-metallic element 94 is incorporated in the pilot-flame ignition device of the present invention. When the bi-metallic element 94 is heated by the pilot flame it moves the plate 96 into the path of the burning hydrogen, and causes the flame and hot gas to be deflected away from direct impingement against the catalyst 64. If a second disc failure (excessive cylinder pressure) occurs before the flame deflector plate 96 has returned to its original position, the temperature of the various metallic portions of the igniter body is high enough, as a result of the previous ignition, to ignite the resulting second discharge of hydrogen. If the second disc failure takes place after the flame deflector plate has resumed its original position, a recycle of ignition processes occurs.

Though exposure to sulfur dioxide poisons the catalyst, and this compound is emitted in some extent from the exhausts of railroad engines burning coal and possibly oil, such exposure is very limited in the present invention. Actually only "breathing" due to atmospheric pressure

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and temperature changes occurs through the air intake opening 62 which might cause poisoning. Periodically replacing the catalyst 64 will prevent this effect. Poisoning of the catalyst is a relative term used to denote both partial and complete poisoning. Thus, if only partial poisoning has occurred, an increased contact time of the hydrogen and air with the catalyst 64 will be needed for ignition of the pilot flame.

I claim:

1. A manifold system for automatically venting and igniting combustible gas such as hydrogen escaping from high-pressure compressed-gas containers, comprising the combination of a high-pressure combustible-gas container manifold having a plurality of individual gas-container vent connections and a common gas outlet vent, a pilot-type catalytic gas igniter operatively associated with said common gas outlet vent for igniting the gas discharged therefrom, said pilot-type catalytic gas igniter being connected to said manifold, so that each time a gas container vents gas to said manifold the pilot-type gas igniter ignites a pilot flame which in turn ignites the gas discharged from said common vent.

2. A manifold system comprising the combination with a plurality of fuel gas containers having safety valve outlets, of gas pipes connected to each of said outlets, a manifold in communication with said pipes for receiving fuel gas discharged by said containers through said outlets, a gas vent connected to said manifold for discharging the gas to the atmosphere, said vent having a separate chamber containing a pilot tip adapted to be supplied with fuel gas from said manifold, and with air from the atmosphere below said tip, a normally closed common cover for the vent and chamber, a latch for said cover releasable when the gas pressure within said vent is above atmospheric, and an automatic catalytic gas-igniter in said chamber for igniting the fuel gas discharged by said tip when said cover opens in response to such fuel gas pressure.

3. A manifold system for automatically venting and igniting fuel gas discharged from a bank of fuel gas containers upon the bursting of a pressure-responsive safety disc thereof, comprising a catalytic gas-igniter device having a housing constituting a common vent for such fuel gas, pipes for delivering fuel gas discharged from said containers to said housing, said housing having a separate pilot-flame chamber containing a catalytic gas igniter and a gas tip for initially discharging a portion of such fuel gas into operative relation with said igniter so that the fuel gas from said tip is ignited thereby, an air inlet in such chamber below said gas tip for supplying combustion supporting gas to the resulting pilot flame, a common cover for said housing and chamber adapted to be opened by the pressure of the fuel gas initially delivered to said housing, and a heat-responsive device operated by the heat of such pilot flame for deflecting the flame away from said catalytic gas-igniter to protect the latter from damage by the flame.

4. The combination comprising gas vent means having a normally closed cover, a pipe for delivering fuel gas under pressure to said vent so that the cover is opened by the pressure of such fuel gas upon the delivery thereof to the vent, a separate catalytic pilot gas-igniter chamber within said vent, said chamber having an open air-inlet at the bottom thereof, and an opening at the top of the chamber which is normally closed by such

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cover, a pilot gas tip mounted in said chamber and connected to be supplied with a portion of the fuel gas delivered to the vent, said tip being adapted to discharge the fuel gas upwardly, a catalytic gas-igniter support mounted in said chamber, a catalytic gas-igniter held by said support so as to be impinged by fuel gas initially discharged from said tip so that such fuel gas is ignited by said catalytic gas-igniter and burns as a flame with oxygen supplied in the air aspirated through such open air-inlet by the fuel gas discharged by said tip, a flame deflector plate, and a bi-metallic member normally supporting said flame deflector plate adjacent but out of the path of the fuel gas initially discharged by said gas tip, said bi-metallic element acting when heated by the pilot flame resulting from the ignition by said catalytic gas-igniter of the gas initially discharged by said gas tip, to move said flame deflector into such flame so as to deflect the flame away from the catalytic gas-igniter, to protect the latter from damage by such flame.

5. A compressed hydrogen container manifold system comprising in combination, a gas-pressure-responsive relief valve that automatically opens to discharge gas therefrom when the pressure in a container exceeds a safe value; a gas ignition device; a conduit connecting said gas ignition device to the outlet of said relief valve; said gas ignition device comprising a gas vent, a separate chamber having its outlet adjacent the gas vent outlet, said chamber having a restricted air inlet, a pilot gas tip in said chamber, a connection for supplying gas from said conduit to said gas tip, a gas ignition catalyst, and a flame deflector comprising a temperature responsive element operative when heated by the pilot flame resulting from ignition by the catalyst of the gas discharged by said tip to prevent damage to said catalyst.

6. A compressed hydrogen container manifold system as defined by claim 5, in which a flame deflector plate is moved by said element into position to deflect the pilot flame away from the catalyst.

7. A compressed hydrogen container manifold system as defined by claim 5, in which said conduit is a manifold connected to each of the outlets of a plurality of relief valves of a group of compressed hydrogen containers.

8. A compressed hydrogen container manifold system as defined by claim 5, in which the gas vent and separate pilot chamber outlets are normally covered by a common blow-off cover which is adapted to be opened by the resulting gas pressure within said vent when the relief valve opens.

9. The combination comprising a horizontal main manifold, a single vertical vent means for said manifold, a vertical chamber within said vent, said chamber being open to the atmosphere below said vent, a normally closed cover sealing the top of said vent and the top of said chamber from the atmosphere, headers communicating with said manifold, a pilot tip in said chamber, a catalytic igniter for said tip, and a horizontal auxiliary manifold connected to said headers for conducting gas to said pilot tip, said cover being adapted to be blown open by the pressure of gas within the system, so that the gas discharged by said vent is ignited by the pilot tip ignited by said catalyst.

10. A manifold system for venting and igniting all hydrogen gas discharged through individual vents of safety valves connected to each high-pressure container of such gas during shipment

of a plurality of such containers, comprising vertical headers having branches connected to such vents, a horizontal main manifold connected above the containers to the upper ends of said headers, a common vertical vent for said manifold, a vertical chamber in said vent, said chamber having an air inlet in the bottom thereof, a horizontal auxiliary manifold connected to said headers directly below said main manifold, a pilot tip in said chamber connected to said auxiliary manifold, a catalytic igniter for the gas discharged by said pilot tip, and a normally closed common cover for the top of said common vent and chamber, said cover being hinged so that the cover is adapted to be blown open by the pressure of gas seeking discharge through the common vent and thereupon remains open, and the hydrogen gas discharged by said common vent is ignited by the pilot flame resulting from ignition of the gas discharged by said pilot tip, said system being normally closed to the atmosphere except for the pilot tip and air inlet in the bottom of said chamber.

11. A repetitive pilot-type catalytic gas-igniter comprising the combination of gas vent means including a housing comprising a wall, a separate pilot-gas ignition chamber in one side of said housing, a catalytic gas igniter in such chamber, a panel closing the housing at the bottom of said wall, the lower end of such chamber being open to the atmosphere to provide an air inlet, a normally closed common cover for said housing and chamber, and a hinge for said cover opposite such chamber, the cover being adapted to be blown open about said hinge by the pressure of gas seeking escape through the vent, so that the cover remains open, and in opening directs the gas initially vented to the atmosphere over the top of the pilot-gas ignition chamber.

12. A repetitive pilot-type catalytic gas-igniter comprising the combination of gas vent means including a housing comprising an annular wall having gas inlets in opposite sides thereof, a separate pilot-gas ignition chamber in one side of said housing, consisting of upper and lower annular sections separably jointed to each other, so that the upper section may be removed from the housing, a panel closing the housing at the bottom of said wall, the lower annular section of said chamber being open to provide a restricted air inlet, a normally closed common cover for said housing and chamber, a hinge for said cover opposite such chamber, and a gasket between the cover and the tops of the annular wall and the upper annular section of the chamber, and spring clips releasably latching the cover closed, the cover being adapted to be blown open by the pressure of gas seeking escape through the vent, about said hinge, so that the cover remains

open, and in opening directs the gas initially vented to the atmosphere over the top of the pilot-gas ignition chamber, and a catalytic gas igniter in said chamber.

13. In a pilot-type catalytic gas-igniter, the combination with gas vent means comprising a housing having a normally closed cover, of means providing a separate pilot-gas ignition chamber in said housing, said means having a lower section which is stationary and an upper section which is removable from the housing when the cover is open, a pilot gas tip in said chamber, and a catalytic gas igniter mounted within said chamber on said upper section for removal thereof, said chamber having an air inlet in said lower section, and said cover when closed covering the top of said chamber.

14. The combination comprising a catalytic gas-igniter chamber, said chamber having an open air-inlet at the bottom thereof, and an opening at the top of the chamber, a gas tip mounted in said chamber and connected to be supplied with fuel gas, said tip being adapted to discharge the fuel gas upwardly, a catalytic gas-igniter support mounted in said chamber, a catalytic gas-igniter held by said support so as to be impinged by fuel gas initially discharged from said tip so that such fuel gas is ignited by said catalytic gas-igniter and burns as a flame with oxygen supplied in the air aspirated through such open air-inlet by the fuel gas discharged by said tip, a flame deflector plate, and a bi-metallic member normally supporting said flame deflector plate adjacent but out of the path of the fuel gas initially discharged by said gas tip, said bi-metallic element acting when heated by the pilot flame resulting from the ignition by said catalytic gas-igniter of the gas initially discharged by said gas tip, to move said flame deflector into such flame so as to deflect the flame away from the catalytic gas-igniter, to protect the latter from damage by such flame.

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