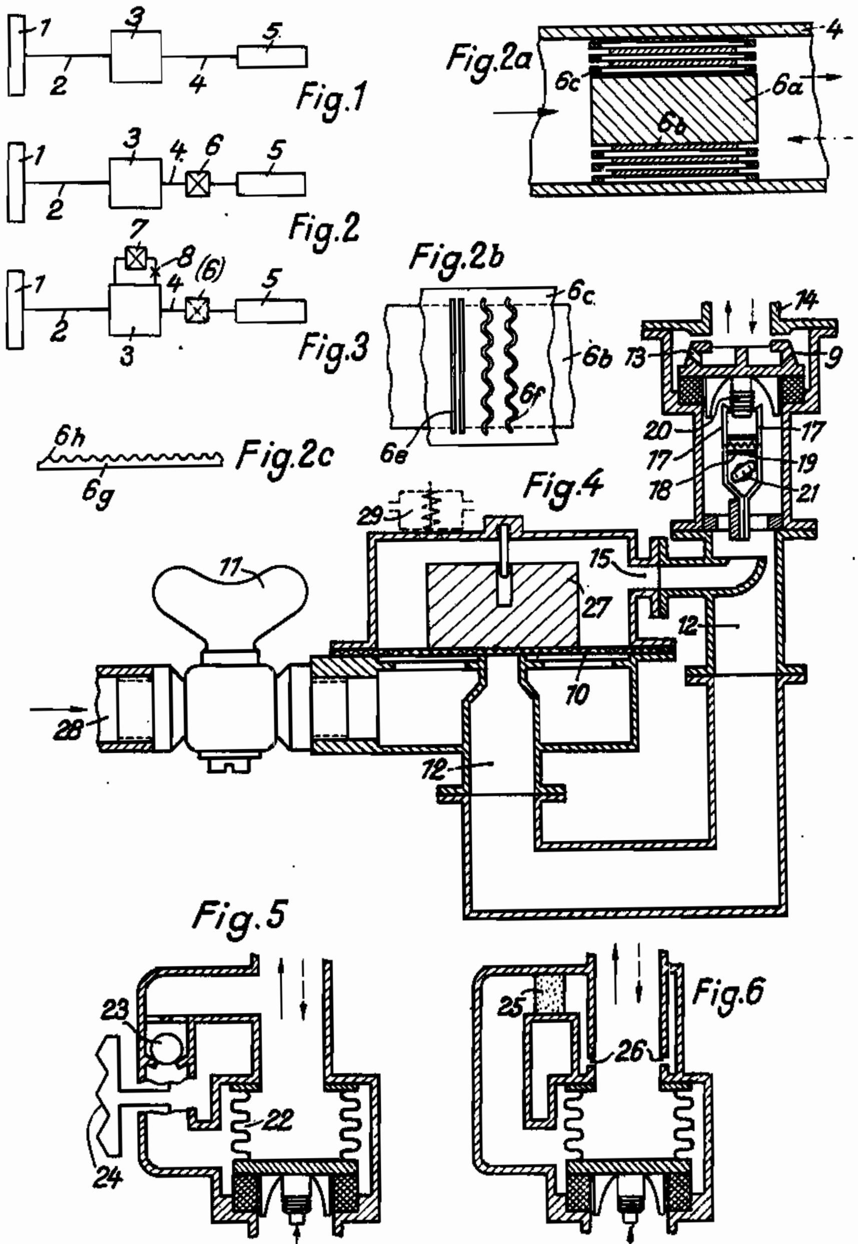
PUBLISHED	E. WEESE	Serial No.
APRIL 27, 1943.	SAFETY DEVICES FOR GAS CONDUITS	285,434
BY A. P. C.	Filed July 19, 1939	5 Sheets-Sheet 1



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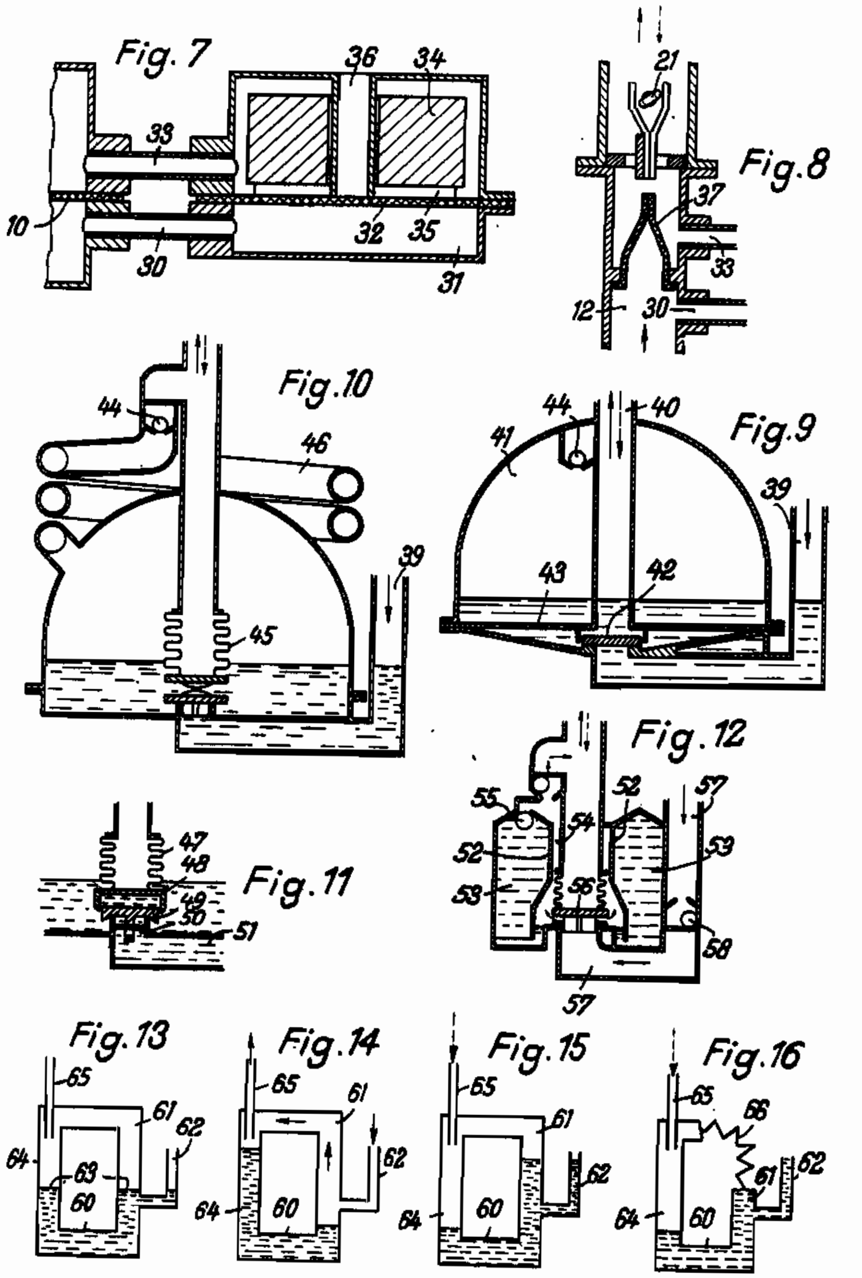

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Fig. 17

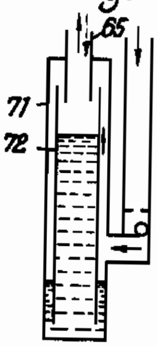

Fig 18

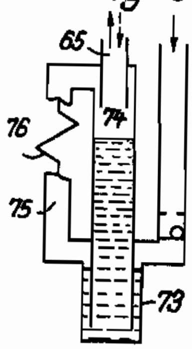

Fig. 19

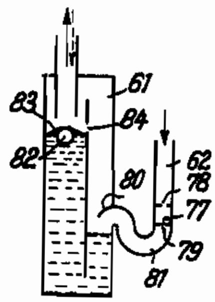

Fig. 20

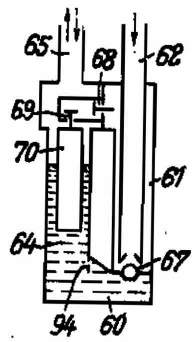

Fig. 21

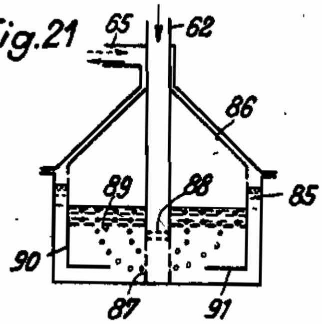

Fig. 22

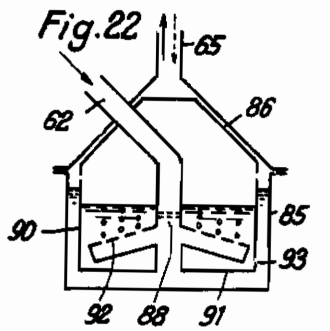

Fig. 23

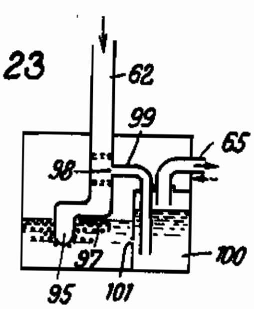

Fig. 24

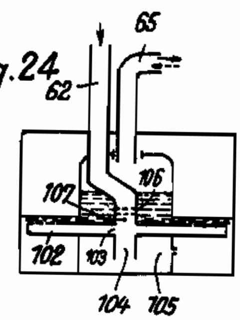

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Fig. 25

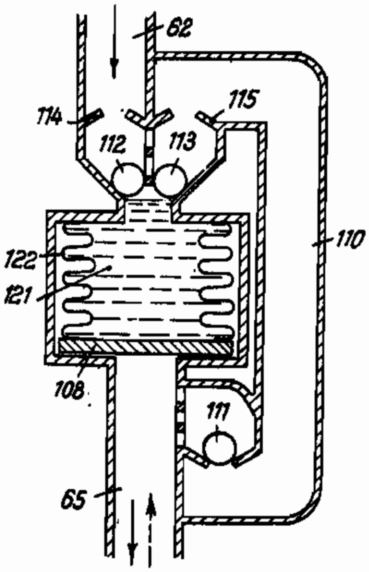


Fig. 27

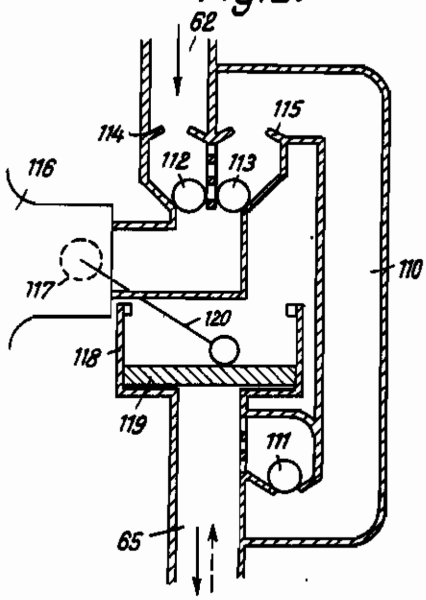


Fig. 26

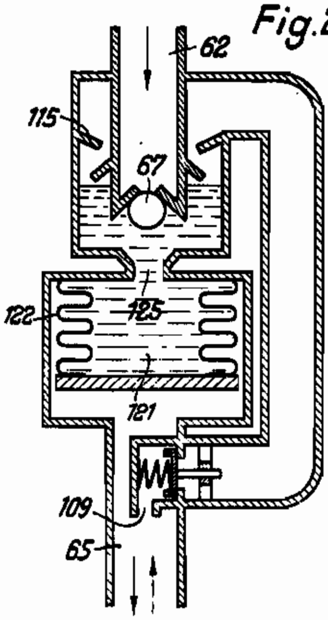
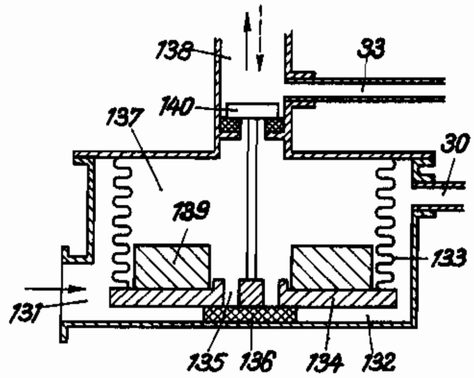


Fig. 28



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SAFETY DEVICES FOR GAS CONDUITS

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Fig. 29

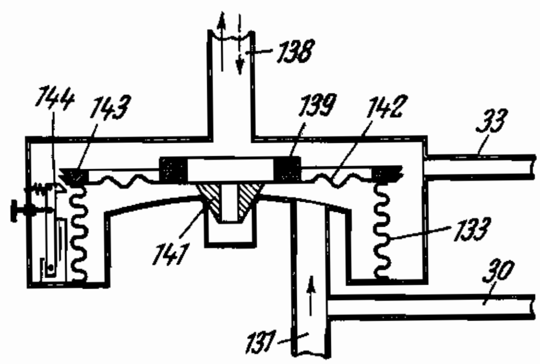
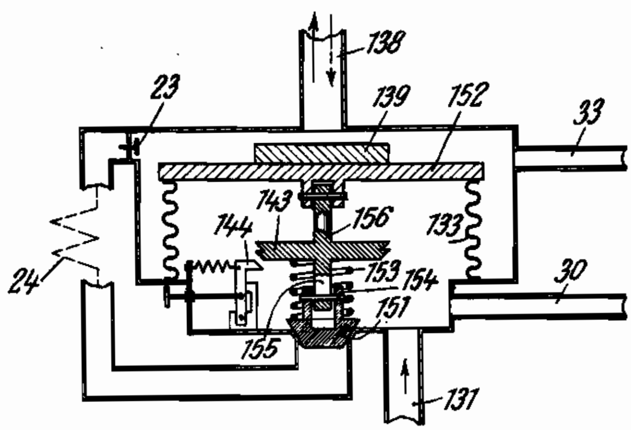


Fig. 30



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Published Apr. 27, 1943 **Serial No. 285,434**

ALIEN PROPERTY CUSTODIAN

SAFETY DEVICES FOR GAS CONDUITS

Ernst Weese, Berlin-Grunewald, Germany; vested in the Alien Property Custodian

Application filed July 19, 1939

To prevent explosions in gas conduits, water-traps are usually employed. In this way the formation of an explosive mixture in the gas supply conduit is prevented in that the water-trap prevents the penetration of air or oxygen into the gas supply conduit from the point of consumption, and on the other hand should such an explosive mixture exist in the supply conduit the flame is prevented from striking back in the conduit in that the stream of gas flowing through the water-trap is subdivided into discontinuous bubbles. The disadvantage of the water-trap is a considerable pressure loss, a picking-up of water which must be limited by complicated baffle plates and the like but which cannot be wholly eliminated, large gas chambers which involve large dimensions and thicknesses of metal for the containers and thus involve considerable expense, the danger of freezing, and the necessity for a constant supervision for checking and maintaining the water content.

The object of the invention is to provide arrangements which afford the same security as the water-traps but avoid the disadvantages wholly or in part.

The invention is based on the known fact that on igniting a gas mixture at one point in a closed conduit there is an increase of pressure in the adjacent mixture which is not yet ignited, i. e. the flame front is preceded by a pressure wave in the gas which is not burning. This preceding pressure is utilised in accordance with the invention to urge a medium (a solid body such as a valve, a liquid or a gas) into the gas conduit at a safety device disposed at some distance from the point of ignition. In this way the flame is prevented from penetrating into that part of the gas conduit which is to be protected, provided that the time difference between the incidence of the pressure wave and the incidence of the flame at the safety device is greater than the time necessary for the complete closure of the gas conduit and if in addition the reopening of the gas conduit is prevented before the flame is extinguished.

With many gases and gas mixtures, the normal conduit from the point of consumption to the safety device is sufficient in respect of length, cross section, walls, structural material and contour, in order to ensure the above-mentioned adequate time difference. When this is not the case the necessary time difference must be produced by separate means in a part of the conduit or throughout the conduit. A known means for effecting the delay in the propagation of the flame consists for example of a reduction in the cross-section of the conduit over a limited length whereby the speed of the gas mixture flowing in the opposite direction to the direction of propagation of the flame is increased, a subdivision of the gas stream and of the heat transfer in vessels which are filled with a porous material, metal chips, glass wool or the like, a cooling of the conduit, a sudden enlargement in cross section, and in some circumstances an elongation of the path by incorporating a helix or the like.

If this retardation conduit independent of the actual safety device does not afford a sufficient time difference between pressure wave and flame, then the time which elapses from the incidence of the flame at the beginning of the safety device up to the incidence of the flame at the inlet of the conduit which is to be protected can be increased by causing the flame to traverse a circuitous path incorporated in the safety device. To utilise the preceding pressure wave in its entirety for closing the conduit which is to be protected, the escape of the pressure in this circuitous path is best prevented by a non-return valve.

Figs. 1 to 3 of the accompanying drawings show diagrammatically the fundamental principle of the arrangements according to the invention.

According to figure 1, the gas (acetylene, coal-gas or the like) passes from the source **1** into the supply conduit **2** and to the safety device **3** and from thence through the delivery conduit **4** to the point of consumption **5** (welding burner, cutting burner, hardening plant, gas fired system or the like). If there is striking back from the point of consumption **5**, the flame is arrested by the safety device which is prevented from reopening.

In Fig. 2 the conduit **4** is constructed as a flame retarding conduit.

In Fig. 3 a flame retarding circuitout path **7**, **8** is incorporated in the safety device, a device **8** for preventing loss of pressure being provided at that end of the circuitous path which is adjacent the consuming device. At the same time the conduit **4** may also be constructed as a flame retarding device.

An example of a flame retarding device **6** or **7**, is shown in figures *2a* to *2c*. Thus for example in figure *2a* a body which fully fills the conduit but is permeable is incorporated in the conduit **4**. This body consists for example of a core **6***a*, about which two very thin strips **6***b* and **6***c* are wound spirally. These strips bear against the core **6***a* on the inside and against the inner wall of the conduit **4** on the outside. One strip **6***b* is smooth. The strip **6***c* is broader than the strip **6***b* and is provided with straight or curvilinear openings **6***e* or **6***f* (fig. *2b*) extending substantially over its entire width. As these openings **6***e* and **6***f* are longer than the strip **6***b* is wide, they project beyond the edges of the strip **6***b* on both sides when the strips are coiled, and thus form a narrow passage for the gas. The very fine passages for the gas in the body formed from the strips

6b and *6c* considerably retard or entirely prevent the propagation of the flame.

According to Figure 2*c*, the two strips *6b* and *6c* could be replaced by a single strip *6g*, one side of which is plain and the other side of which is provided with projections, ribs or the like *6h*. These projections then lie against the smooth side of the strip *6b* when the latter is coiled. The fine passages for the gas then lie between these projections, which can be of any desired configuration.

For the sake of clarity, the scale has been very much enlarged in the representations of this device. In practice the gas passages formed by the openings *6e* and *6f* or the projections *6h* have a cross section of only a few hundredths of a square mm.

Figs. 4 to 7 show by way of example a safety device in which a solid body, namely a valve **9** prevents the propagation of the flame and a diaphragm valve **10** prevents the penetration of oxygen.

During operation the gas supplied at a pressure p_1 flows through an opening in the tap **11** into the chamber beneath the diaphragm **10**, lifts it and passes into the conduit **12**, urges the valve **9** against its upper seating and then flows through the openings **13** in this valve into the conduit **14** which leads to the point of consumption.

The chamber above the diaphragm **10** is connected with the conduit **12** by way of conduit **15**. During the flow of the gas the ejector mounted on the conduit **15** gives rise to a reduced pressure in comparison with the supply pressure p_1, so that the diaphragm **10** is constantly maintained in the raised position.

In order that the valve **9** should close as quickly as possible, it is made particularly light and with a particularly short stroke and is connected directly to the delivery pipe without any enlargement in cross section of this delivery pipe. The valve plate is arranged at right-angles to the direction of flow and is provided with gas passages which extend obliquely upwardly. The incident pressure wave preceding the flame is thus utilised fully for the rapid closing of the valve plate so that a flame which is only slightly retarded relatively to the pressure wave encounters a closed valve.

The reopening of the valve **9** is prevented by means of a retaining device disposed beneath the valve. This retaining device is so arranged that it does not prevent the free movement of the valve between its upper and lower seatings but first operates when the packing **16** is compressed somewhat. This packing must be very elastic in order that the valve plate should be held even with a pressure wave of small intensity. It suitably consists of a moss rubber with an impervious rubber layer on the outside.

The retaining device has two resilient clamping jaws **17** which are urged together by means of the spring **18** and are held at a minimum separation by means of the tube **19**. When the valve plate is urged against the rubber seating the points of the clamping jaws engage the grooves **20** on the stem of the valve.

The retaining device is released manually by turning the shaft **21**, which is mounted in a stuffing box. On releasing the shaft, the trip member on this shaft is restored to the position shown by spring means.

Fig. 5 shows a construction with an auxiliary flame retardation by means of a circuitous path. The valve plate is secured to a spring diaphragm **22** and a circuitous path with a ball valve **23** and a coil **24** is arranged between the delivery pipe and the valve opening. If, in the rest position, the valve plate lies on its seating and is raised by the gas pressure, then the action of the pressure wave preceding the flame assists the spring action of the diaphragm and rapidly closes the valve. The ball valve **23**, which could be replaced by a spring loaded plate valve, prevents the pressure wave from being dissipated.

Instead of the coil **24** (Fig. 5) extending the path of the flame, the arrangement according to Figure 6 incorporates a cartridge **25** filled with a permeable medium which at the same time reduces the dissipation of pressure and retards the flame. Both effects are assisted by the provision of the flow-obstructing device **26**, at which the direction of flow is changed. Such an obstruction to flow can be provided in the embodiment according to Figure 5 in place of the valve **23**.

Instead of the bellows-like diaphragms shown in Figures 5 to 6, flat diaphragms could be employed.

The valve **9** does not prevent the penetration of oxygen in all cases which arise, because with approximate equality of the pressure in the oxygen and in the working gas, the valve assumes a condition of unstable equilibrium in which there is a chattering of the valve plate so that oxygen can penetrate back into the supply pipe.

In order to prevent the penetration of oxygen even when the valve is in a state of unstable equilibrium, a non-return valve loaded by its own weight or by some other force must be incorporated. If the supply pressure p_1 is not sufficient to lift such a loaded valve or if the considerable pressure drop which arises on opening the valve is an impedance, then the necessary lifting force is preferably supplied by a diaphragm. Such an arrangement is shown in Figure 4.

If oxygen passes in the direction of the broken line arrow into the conduit **15**, then the diaphragm **10** is lowered and the diaphragm valve is closed when a pressure p_2 is reached above the diaphragm. Due to the loading by the weight **27** the pressure p_2 is appreciably below the pressure p_1. Even if the diaphragm chatters when in a condition of unstable equilibrium, the passage of oxygen into the supply chamber is not possible because the low pressure oxygen cannot penetrate into the supply chamber which is subjected to a higher pressure.

The diaphragm cannot be damaged because the flame and also the pressure of the explosion is trapped by the valve **9**.

This safety device satisfies all requirements provided that the diaphragm **10** is gas-tight and the diaphragm valve seating also gives a reliable closure. If, on the other hand, the diaphragm leaks, for example due to ageing of the material constituting the diaphragm, or if foreign bodies become deposited between the diaphragm and the diaphragm seating, then when oxygen passes back in the conduit **12** there will be a further passage of oxygen into the supply chamber as soon as the pressure of the oxygen is higher than the supply pressure p_1 in **28**. This condition will not be apparent to the attendant.

To avoid this dangerous condition, which can be eliminated only in part (namely in respect of ageing only) by using a metal bellows instead of a diaphragm **10**, the non-return valve **29** leading to the surrounding atmosphere and shown in dotted lines in Figure 4 can be incorporated, the spring being so adjusted that the valve opens at at a pressure p_3 which is slightly above the pressure p_2 and considerably below the pressure p_1. In this way the pressure of the oxygen can never reach the magnitude of the supply pressure and thus even in the case of leaks no oxygen can pass to the supply chamber.

The operation of the device presupposes a constant pressure p_1. Where such a constant pressure is not present a valve must be employed the opening of which is not determined by the pressure p_3 but by the difference in the pressures p_1 and p_2.

An example is shown in the valve represented in Figure 7 which is controlled by pressure difference. The chamber 31 beneath the diaphragm 32 is connected by way of the pipe 30 with the chamber beneath the diaphragm 10 and the chamber above the diaphragm 32 is connected by the pipe 33 with the chamber above the diaphragm 10. The diaphragm 32 is loaded by the weight 34 which is provided at its base with a number of grooves 35. The weight is so chosen that there is a condition of equilibrium at the diaphragm when the pressure p_3 above the diaphragm is somewhat greater than p_2 and is substantially less than p_1. Consequently any oxygen travelling back in the conduit escapes into the surrounding atmosphere through the opening 36 when the pressure p_3 is exceeded.

If in special cases and in contradistinction to the assumption hitherto made, the operating gas is at a pressure sufficient for opening a simple non-return valve subjected to a considerable load and if the resultant pressure loss is tolerated, then the diaphragm valve 10 shown in Figs. 4 and 7 can be replaced by a simple plate valve or by means of a teat valve 37 according to Fig. 8.

In order to prevent the passage of oxygen even with leaks in such a valve, according to the invention the non-return valve 29 which leads to the surrounding atmosphere and is indicated in dotted lines is incorporated, or if the supply pressure varies, a valve according to Fig. 7 which is controlled by means of the pressure difference is provided and the connections therefor are indicated at 30 and 33 in Fig. 8.

The arrangement of a non-return valve leading to the outer atmosphere is certainly known but in this known arrangement the oxygen creates an excess pressure in the space between the tap at the point of consumption and the inlet valve corresponding to the valve 8, with the result that this valve 8 is closed and the non-return valve leading to the surrounding atmosphere is opened. This excess pressure must be greater than the working pressure opening the inlet valve and thus the passage of the oxygen is not prevented during the condition of unstable equilibrium at the inlet valve.

In the embodiments according to Figs. 9 to 12, the passage of oxygen is not prevented by a separate mechanical device but by providing a liquid seal at the valve which prevents striking back. The device for holding the valve in the closed position then becomes superfluous. The equivalent water column of the liquid seal need only be small as the water or other liquid is to serve substantially only as a seal preventing the passage of oxygen. The pressure loss and the amount of water carried along by the gas stream are therefore very small in comparison with the usual water-traps.

In the embodiment according to Fig. 9 the liquid stands at the same level in the gas supply tube 39, in the extension of the tube 40 leading to the point of consumption and in the gas space 41 during the rest condition. On opening the closure device or tap at the point of consumption the gas flowing into the supply pipe 39 urges the liquid beneath the rising valve plate 42 into the space beneath the apertured distributor 43 and the gas then flows through the liquid seal and beneath the raised ball 44 into the tube 40. If the flame strikes back the ball 44, which can be replaced by a device impeding the flow according to Fig. 6, prevents the leading pressure wave from passing into the space 41 so that the full pressure acts on the water above the valve plate 42 or on this plate itself and forces it against its seating. A valve holding device is not necessary because if there should be any rebound, only water free from gas would penetrate into the supply pipe. When the device is acting to prevent rearward passage of oxygen, the valve plate 42 prevents the water content from running into the supply pipe.

Fig. 10 shows a construction similar to that of Fig. 9 but provided with the bellows 45 and the circuitous path 46. If with the safety device according to Fig. 9 a circuitous path were provided, there would be the danger that if the valve plate did not fit completely tightly against the delivery pipe 40 the water would be displaced into the delivery pipe 40 from the space 41 due to the increased pressure in this space due to the resistance to flow through the coil constituting the circuitous path. The flame could then pass directly from the conduit 40 through the gas bubbles rising in the water above the plate 42 and into the conduit 39. This danger is avoided by the incorporation by the bellows 45 which permanently closes the lower end of the delivery pipe 40.

In the embodiment according to Fig. 11 the spring diaphragm 47 carries a plate 48, the peripheral edge of which extends round the valve plate 49. During normal operation this valve plate is raised by the gas stream until it is arrested by the pin 50, so that there is a water cushion between the plate 48 and the valve plate 49. If striking back ocurs, the disc 49 is depressed and simultaneously surrounded by an annular jet of water so that it is impossible even during the downward movement of the valve plate for a flame which has already passed through the water seal to penetrate to the supply conduit 51. To prevent gas from entering the plate 48 while gas is flowing through the valve, the lower edges of the valve plate and of the plate 48 are cut off obliquely. For the sake of security a hole may be provided at the top of the plate 48 so that any individual gas bubbles which enter in spite of the oblique edges can escape from the plate 48.

In the constructions according to Figs. 9 to 11 there exists the possibility of liquid being carried along by the gas as the gas bubbles through, although due to the small depth of liquid the amount which is carried along is not considerable.

Fig. 12 shows a construction in which the prevention of the passage of oxygen is also effected by a sealing liquid but the possibility of liquid being carried along by the gas stream during the normal operation is eliminated. The arrangement and mode of operation is similar to that of Figs. 9 and 10 but the space which in Fig. 9 is indicated by 41 is divided by a partition 52 into two chambers 53 and 54 which communicate with one another above and below the partition. When gas is passing through, the liquid is displaced into the chamber 53 so that the condition shown in Fig. 12 is obtained. The gas thus flows in the dry condition through the safety device to the point of consumption. The difference in level of the liquid in the chambers 53 and 54 corresponds to the resistance to flow on the path of the gas through the chamber 54. To prevent the liquid from overflowing at the top of the chamber 53 even with the maximum passage of gas, a ball 55 floating on the surface of the liquid is provided in the chamber 53. It closes the upper outlet of the chamber at the maximum liquid level. When an explosion occurs the valve plate 56 which is secured to a spring diaphragm is closed, and in the meantime water flows from the chamber 53 up to the level of the valve plate so that the flame cannot penetrate to the conduit 57. The displacement of water into the conduit 57 due to the penetration of oxygen is prevented by means of the ball float 58. In place of this ball, a valve plate according to Fig. 10 can be provided or circuitous path with coils or devices impeding the flow in accordance with Figs. 5 and 6 could be incorporated.

Figs. 13 to 24 show examples of safety devices in which the propagation of the flame is prevented by a liquid column which extends into the supply pipe and the passage of oxygen is prevented by a liquid trap.

In the examples according to Figs. 13 to 20 the passage of the gas through the liquid during normal operation is avoided. The disadvantages of the gas passing through the liquid have previously been mentioned. These safety devices are constructed as closed pipes having two communicating limbs and in one limb the gas supply pipe is connected at a point immediately below the water level in the rest condition, and the conduit leading to the point of consumption extends into the other limb at the top. If necessary, further arrangements could be provided in the path of flow of the gas within the device in order to retard the equalisation of pressure and the propagation of the flame. Such arrangements may comprise a coil, wire gauze, porous bodies, valves or the like.

In Figs. 13 to 15, the safety device according to the invention is constructed fundamentally as a closed tube 60, in one limb 61 of which the gas supply pipe 62 terminates immediately below the water level 63, and the pipe 65 leading to the point of consumption projects from the top into the other limb 64.

In the rest position the gas supply pipe 62 is closed by the water content of the safety device. In normal operation the gas flows through the supply pipe 62 and depresses the water level in the limb 61 of the tube 60. The water level in the limb 64 of the tube 60 rises correspondingly, without however reaching the opening of the pipe 65. The gas thus flows from the pipe 62 in the direction of the arrow (Fig. 14) to the pipe 65 and through the latter to the point of consumption. If the flame should strike back, then as shown in Fig. 15, the pressure preceding the flame operates directly on the raised water surface in the limb 64 of the tube 60 and depresses it, as due to the projection of the pipe 65 into the limb 64, the spreading of the pressure to the conduit 62 is retarded. The water level in the limb 61 of the tube 60 is therefore raised and thus the gas supply pipe 62 is closed. The flame which then arrives can consequently not pass to the gas supply pipe 62. Inside the safety device, devices of the kind already mentioned may be provided in the path of flow of the gas as shown in Fig. 16 for further retarding the spread of the pressure to the water in the limb 61 or for retarding the propagation of the flame along the same path. The device may for example be constituted by a coil 66, as indicated in Fig. 16.

In the embodiment according to Fig. 17 the gas supply conduit 62 enters the closed jacket 71 below the water level in the rest condition. Provided in the jacket 71 is a tube 72 which is open top and bottom and into which the conduit 65 which leads to the point of consumption projects from the top.

In the embodiment according to Fig. 18 the tube 74 which is open at the bottom is surrounded by the jacket 73 only up to about the level of the gas inlet and the jacket 73 is connected with the upper end of the tube 74 by means of a pipe 75, if desired, with a device for impeding the flow or with other retarding devices, e. g. a coil 76. The conduit 65 leading to the point of consumption extends into the upper end of the tube 74.

Fig. 19 shows another embodiment of the gas supply conduit 62. To ensure with complete certainty that the gas supply pipe 62 is closed by the water column which is urged suddenly in the limb 61 of the device when the flame strikes back, a deflector device 80 may be provided in the safety device in association with the gas supply pipe 62 in the form of a projection, a downwardly sloping deflecting plate or the like. This deflector ensures that a part of the water column which is suddenly urged upwardly is deflected into the gas supply conduit 62 and closes it.

To prevent the gas supply conduit 62 being opened by the falling water column in the limb 61 before the flame is extinguished, the supply conduit 62 can be in the form of a water trap 81 in front of its entry into the safety device and the water seal formed by the initial upward movement of the water in the safety device remains in this trap 81 until the gas stream again flows through the safety device to the point of consumption.

To prevent excessive displacement of water into the conduit 62 if striking back occurs, irrespective of whether a water-trap 81 is provided in the conduit 62 or not, a valve opening only in the direction of normal flow, e. g. a floating rubber ball 77 is provided in the conduit 62. The valve seating 78 is arranged above the rubber ball 77 and arranged below it is a retaining device, e. g. a grid 79, which prevents the rubber ball from being urged into the safety device during the normal operation. This rubber ball also serves to prevent water from flowing into the supply pipe if oxygen is passing back through the device.

If the tap at the point of consumption is suddenly opened or if the gas consumption is uniform but unusually large, there is the danger that the water in the limb adjacent the delivery pipe will rise to the level of the delivery pipe and will be carried along by the gas. To prevent this a ball 82 floating on the surface of the water is provided, which when the water level rises encounters the seating 83 and prevents the water level from rising further. At the same time this ensures that the water level on the gas inlet side always remains immediately below the inlet so that if there is striking back, the water has only to be raised a little in order to close the supply pipe quickly. Water escaping past the rubber valve flows through a small aperture 84 back into the inlet limb.

To avoid defective operation due to leaks at the rubber ball valve, this valve can be replaced by a metal bellows which during normal operation dilates under the action of the water which is forced into it and contracts when there is striking back so that the water is forced out of the delivery limb into the inlet limb.

Fig. 20 shows a safety device of the same nature as Figs. 13 to 15 but with the gas supply pipe introduced through the top and with an auxiliary float device which permits gas to be drawn off at the point of consumption only when there is sufficient water in the safety device.

The gas supply pipe 82 is provided at its lower end with a valve seating opposite a valve seating between the limb 61 and the tube 60. In the normal operation the gas depresses the ball float 67 and passes through the limb 61, the opened valve 88 and the opened valve 69 to the delivery pipe 65. Valve 68 is loaded by a light spring and is intended to prevent the pressure wave from passing directly into the limb 61. The valve 69 is also closed in the rest position. It is opened by a float 70 provided in the limb 64 when the float is raised by the water rising in this limb during the normal operation. If striking back occurs the water and the float in the limb 64 are depressed and the ball 67 is urged against the upper valve seating by a jet of water. Any gas penetrating through leaks at the ball valve passes only in individual bubbles through the limb 64 in the upward direction so that the flame cannot strike back through the limb 64. If necessary a distributor 94 provided with a number of apertures can be provided.

In the examples according to Figs. 21 to 24, in order to increase the reliability, the passage of the gas through water is retained as in existing water traps but the depth of water can be made less than in the known arrangements because only an additional safeguarding is sought. Consequently the loss of pressure and the amount of water carried along by the gas stream are maintained very small.

In the embodiments according to Figs. 21 and 22 a funnel-shaped member 86 is arranged above the water space 85 corresponding to one limb of the communicating tube. This funnel, together with the corresponding cover of the device, forms the inner continuation of the delivery pipe 65 down to the water level in the annular space which is filled with water free from gas. It is important that the cross section is kept as small as possible in order to avoid a reduction in the magnitude of the pressure wave.

In the embodiment according to Fig. 21 the gas supply pipe 62 which is attached to the bottom of the container is provided with gas outlet openings 87 at its lower end. Arranged above these openings is an obstruction 66 which prevents excessive passage of water into the conduit 62. Further, the supply pipe 62 carries a distributor plate 69 below the level of the water in the rest condition. This distributor extends up to the partition 90. The base member 91 is attached to the bottom of the partition 90.

In the embodiment according to Fig. 22 the supply conduit 62 is constructed inside the apparatus to constitute a gas distributor 92 above which an obstruction 68 is provided in the conduit 62. The supply pipe 62 is open at the bottom and the partition 90 is connected thereto by means of the base member 91 so as to prevent upward displacement of the water which is subjected to pressure and is not traversed by gas. Communication is afforded by a few openings 93 in the partition 90.

Whereas in the examples of Figs. 21 to 22, the pressure wave is caused to operate on an external annular surface, in the examples of Figs. 23 and 24 it is applied to water in a separate receptacle. The water receptacle is provided with a container which is filled with water free from gas and has only a small gas space and communicates with the water container by means of a small aperture in the water space. The conduit leading to the point of consumption extends into the container at right-angles to the water surface. The water for forming the liquid seal is derived from this container. The container is in communication with the gas space of the safety device only by way of a small opening, e. g. an annular slot.

In the embodiment according to Fig. 23, the gas passes out of the supply pipe 62 at 95 into the water and if desired through a distributor 97 into the gas space. From there it passes through the pipe 65 to the point of consumption. A pipe 99 branches from the gas supply pipe 62 at 98 and projects farther into the water than the gas supply pipe. The pipe 89 is surrounded by a separate vessel 100. The water in this vessel is in communication with the water in the main container, for example by way of a small hole, 101 in the dividing wall. When striking back occurs, the pressure which is applied through the pipe 65 operates in the first place on the water in the vessel 100. This water is not permeated by gas bubbles and thus is not compressible Consequently water is forced immediately through the pipe 89 to the point 88 so that a water seal is formed there. At the top the container 100 has a small opening in the form of an annular gap. Here the pressure wave preceding the flame is propagated at a reduced rate into the gas space ond then forces the gas impregnated water through the opening 85 into the tube 62 up to the point 99. Here in the meantime the seal with water free from gas has been produced so that the flame cannot travel further. The reduced spread of the pressure occasioned by the annular gap can also be obtained by incorporating a one-way valve.

A retardation of the penetration of the gas laden water to 98 can be obtained by increasing the length of the gas supply pipe between 98 and 95, e. g. by incorporating a coil.

In the embodiment according to Fig. 24, distributor arms 102 into which the gas flows at 103 are attached to the gas supply pipe 62. The upper sides of these distributor arms are provided with apertures through which the gas emerges into the water. Below 103 the gas supply pipe has a tubular extension 104 which is open at the bottom. The pressure wave urges water free from gas from the container 105 through the tubular extension 104 and past the openings 103 up to the obstructing device 106 so that a water seal is obtained at 107.

Here also the penetration of gas-laden water to the point 107 can be retarded by lengthening the path from 167 to 103 or from 103 to the gas cutlet apertures, e. g. by incorporating a coil.

Whereas in all the examples of Figs 13 to 24 a communicating liquid seal is utilised, the construction according to Fig. 25 shows a single liquid seal.

The compressible vessel 121 which is filled with liquid and which can consist of a resilient diaphragm 122 with an end plate 108, or a rubber ball or a cylinder and piston or the like, is compressed by the pressure wave travelling through the conduit 65 from the point of consumption in advance of the flame when striking back occurs. The conduit 110 is closed by the valve 111 so that the entire pressure is utilised for compressing the vessel 121. Due to the pressure, the balls 112 and 113 are urged against their seats 114 and 115 and the liquid fills the space between these two seats. The flame subsequently arriving through the conduit 110 can thus no longer pass into the conduit 62. When the pressure is released the spring diaphragm expands again and draws in the sealing liquid again so that the safety device is again ready for operation because the balls 112 and 113 also revert to the rest position. The ball 111 is a light ball which is raised and held up by the working pressure applied through the conduit 62.

Fig. 26 shows a modification of the construction according to Fig. 25, by which the penetration of oxygen is prevented. The mode of operation of the floating ball 67 is the same as in the embodiment according to Fig. 20. In the rest condition the ball bears against the upper seating. It is depressed by the flowing gas and the water passes into the bellows 122 which expands accordingly. This expansion of the bellows is occasioned by the difference between the pressure operating at the upper opening 125 and the reduced pressure at the lower surface of the bellows due to the ejector 109. A nozzle can be incorporated in the opening 125 in order to produce a jet of water extinguishing the flame immediately striking back occurs.

In order to prevent the ball from being thrown upwardly when striking back occurs and also to prevent loss of water if the tap at the point of consumption is opened suddenly, deflector plates 115 are provided which at the same time constitute an arrangement impeding flow.

Instead of employing a liquid, the container 121 could be filled with a gas which either has a flame extinguishing action or, if it is itself inflammable, produces a non-inflammable mixture with the mixture already present in the conduit.

Finally it is possible, as shown in Fig. 27, to provide a separate cylinder 116 filled with compressed gas, the closure member 117 of which is opened by the pressure wave by means of lever 120 through the intermediary of a cylinder 118 and piston 119 for example.

In the arrangements according to Figs. 25 and 27 a device for preventing the passage of oxygen should be incorporated between the device shown for preventing striking back and the source of supply. This further safety device may be in accordance with Fig. 4 or can be constructed in accordance with the principles of Figs. 13 to 20.

Moreover the devices according to Figs. 13 to 20 could be used separately for preventing the penetration of oxygen in conjunction with any desired devices for preventing striking back.

In the liquid filled safety devices as described in which the gas does not flow through the liquid during the normal operation, it is advantageous to utilise in place of water a liquid which is not volatile or which evaporates only with difficulty, e. g. glycerine. In view of the small dimensions the question of cost is of little importance in comparison with the reduced attention which is required.

The invention can be applied for all purposes in which there is the risk of an explosion, e. g. in autogenous welding, cutting and hardening plant, gas firing equipment plant producing lighting gas, oil and gas machines and so on.

A modification of the construction of Fig. 4 is shown in Fig. 28.

The working gas entering the space 132 through the gas supply pipe 131 lifts the valve plate 134 from the seating 136. The valve plate 134 is loaded by the weight 139 and constitutes the bottom of the bellows 133. The gas can thus gass through the opening 135 in the disc 134 into the space 137 and through the conduit 138 to the point of consumption.

When oxygen passes back the disc 134 closes. When striking back occurs the valve plate 134 is urged downwardly very rapidly because the weight 139, the tension in the bellows and the pressure wave operate in the same sense. The valve thus not only prevents the passage of oxygen but also prevents striking back.

To protect the bellows against the high pressure arising when striking back occurs, a nonreturn valve 140 can be incorporated in the conduit 138. This valve may be connected rigidly or loosely with the plate 134 or it may be an independent valve. The valve 134 or the valve 140, or both may be provided with an arresting device.

Instead of employing a bellows, use can be made of an apertured flat diaphragm which may be subjected to preliminary tension.

The connection with the diaphragm valve controlled by the pressure difference can be effected through the conduits 33 and 39.

Fig. 29 shows a construction similar to that illustrated in Fig. 28 in which a special spring is used instead of the rubber which may be burnt. The perforated valve-cone 141 is fixed to a heavy spring plate 142, loaded by a weight 139, at the edge of which plate a toothed rim 143 is provided. During normal operation the spring plate 142 is not bent but on admission of gas by way of the supply pipe 131 the spring 133 is stretched only and the gas passes, by way of the opening in the valve-cone 141, into the discharge pipe 138. If oxygen flows back in the direction indicated by the arrow shown in dotted lines, the valve 141 is closed. If striking back occurs, however, the plate 142 is bent to such an extent that the tooth 144 of the holding device engages in the teeth of the toothed rim 143.

According to Fig. 30 a heavy spring is arranged between the plate 143 fixed to the valve rod 156 and the valve-cone 151 which spring firmly presses the pin 154, fixed in the valve-cone 151, against the lower surface of the slot 155 provided in the rod 156. During normal operation the valve-cone 151 and the bellows 152 form a unit. If striking back occurs, however, the spring 153 is compressed so that the tooth 144 of the holding device engages the teeth of the toothed rim 143. The transfer of the leading pressure into the coil 24 may be prevented by a valve 23. If necessary, this coil 24 may specially be formed as a retarding coil. Instead of the bellows 152 a flat disc diaphragm may be used which is protected by a refractory substance against the flame.

Due to the arrangement of the holding device, the constructions shown in Figs. 29 and 30 in no way prevent the free play of the valve during the normal operation.

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