July 13, 1937. A. STEPHENSON 2,087,170

DEVICE FOR THE PREVENTION OF BACKFIRES IN GAS APPARATUS

Filed Aug. 15, 1931 4 Sheets-Sheet 1

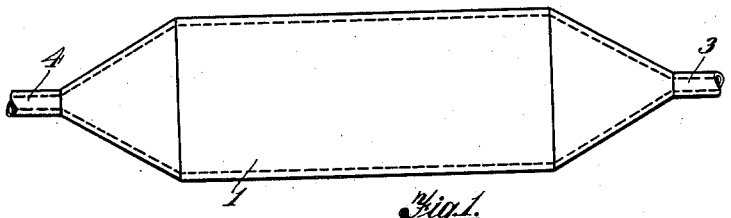


Fig. 1.

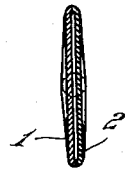


Fig. 3.

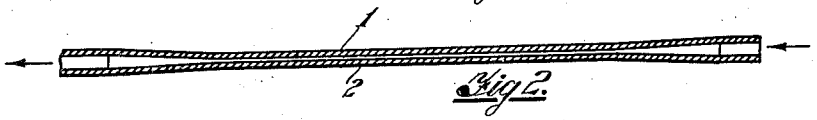


Fig. 2.



Fig. 4.



Fig. 5.

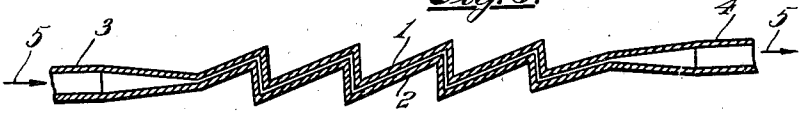


Fig. 6.



Fig. 7.

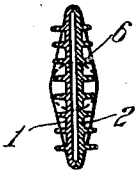


Fig. 8.

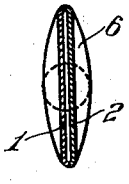


Fig. 9.

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DEVICE FOR THE PREVENTION OF BACKFIRES IN GAS APPARATUS

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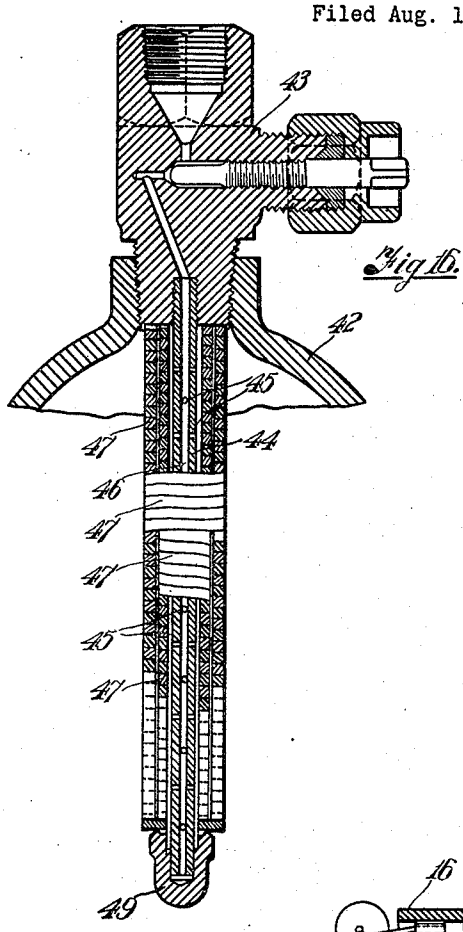


Fig 16.

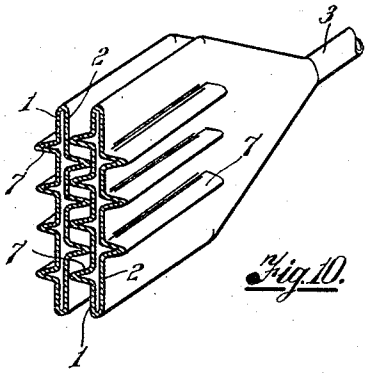


Fig 10.

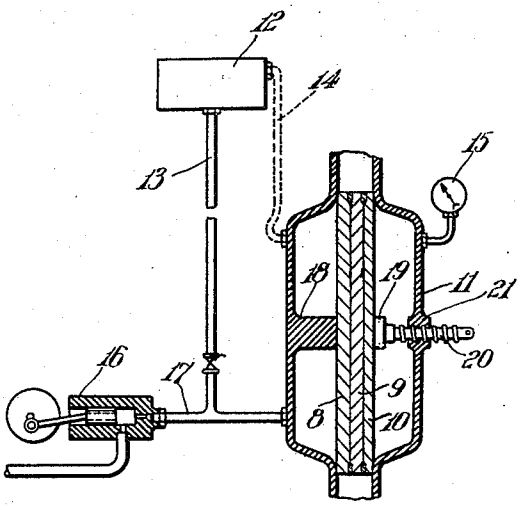


Fig 11.

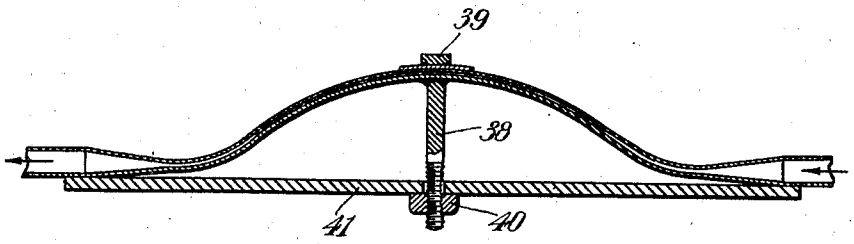


Fig 15.

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DEVICE FOR THE PREVENTION OF BACKFIRES IN GAS APPARATUS

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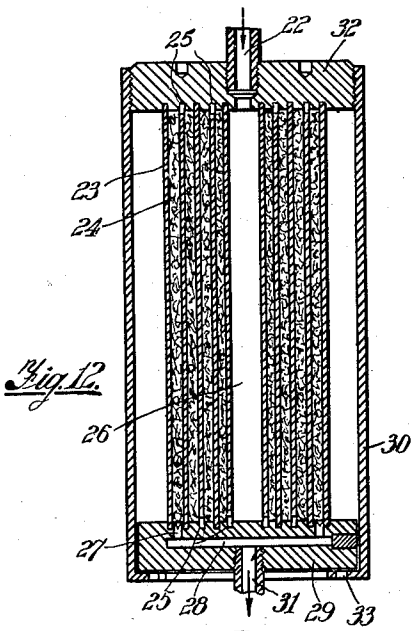


Fig. 12.

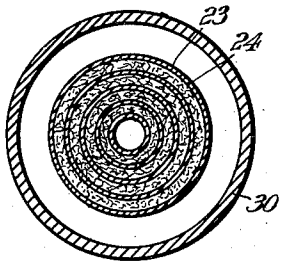


Fig. 13.

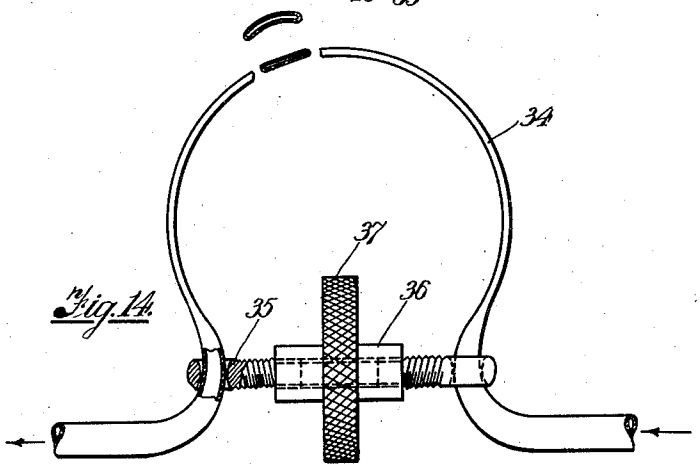


Fig. 14.

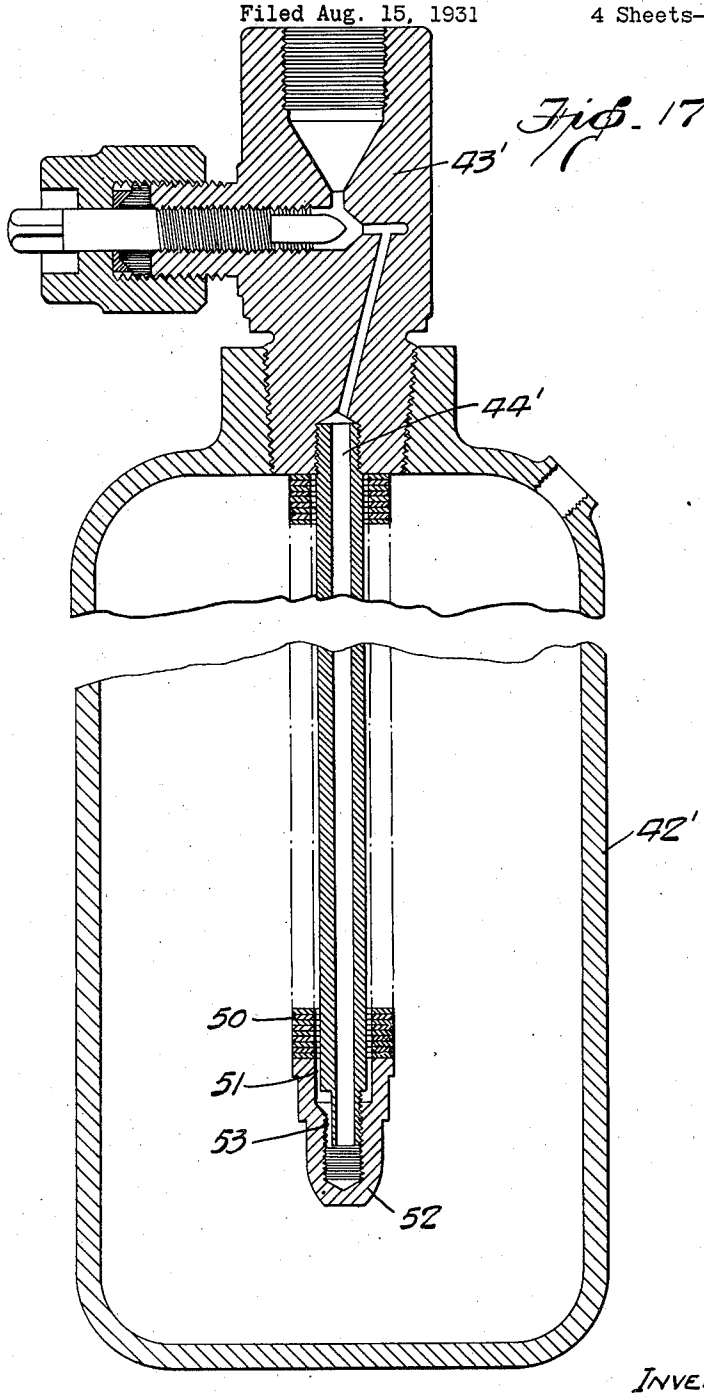
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DEVICE FOR THE PREVENTION OF BACKFIRES IN GAS APPARATUS

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Fig. 17.



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DEVICE FOR THE PREVENTION OF BACK-FIRES IN GAS APPARATUS

Arthur Stephenson, Westminster, England

Application August 15, 1931, Serial No. 557,397
In Great Britain September 12, 1930

3 Claims. (Cl. 48—192)

This invention relates to devices for retarding and/or arresting the propagation of flame or caloric waves in gas apparatus, and though not limited to any gas or mixture of gases has more particular reference to apparatus for the production, compression, storage supply and use of acetylene or mixtures containing acetylene.

Acetylene or mixtures containing acetylene especially when under a state of supernormal pressure, are very susceptible to the propagation of flame or caloric waves resulting from shock, explosive detonation, chemical dissociation, combustion or backfiring from the point or points of application. Therefore apparatus used in connection with acetylene or mixtures containing acetylene can be regarded as representative of the more severe conditions of use of such retarding and arresting devices.

The dangers which attend the propagation of flame or caloric waves in such apparatus especially when used for compressing or storage and for applying the processes of welding, heating, metal cutting and chemical manufacture, are well-known, and various forms of arresting devices have been proposed and employed for countering these dangers.

These known devices can be divided into two comparative classes (1) those which aim at ensuring a uni-directional flow under normal conditions and which are intended to provide a means for complete arrest of the gas flow in the event of flame or caloric waves being propagated on the delivery side of the device, and (2) those which aim at impeding the propagation of flame or caloric waves in either direction, but especially against the normal direction of flow by retarding them for the necessary interval of time to permit of cooling them to the point of extinction.

Devices of the first class have taken the form of mechanical or hydraulic non-return valves or combinations of these arranged in the supply conduit between the source or bulk storage and the point or points of application.

Devices of the second class have taken the form of dry gas traps or chambers which although substantially filled with solid materials have provided a subdivided tortuous gas passage through pores or interstitial spaces formed in the filling, or a plurality of separate but restricted gas passages in the direction of gas flow. These have also been disposed in the supply conduit between the source or bulk storage and the point or points of application or between the compressing unit and the storage vessel.

A known example of a device in the second class comprises a nest of closely fitting concentric tubes which have slots or grooves formed in their inner surfaces so as to provide a plurality of separate straight but less restrictive gas passages through a comparatively large cooling mass.

A further example of devices of the second class as applied directly to checking backfires in blowpipe apparatus, comprises a partition made up of a number of blocks or elements of annular form in which the adjacent faces intended to provide the restrictive passages and the cooling surfaces are permanently separated by spacing pieces of comparatively small area either formed on the blocks or elements themselves, or are inserted between them to maintain a definite spacing between the surfaces for providing adequate free passage of gas.

The object of the present invention is to remedy the defective features in these flame retarding and arresting devices in order to render them effective for both the high and the low ranges of pressure, by increasing the degree of impedance and the factor of cooling, so that the flame or caloric waves, even at a state of high pressure can be brought to the quenching point and extinguished with certainty, and without subjecting the system to the degree of shock sufficient to give rise to the propagation of secondary or sympathetic flame or caloric waves which are likely to occur when acetylene or mixtures containing acetylene are produced, compressed, stored, applied and used, especially at higher pressures.

According to the present invention means are provided for retarding and arresting the propagation of flame or caloric waves which comprise one or more gas passages formed by closely fitting surfaces in substantially uniform contact or slightly spaced so that they are permeable to gas but impenetrable to flame or caloric waves owing to the large factor of superficial cooling, condensation and flame suppression provided in proportion to the thinness of the gas flow.

Reference will now be made to the accompanying drawings which illustrate by way of example constructions according to the invention and in which:—

Fig. 1 is a plan of the simplest form of construction.

Fig. 2 is a longitudinal section of the device shown in Fig. 1.

Fig. 3 is a cross section of Fig. 1.

Figs. 4, 5, and 6 are longitudinal sectional

views of modifications of the device shown in Fig. 1.

Fig. 7 is a plan of another modification of Fig. 1 provided with radiating fins.

Fig. 8 is a cross sectional view of Fig. 7.

Fig. 9 is a cross sectional view of a modification of Fig. 7.

Fig. 10 is perspective view of a modification adapted to the requirement of more than one passage,

Fig. 11 is a diagram showing an arrangement provided with means for maintaining and indicating pressure on the outside of the gas passage,

Fig. 12 is a sectional elevation of a multiple concentric arrangement,

Fig. 13 is a sectional plan of Fig. 12.

Figs. 14 and 15 show two forms of an arrangement wherein the ends of the co-operating elements are moved to vary the pressure.

Fig. 16 is a sectional elevation showing the application of the invention to a compressed gas cylinder.

Fig. 17 is a sectional elevation showing another application of the invention to a compressed gas cylinder.

Figs. 1 to 3 illustrate the simplest form of the invention in which two flat rectangular plates 1 and 2 are placed in substantially uniform and coincident surface contact with each other and are held together in a gas tight manner at their edges so that the supply of gas can permeate in a thin layer between the closely fitting surfaces which provide maximum width and surface area but minimum thickness of gas stream. These plates are tapered at their ends as shown in plan in Fig. 1 and at these places are flared slightly outwardly as shown in Fig. 2 in order to connect them with conduits 3 and 4 one of which communicates with a source of supply, compression or storage and the other with the delivery side of the system or point or points of application. In this, as in succeeding examples, a clear spacing is shown between the elements but it is to be understood that in practice the plates or the like would be in actual contact. In the form illustrated in Figs. 1–3 the direction of flow of gas is optional, the device working equally well in either direction.

Developments of the arrangement of Figs. 1–3 are shown in Figs. 4, 5, and 6 wherein Figs. 4 and 5 show even corrugations and Fig. 6 a "saw tooth" type of corrugation designed to offer greater resistance to any return flame travelling at high velocity when the normal path of the gas flow is that shown by the arrows 5.

To enable the degree of contact between the plates to be varied by the pressure on the gas supply, the plates may be mounted in a closed chamber one end of the pair of plates being fixed in one end of said chamber adjacent and in communication with an opening serving as inlet or outlet, Figures 12 and 13, the gas passing out or entering the plates at the end remote from this opening and leaving or entering the chamber through another opening disposed at the end adjacent the first mentioned opening. With this arrangement superior pressure in the chamber due to backfire tends to press the plates together, interrupts the flow of incoming gas and offers more resistance to return flame or heat passing towards the source of gas supply. If operating in the reverse direction the pressure at the source of supply would tend to press the plates into contact during ordinary working and any return flame or pressure wave would open the space between the contacting surfaces the cooling effect of which, however, would be sufficient to prevent the flame or pressure wave from travelling further.

In cases where several outlets are required for a number of separate services the inlet may be at the centre of one of a pair of plates of the kind shown in Fig. 1 but the ends instead of being tapered as shown in that figure are formed with conduits from the ends of which four deliveries can be taken. This arrangement may be modified by providing a central outlet in the second plate and by providing an intermediate plate around the edges of which the gas has to pass to increase the gas passage for given external dimensions. In this construction with central inlet and outlet the plates may be of rectangular, circular or other form and the contacting surfaces plain or corrugated.

The heat absorption capacity, and therefore, the cooling influence of the plate surfaces, may be conveniently augmented by providing the outer surface which is not in contact with the gas flow, with radiating projections, this form of construction being shown in Figs. 7 and 8 wherein the plates 1 and 2 are formed with radiating fins 6 which not only increase the cooling surface but reinforce the plates to prevent any tendency to inflation. Where necessary the fins 6 may be formed in the opposite direction to that shown in Figs. 7 and 8 and as indicated in Fig. 9. The heat absorption capacity may also be augmented by immersing the device in a cooling agent such as water or similar heat absorbing liquid, in which may also be dissolved chemicals such as sodium acetate for increasing the heat absorbing capacity of the liquid.

Fig. 10 shows a further modification of the device illustrated in Figs. 7 and 8 in which stiffening and radiating fins 7 are produced out of the material formed by the contacting elements 1 and 2. This figure also shows how the elements can be assembled where the number of passages has to be increased to more than that which can be provided by two plates.

Fig. 11 also shows a multiple arrangement in which contacting plates 8, 9, and 10 are disposed within a retaining jacket 11 to enable a cooling agent therein to be kept in flow or circulation, the jacket being sealed at its points of contact with the plates so that the contained fluid may be kept under pressure, in order to maintain and regulate the pressure of contact between the adjacent closely fitting surfaces of the plates 8, 9, and 10 which form the permeation spaces for the gas. The cooling liquid is circulated through the space within the jacket 11 from the tank 12 through pipes 13 and 14 and an indicating gauge 15 is provided to enable the pressure within the jacket 11 to be observed at any time. If in any case the pressure is intended to be variable, that is to say, if the supply of gas passing through the elements 8, 9, and 10 is of a pulsating nature the pump 16 connected by a branch pipe 17 with the pipe 13, can be used to produce this effect. Alternatively, the pump may be used to lift the cooling liquid to the required head in the tank 12 and suitable valves are disposed in the pipes 13 and 17 to enable the pump to be used for either purpose.

As a further means to prevent inflation and at the same time provide for the variation of the pressure of the contacting surfaces through which the gas has to pass one wall of the jacket

11 may be provided with an inwardly projecting member 18 which co-operates with a head 19 formed at the inner end of a screw threaded spindle 20 which passes through a screw threaded socket 21 in the opposite wall of the jacket 11 and is provided with means for manual operation. By partial rotation of this spindle 20 the pressure on the plates 8 and 10 may be increased or relaxed as required and this arrangement may if desired be employed independently of the cooling liquid circulation system shown in Fig. 11.

In cases where it is desirable to increase the length of the passage or passages through which gas may permeate without unduly increasing the external dimensions of the apparatus, the contacting plates may be made in the form of cups, bells or truncated cones capable of being assembled one inside another and if necessary of enclosing a space for water or other cooling liquid under pressure. Alternatively the same result may be achieved by mounting the elements concentrically and Fig. 12 shows an arrangement of this character. This construction is of the sequent type, in which the gas is normally admitted through an inlet 22 and passes through a series of passages formed between closely fitting tubes 23 and 24 of dissimilar material arranged so that the alternate ends provide gas passages 25 by which the gas passes from one pair of tubes to the next adjacent pair. The tubes may be formed all of similar material, that is to say, they may be constituted by a series of concentric metal tubes or they may be formed as shown so that the passage of gas is between dissimilar materials, the tubes 23 being of metal alternating with tubes 24 of asbestos cement and asbestos cloth. In cases where it is intended to increase the heat absorption capacity of the tubes 24 the materials of which they are composed may be given a dressing with a solution of a material such as sodium acetate. Alternatively, if the material is to serve as a drying medium it can be dressed with a drying agent such as calcium chloride. The layers may be left in the moistened condition but are preferably dried out so as to crystallize the drying agent. Where it is desirable to make the material capable of damping out flame the dressing may be of any well known fire proofing agent such as ammonium sulphate. Any suitable medium other than asbestos can be employed for absorbing the dressing.

The gas flow from the inlet 22 in Fig. 12 is through a central passage 26 from the lower end of which it passes beneath the end of the tube and upwards through the asbestos layer over the upper edge of the next tube 23 and so on until it remains the outermost layer 24. From the base of this layer passages 27 lead the gas to a collecting space 28 formed within the lower closure member 29 of an outer cylinder 30 and from which the gas passes to an outlet 31. The upper and lower edges alternately of the metal tubes 23 are serrated to allow gas to pass over or under these tubes but this does not apply to the outermost tube 23 which is sealed in the upper and lower closure members 29 and 32. The space between the outermost metal tube 23 and the wall of the cylinder 30 may serve as a space for circulation of cooling medium for which inlet and outlet passages 33 are provided at the lower end of the apparatus. In the construction shown the gas flow can pass in the reverse direction to that described. The means for circulating the cooling medium and maintaining it under pressure described with reference to Fig. 11 may also be applied to the apparatus illustrated in Fig. 12 or the chamber 11 may be filled and sealed under any desired pressure.

Figures 14 and 15 show two forms of the invention in which the contacting elements are constituted by the walls of a flattened tube 34 the extremities of which in Fig. 14 are connected by screw eyes 35 and a turnbuckle 36 provided with a milled or knurled hand wheel 37 for manual operation. As the extremities of the tube are forced apart the pressure on the contacting surfaces is decreased and increased as the extremities are drawn together. Two alternative types of tube are indicated in the cross sectional views embodied in this figure.

In Figure 15 the pressure on the two contacting surfaces is varied by means of a bolt 38 the head 39 of which embraces both elements, the adjustment being effected by rotation of a nut 40 which makes contact with a fixed abutment surface 41. In this construction the contacting surfaces may be formed of dissimilar metals and in both constructions of Figs. 14 and 15 the flow of gas may be in either direction.

For the protection of high pressure storage units, such as compressed or dissolved acetylene cylinders, a number of superimposed elements may be provided formed of similar or dissimilar annular discs and/or laminae, plain, cupped or corrugated and maintained in contact with one another on adjacent surfaces by means of springs or tightening screws, and formed into a column of small diameter in relation to length so as to permit of insertion into the cylinder through the usual valve aperture and preferably connected to the valve so that any gas passing into or out of the cylinder during filling and emptying must pass through the closely fitting surfaces of the device, which although permeable to the gas, are impermeable to flame or caloric waves.

Examples of this form of construction are illustrated in Figs. 16 and 17. In Fig. 16 a compressed gas cylinder 42 is provided with the usual screwed in valve housing 43 from the base of which depends a hollow rod or tube 44 provided with gas exit passages 45 extending through it in different directions and all communicating with the central passage 46. Surrounding the rod 44 is disposed a series of helically wound elements 47 of square or other cross section mounted the one within another which may be of a resilient or non-resilient character and are assembled on the tube 44 of the housing 43 from which the rod 44 also, depends. The whole assembly comprising the rod 44 and elements 47 is held in position by means of a nut 49 screw threaded onto the lower end of the rod 44 and which serves to produce the necessary pressure to bring the surfaces of the elements 47 into the degree of contact required to assist in damping out any flame or caloric wave.

According to another form of the invention, for instance that of Fig. 17, an arrangement is shown having a compressed gas cylinder 42' provided with the usual screwed-in valve housing 43' in the base of which a hollow rod or tube 44' is screwed, on which tube a number of circular plates 50 may be assembled inside a chamber providing free space around the assembly for the separation of foreign matter either liquid or solid which may be prevented from passing through the passages between the closely fitting plates. These circular plates may be

held in operative contact by the said rod 44' passing centrally through them and around which an outlet passage 51 is formed. Alternatively and in apparatus of larger size, the plates may be of annular form held together by a number of bolts or rods. In the simplest form the plates consist of flat washers but they may be of conical cup-shaped, or composite forms according to requirements. Said plates or washers 50 are held in place and under the desired contacting pressure by a cap nut 52 screwed on the lower end of tube 44', the gas passing downwardly through the bore of the tube into the interior of the nut 52, and thence upwardly through a passage 53 in the nut in communication with the outlet passage 51.

In another example of carrying the invention into effect the closely fitting surfaces which are maintained substantially in contact are provided between the helices of a spring or springs of spiral form preferably made of material of rectangular section, compressed so as to bring the surfaces together. In a sequent arrangement of this form of construction the device comprises a plurality of compressed spiral springs of different diameters arranged one inside the other or concentrically, and in which the springs are preferably assembled so that the permeable gas passages in the respective springs do not coincide with each other. The contacting surfaces of the spring or springs may be coated or treated in the manner described for the flat elements, or the adjacent surfaces in the helices may be of different materials by disposing a spiral of less rigid material between the helices.

The plates or elements may be of any convenient thinness or thickness consistent with obtaining and maintaining closely fitting surfaces. The plates or elements may be of any suitable material capable of being maintained in contact on the surfaces and withstanding the conditions of use, such for example, as metal or metal alloys, metal gauze, cement, ceramic or magnesia blocks, silica or silicious materials, such as vitreosil, mica, asbestos, or asbestos cloth or paper, glass, or any organic material which may have been rendered fireproof by the addition of well known fireproofing agents, such as alum, ammonium sulphate or phosphate, sodium silicate or tungstate, mica and the like.

For use with acetylene gas, the material of which the plates are composed may be treated with chromic acid and calcium chloride or with ferric oxy-chlorides which can be reactivated by pumping air through them. Alternatively, the plates may be formed of the more rigid material and faced or impregnated with or made to accommodate the more fragile or pliable substances. The plates need not be all of the same materials, and it is unnecessary that the two adjacent faces of any element should be of the same material. The plates may be comprised of, or carry, or be impregnated with materials capable of separating, extracting, combining with, or resisting the passage of impurities admixed with or entrained by the gas or gaseous mixture.

The device may be disposed anywhere in the apparatus or system where protection is desired, either at the point of application i. e. in the blowpipe; in the supply conduit; at the outlet of the gas storage chamber; or in the interior of the gas producing compressing or storage units.

Any method of maintaining the surfaces of the devices above described in contact may be employed, as for example, by riveting, welding, weighting, clamping by screws or wedge pieces, springs or elastic cushions, cambering, fluid pressure, either exerted through the medium of the gas itself or from some extraneous pressure source, or a combination of two or more of these. The means of maintaining the surface contact may be applied either directly to each separate element or to a plurality of elements. As a modification of these examples of maintaining a suitable degree of contact between the adjacent surfaces the elements comprising two or more contacting surfaces may be constructed in the first place with an excessive degree of pressure which is sufficient to normally prevent permeation entirely or to the requisite extent for the supply pressures, in which cases the pressure of contact may be reduced, for example, by flexion, counterweighting, creation of a partial pressure outside the elements or by inclining or rotating the set of superimposed elements out of the vertical so as to reduce the static load.

It is obvious that with suitable prepared surfaces and the application of suitable pressure to hold them in contact, the rate of gas permeation between the surfaces can be reduced or increased at will to suit the susceptibility of the gas or mixture of gases passing to the propagation of flame or caloric waves.

It is also obvious that by a suitable alteration of the applied pressure on the connecting surfaces the rate of gas permeation can be reduced to nil so that the device can be made to serve as a means of retarding and arresting the propagation of flame or caloric waves when gas is passing, and as a stop valve when no gas is required.

The term "flame" as herein employed refers to a condition where the vapour or gas burns in conjunction with a supporter of combustion, such as air or oxygen, and where "backfire" is brought about by the flame traveling backwards through the mixture of the combustible and supporter of combustion against the direction of normal flow.

The term "caloric wave" as herein employed refers to the conditions which accompany dissociation or decomposition of the fuel elements, e. g. acetylene, which can take place quite independently of combustion; in fact, even in the absence of a supporter of combustion a caloric wave can take place whether the gas is in normal flow or stationary.

Heat is evolved in either case, in the one case from combustion and in the other case from dissociation or decomposition, but if the fuel is endothermic, as in the case of acetylene, both conditions can occur. We have found, however, that although a spaced chamber may arrest a flame with ordinary fuels, it requires infinitely small spacing to deal with the caloric wave in an endothermic fuel, or a flame and caloric wave combined, consequently we have adopted the smallest space possible, that is, where the plates or elements are actually in contact and without spacing elements of any description.

I claim:

1. A device for preventing the propagation of flame and caloric waves in a gas apparatus including means providing a passage through which the gas may pass from a source of supply to a point of delivery, said means comprising a helically wound element disposed in said apparatus and having the surfaces of adjacent convolutions in contact between which thin films of gas may

pass and, further, having one end of the interior passage thereof connected about an outlet of said device and the other end of said passage being closed, and a perforate conduit connected with the outlet of said device and extending into said passage from one end of said helical element.

2. A device for preventing the propagation of flame and caloric waves in a gas apparatus including a metallic layer and an impermeable non-metallic layer providing a passage having continuous opposing surfaces in contact and between which gas may pass.

3. A device for preventing the propagation of flame and caloric waves in a gas apparatus including means providing a passage through which the gas may pass from a source of supply to a point of delivery, said means comprising a plug member, a tube depending from the plug member, a plurality of elements surrounding said tube providing adjacent surfaces in contact between which thin films of gas discharging from the said tube may pass, and an adjustable member on the said tube supporting said elements and operable to vary the pressure thereon.

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