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SAFETY DEVICES FOR COMPRESSED GAS CONTAINERS

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FIG. 1

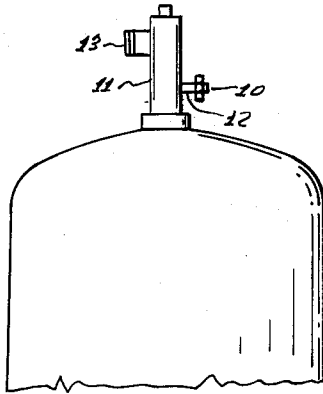


FIG. 2

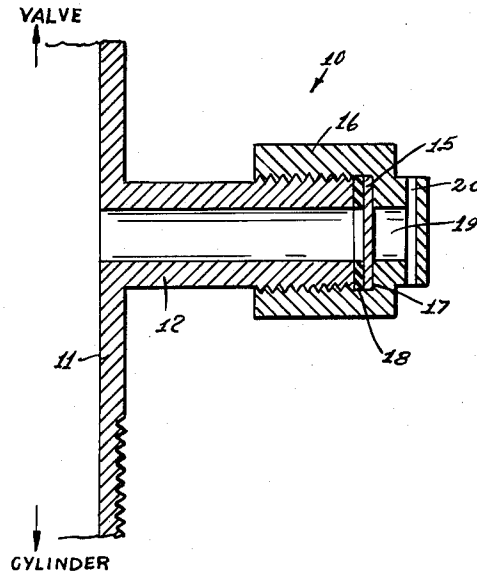
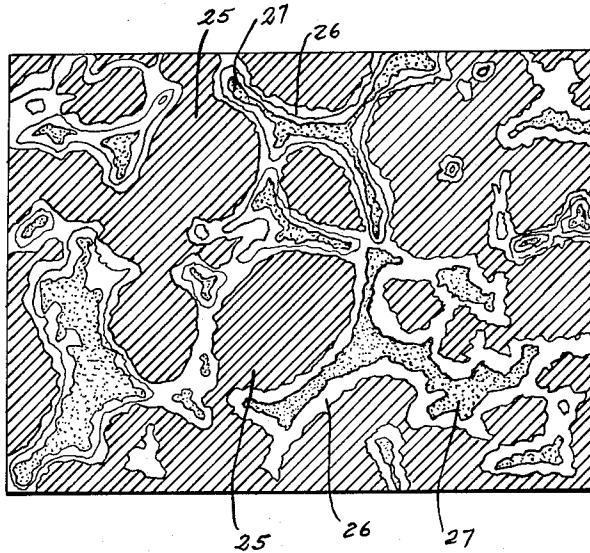


FIG. 3



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1

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SAFETY DEVICES FOR COMPRESSED GAS CONTAINERS

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This invention relates to safety devices for compressed gas containers, and more particularly to safety devices known as frangible disc safety devices.

Generally, two types of safety devices are used on compressed gas containers depending upon the amount of gas pressure within the container. High pressure gas containers, such as those containing oxygen, use a safety device consisting of a thin copper disc inserted in a specially designed nut attached to a fitting on the valve stem on the upper portion of the gas cylinder. The physical dimensions of the copper disc are chosen so that it will fracture or burst at a specified pressure thereby permitting the confined gas to escape and avoiding the dangerous possibility of the increased gas pressure fracturing the walls of the container and propelling it through the air. Because the copper material is subject to conditions of creep under the continually applied load of the compressed gas, it is backed up by a low temperature fusible alloy; the theory being that only heat might cause an increase in the pressure of the gas within the cylinder, and that under conditions of heat, the fusible alloy would melt permitting the copper disc to expand back into the rupture chamber and fracture.

Low pressure gas cylinders such as those containing acetylene gas, merely have fusible metal plugs which melt under conditions of heat, it being impossible to manufacture and handle the thin bursting discs necessary for fracturing under such low pressures.

One of the main disadvantages of these safety devices is that local heating at the base or at the sides of the gas container would not melt the fusible alloy although the gas pressure in the cylinder rises high enough to burst it. Another disadvantage is that the fusible alloy is itself subject to creep under the continually applied load of the compressed gas.

The present invention overcomes these difficulties by providing a frangible disc safety device having a creep-resistant bursting disc which eliminates the need for a fusible alloy backing and in addition provides for the slow rather than the explosive escape of gas through the bursting disc, since the danger of fire due to the escaping gases is materially reduced under these circumstances.

In accordance with the invention, a bursting disc consisting of a substantially strong creep-resistant porous matrix or skeleton of alloy steel, tungsten carbide, bronze, beta brass or any other suitable strong material is produced and thereafter its pores are completely filled with a low-temperature fusible material. With such a construction, the skeleton provides the strength and resistance to creep desired in the bursting disc, while the fusible alloy filling its pores provides the gas seal. With a disc of such design, failure will occur either through over-pressure (by bursting of the disc in the normal manner), or in the event of local heating by melting out of the fusible alloy with consequent loss of the gas through the now porous bursting disc.

One object of the invention is to provide a safety device for compressed gas containers having a creep-resistant

2

bursting disc, and a method for making such a bursting disc.

Another object of the invention is to provide a safety device for compressed gas containers which will permit the slow escape rather than the explosive escape of gas upon failure of the safety device.

A further object of the invention is a method for manufacturing such safety devices on a production basis using unskilled labor.

The foregoing and other objects of the invention will be best understood from the following detailed description of exemplifications thereof, reference being had to the accompanying drawings, wherein:

Fig. 1 is an elevational view of the upper part of a compressed gas container containing the safety device of the invention;

Fig. 2 is a cross-sectional view of a frangible disc safety device containing one form of a bursting disc of the invention; and

Fig. 3 is a photomicrograph (X200) of the structure of the bursting disc shown in Fig. 2.

Referring to Fig. 2, in the specific form shown, the safety device 10 is attached to the valve stem of the gas cylinder 11 by a hollow laterally extending pipe extension 12, just prior to the outlet control valve 13. The safety device 10 contains a bursting disc 15 held in its operative position generally perpendicular to the longitudinal axis of the pipe extension 12 by a back-up nut 16.

The back-up nut 16 comprises an inside threaded cup-shaped cover wall which threadingly engages a threaded outer end of the hollow pipe extension 12. The bursting disc 15 is interposed between the boundary edge of the outer end of the hollow pipe extension 12 and an inner facing shoulder 17 of the back-up nut 16 to provide a barrier through which the compressed gas in the hollow pipe extension 12 cannot flow. A circular washer 18, of fiber for instance, having a center opening is interposed between the facing surfaces of the pipe extension 12 and the bursting disc 15 to prevent any gas leakage through the threaded contact surface portions of the back-up nut 16 and the pipe extension 12.

When the pressure of the gas within the pipe extension 12 exceeds a specified amount, the bursting disc 15 will expand back into a rupture chamber 19 and fracture. The gas will flow past the fractured bursting disc 15, through the rupture chamber 19 and out through a blow-out hole 20, in the rear of the back-up nut 16.

In the form shown the bursting disc 15 comprises a substantially strong-rigid-porous skeleton having its pores filled with a low temperature fusible alloy. The skeleton material can be any suitable strong material that will not creep under the normal working pressures of the compressed gas, such as alloy steel, tungsten-carbide, bronze and other like strong materials. The fusible alloy may be any metal or alloy that will melt at low temperatures of the order of about 150–250° F. Wood's metal, an alloy of bismuth, lead, tin and cadmium, is very satisfactory as the fusible alloy.

There will now be described one practical way of making a bursting disc in accordance with the principles of the invention using bronze as the skeleton material and Wood's metal as the easily fusible alloy.

A desirable method for producing the bursting disc 15 in accordance with the invention is by using powdered metallurgical techniques.

In general, the bronze metal may be pulverized or disintegrated to form suitable sized powder particles. The powder particles are then compacted and heated at an elevated temperature in a mold having the desired shape of the bursting disc 15 so as to form a substantially strong rigid porous structure. Thereafter, the so-produced porous structure is infiltrated with the low temperature fusible alloy.

Fig. 3 shows a photomicrograph (X200) of the structure obtained in a cemented bronze powder particle porous structure infiltrated with Wood's metal. The cross-hatched large oval particles 25 are the bronze particles; the ribbon-like structure 26 abutting the bronze particles is a tin-rich layer which normally exists on the surface of the bronze as manufactured; the dotted intergranular phase 27 is the eutectic of the fusible alloy.

In order to enable those skilled in the art to readily practice the invention but without limiting the scope thereof, I will now give a more detailed description of a practical method for forming the bursting disc in accordance with the invention.

The bronze metal is disintegrated or pulverized by ball milling or other like disintegrating processes into fine powder particles of suitable size. Thereafter the bronze powder particles are formed into the desired shape of the bursting disc by compacting in a mold having a cavity contour conforming to the desired shape. The compacted particles are then heated at an elevated temperature so as to give the compacted body the desired physical strength and rigidity and to form a porous matrix. The bronze powder particles may be loosely packed in a mold and thereafter sintered while still in the mold in a protective atmosphere (such as partially combusted natural gas or producer gas) at a temperature of the order of 800° C. Bronze powders sinter easily and need not be prepressed but other powders may be green pressed, i. e., pressed before sintering.

In order to manufacture the safety device in accordance with the invention on a production basis, it is necessary that the porosity of the cemented bronze powder body be controlled within extremely close limits in order that each unit be identical in physical properties to the preceding unit so that each safety device will fail or fracture at the same proper bursting pressure.

To this end it has been found to be advantageous to employ spherical powders in forming the bursting disc, since the geometry of the stacking of the spherical powders will give good reproducible results.

The completed porous matrix or skeleton is then ready for infiltration. The porous matrix or skeleton must be completely infiltrated by the low temperature fusible alloy else the gas will gradually leak through the bursting disc. Because of the low melting point of the fusible alloys, infiltration must be carried out at temperatures of the order between about 200° F. and about 300° F. This is a region in which hydrogen no longer acts as a reducing agent or flux for any oxides that will have formed in the porous skeleton.

In order to reduce any oxides that may have formed within the porous skeleton so that complete infiltration will result, it has been found desirable to employ liquid fluxes, such as hydrochloric acid plus alcohol or liquid soldering flux, or other like liquid fluxes.

The technique employed in infiltrating the bronze porous matrix or skeleton is to first impregnate the skeleton body with the liquid flux as by immersing the body in the liquid flux. Thereafter, the impregnated skeleton body is slowly immersed in a pool of the

molten low temperature fusible alloy, such as Wood's metal. The molten fusible alloy gradually displaces the liquid flux within the pores of the skeleton resulting in a completely infiltrated skeleton body.

The bronze skeleton matrix provides sufficient strength to resist the continually applied load of the compressed gas, while the infiltrated fusible alloy provides a seal which prevents the escape of the confined gas.

It will be apparent to those skilled in the art that the novel principles of the invention disclosed herein in connection with specific exemplifications thereof will suggest various other modifications and applications of the same. It is accordingly desired that in construing the breadth of the approved claims they shall not be limited to the specific exemplifications of the invention described herein.

I claim:

1. In a safety relief device for gases under pressure, the combination of a tank having a discharge duct and a safety bursting disk providing a sealing closure for said duct, said bursting disk comprising a porous skeleton body of cemented metal particles to provide a strong creep resistant body, the pores of said skeleton body being filled with a readily fusible material which melts at temperatures above normal to permit gas to escape through said pores.

2. In a safety relief device for gases under pressure, the combination of a tank having a discharge duct and a safety bursting disk providing a sealing closure for said duct, said bursting disk comprising a porous skeleton body of cemented metal particles to provide a strong creep resistant body, the pores of said skeleton body being filled with a readily fusible material which melts at about approximately 150° to 250° F. to permit gas to escape through said pores when the melting point of said filling material is exceeded.

3. The device as set forth in claim 2 in which said skeleton body consists essentially of alloy steel.

4. The device as set forth in claim 2 in which said skeleton body consists essentially of tungsten carbide.

5. The device as set forth in claim 2 in which said skeleton body consists essentially of bronze.

6. The device as set forth in claim 2 in which said skeleton body is made up of cemented particles which are substantially spherical in shape.

7. The device as set forth in claim 2 in which the material of said pores consists essentially of Wood's metal.

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