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RUPTURE DISC

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The present invention deals with a rupture disc and more particularly to an alloy for a rupture disc adapted to be ruptured by fluid pressure when the fluid pressure exceeds a predetermined value.

Storage containers containing fluid, or fluid chambers containing, e.g. pressurized gases or liquids are usually provided with a safety device for effecting a pressure release to safeguard against the buildup of excessive gas or liquid pressures which become potentially dangerous. A convenient safety device comprises a structure in the form of a valve which contains a frangible or rupturable diaphragm or disc. While a rupture diaphragm or disc may be composed of various metals or metal alloys such as copper, silver, gold, platinum, aluminum, etc., and alloys thereof, discs made from platinum or platinum alloys are advantageous especially when the container contains highly corrosive gases. While gold and silver rupture discs have adequate resistance to corrosion from moderately corrosive chemicals or gases, they do not satisfactorily withstand highly corrosive conditions under elevated temperatures. For example, gold and silver discs do not adequately withstand contact with liquids and gases containing halogens including bromides, chlorides, fluorides and iodides under substantially high temperatures. Contact of such discs with moist hydrogen sulphide is particularly undesirable. Under such highly corrosive conditions it has been found that discs or diaphragms made from substantially pure platinum are advantageous in providing desirable corrosion resistance and rupture characteristics. However, the disadvantage in the use of such platinum discs is that they inherently contain very small or minute amounts of metal impurities and the impurities vary as to composition and amount. For example, it has been found that substantially pure platinum usually contains a variation as to the amount and the nature of other metal impurities. In such case it is extremely difficult to control the metals to provide uniform rupture pressures.

It is an object of this invention to provide a platinum alloy for rupture discs which provides substantially uniform rupture pressures. It is another object of this invention to provide a platinum alloy for rupture discs which provides uniform and the substantially low pressure rupture characteristics of pure platinum. It is a further object of this invention to provide a rupture disc composed essentially of platinum and having controlled and reproducible rupture characteristics. Other objects and advantages of the invention will be apparent from the description hereinafter following.

The present invention relates to platinum alloys for the manufacture of rupture discs and which alloys contain inherent minute amounts of impurity metals including at least two of the metals gold, iridium, palladium, rhodium, ruthenium, copper, iron, nickel, manganese, calcium, silver, lead, tin, zinc, boron, aluminum, magnesium, chromium and antimony. A certain small amount of such impurity metals is in fact favorable because they tend to restrict grain growth. However, even in minute amounts, a variation of the impurity metal content between two pieces of metal stock will render a disc or diaphragm made therefrom variable as to rupture pressure. It has bene found, in accordance with this invention, that by adding from 0.1% up to less than 1% of a metal selected from the impurity metals, which amount is more

or greater than all non-selected impurity metals combined, that such addition will render the other impurity metals ineffective to vary the rupture characteristics of the platinum disc or diaphragm.

The term "impurity metals" refers to minute amounts of residual metals other than platinum contained in commercially or chemically pure platinum.

When 1% or more of an additive metal is employed it is very difficult to obtain the desirable pressure characteristics approaching those of pure platinum for a given set of parmeters, e.g. thickness and working diameter of the rupture disc. In such cases the rupture disc or diaphragm no longer resembles the rutpure character of pure platinum within a desirable tolerance.

By adding to substantially pure platinum containing impurity metals, iridium in an amount of from 0.1% up to less than 1%, which amount is greater than all minute amounts of other impurity metals combined, the rupture disc alloy is substantially standardized for the provision of reproducible rupture characteristics. It is important that the additive metal is present in such amount that it will go into solid solution with the platinum metal conent and will not affect the nobility of such metal.

The alloys herein contemplated are essentially composed of from 99.0% to 99.9% of platinum with from 0.1% to less than 1% of one of the impurity metals above listed. For example, a satisfactory alloy consists of 99.4% platinum, 0.5% rhodium and 0.1% impurity metals. Another satisfactory alloy consists of 99.7% platinum, 0.2% iridium and 0.1% impurity metals.

Rupture discs were made and tested according to the following examples and tables.

EXAMPLE I

Commercial grade platinum having a weight of fifty ounces and the specific composition illustrated by the following Table I was melted under usual rupture disc melting conditions and formed into a bar. The bar was rolled into a sheet having a thickness of 0.010 inch. From this sheet ten discs $1\frac{15}{16}$ inches in diameter were blanked and annealed at 950° C. for fifteen minutes. The annealed discs were then tested for rupture pressure using a ½ inch working diameter. The rupture pressure for each disc was obtained and tabulated as illustrated by the following Table II. A statistical evaluation of this data showed that the discs were ruptured within a standard deviation of ±63 p.s.i. from the mean bursting pressure of 1840 p.s.i. The coefficient of variation was found to be 3.4%.

EXAMPLE II

After testing the discs provided by Example I, the sheet material and discs were divided into two lots of 25 ounces each. One 25 ounce lot was remelted with an addition of iridium sufficient to provide an alloy containing 0.2% iridium. A remelted lot was rolled into a sheet having a thickness of 0.10 inch. From this sheet ten discs $1\frac{15}{16}$ inches in diameter were blanked and annealed at 950° C. for fifteen minutes. The annealed discs were then tested for rupture pressure using a ½ inch working diameter. The rupture pressure for each disc was obtained and tabulated as illustrated by the following Table III. A statistical evaluation of this data showed that the discs were ruptured within a standard deviation of ±36 p.s.i. from the mean bursting pressure of 2,150 p.s.i. The coefficient of variation was found to be 1.7%.

EXAMPLE III

The remaining 25 ounce lot was remelted with an addition of rhodium sufficient to provide an alloy containing 0.5% rhodium. The remelted lot was rolled into a sheet having a thickness of 0.010 inch. From this sheet ten

discs 1 15/16 inches in diameter were blanked and annealed at 950° C. for fifteen minutes. The annealed discs were then tested for rupture pressure using a ½ inch working diameter. The rupture pressure for each disc was obtained and tabulated as illustrated by the following Table IV. A statistical evaluation of this data showed that the discs were ruptured within a standard deviation of ±30 p.s.i. from the mean bursting pressure of 2,215 p.s.i. The coefficient of variation was found to be 1.4%.

Table I

SPECTROGRAPHIC ANALYSIS

Material: Commercial grade platinum

Element:	Percent
Pt	99.85+
Ir	0.014
Pd	0.04
Rh	0.024
Ru	------
Au	0.0023
Ag	0.004
Cu	0.004
Fe	0.012
Ni	0.0024
Cr	0.001
Mn	0.0002
Mg	0.0003
Ca	0.0003
Si	0.034
Pb	0.001
Sn	0.0022
Zn	0.0021
Sb	0.002
Al	0.0005
B	0.0011
Mo	------
As	------

Table II

Material: Commercial grade platinum 99.85% pure
Disc diameter: 1 15/16 inches
Working diameter: ½ inch (diameter of rupture area)
Disc thickness: 0.010 inch

Specimen No.:		
1	rupture pressure, p.s.i..	1900
2	do....	1800
3	do....	1940
4	do....	1820
5	do....	1780
6	do....	1770
7	do....	1910
8	do....	1800
9	do....	1800
10	do....	1900
Mean rupture pressure	p.s.i..	1840
Standard deviation	p.s.i..	±63
Coefficient of variation	percent..	3.4

Table III

Material: Platinum-0.2% iridium
Disc diameter: 1 15/16 inches
Working diameter: ½ inch (diameter of rupture area)
Disc thickness: 0.010 inch

Specimen No.:		
1	rupture pressure p.s.i..	2080
2	do....	2140
3	do....	2160
4	do....	2120
5	do....	2160
6	do....	2170
7	do....	2180
8	do....	2170
9	do....	2190
10	do....	2100

Mean rupture pressure	p.s.i..	2150
Standard deviation	p.s.i..	±36
Coefficient of variation	percent..	1.7

Table IV

Material: Platinum-0.5% rhodium
Disc diameter: 1 15/16 inches
Working diameter: ½ inch (diameter of rupture area)
Disc thickness: 0.010 inch

Specimen No.:		
1	rupture pressure p.s.i..	2200
2	do....	2200
3	do....	2280
4	do....	2190
5	do....	2210
6	do....	2230
7	do....	2250
8	do....	2210
9	do....	2200
10	do....	2180
Mean rupture pressure	p.s.i..	2215
Standard deviation	p.s.i..	±30
Coefficient of variation	percent..	1.4

The above examples and tables demonstrate the superiority of the alloys platinum-0.2% iridium and platinum-0.5% rhodium over commercial grade platinum when employed as rupture discs. The addition of iridium and rhodium to the platinum has brought about a great increase in the precision that may be obtained in the rupture pressure of a given lot of discs of the same thickness.

While specific rupture discs have been described and tabulated, various modifications are contemplated within the scope of the appended claims.

What is claimed is:

1. In a safety device for containers containing pressurized fluids and comprising a safety valve means in said container and of the type containing a rupture disc, the combination of the valve means and a rupture disc contained therein which is composed of an alloy consisting of platinum in an amount of from 99.0% to 99.9% and at least two metals taken from the group consisting of gold, iridium, palladium, rhodium, ruthenium, copper, iron, nickel, manganese, calcium, silver, lead, tin, zinc, boron, aluminum, magnesium, chromium and antimony, one metal of said group being present in an amount of from 0.1% to less than 1.0% of the alloy, other metals of said group being residual impurity metals present in impurity amounts found in commercially pure platinum, the amount of said one metal being greater than the combined amount of all other metals of said group.

2. In a safety device according to claim 1, wherein said one metal is iridium.

3. In a safety device according to claim 1, wherein said one metal is rhodium.

4. In a safety device according to claim 2, wherein said iridium is present in an amount of 0.2%.

5. A method according to claim 3, wherein said rhodium is present in an amount of 0.5%.

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