

Oct. 23, 1956

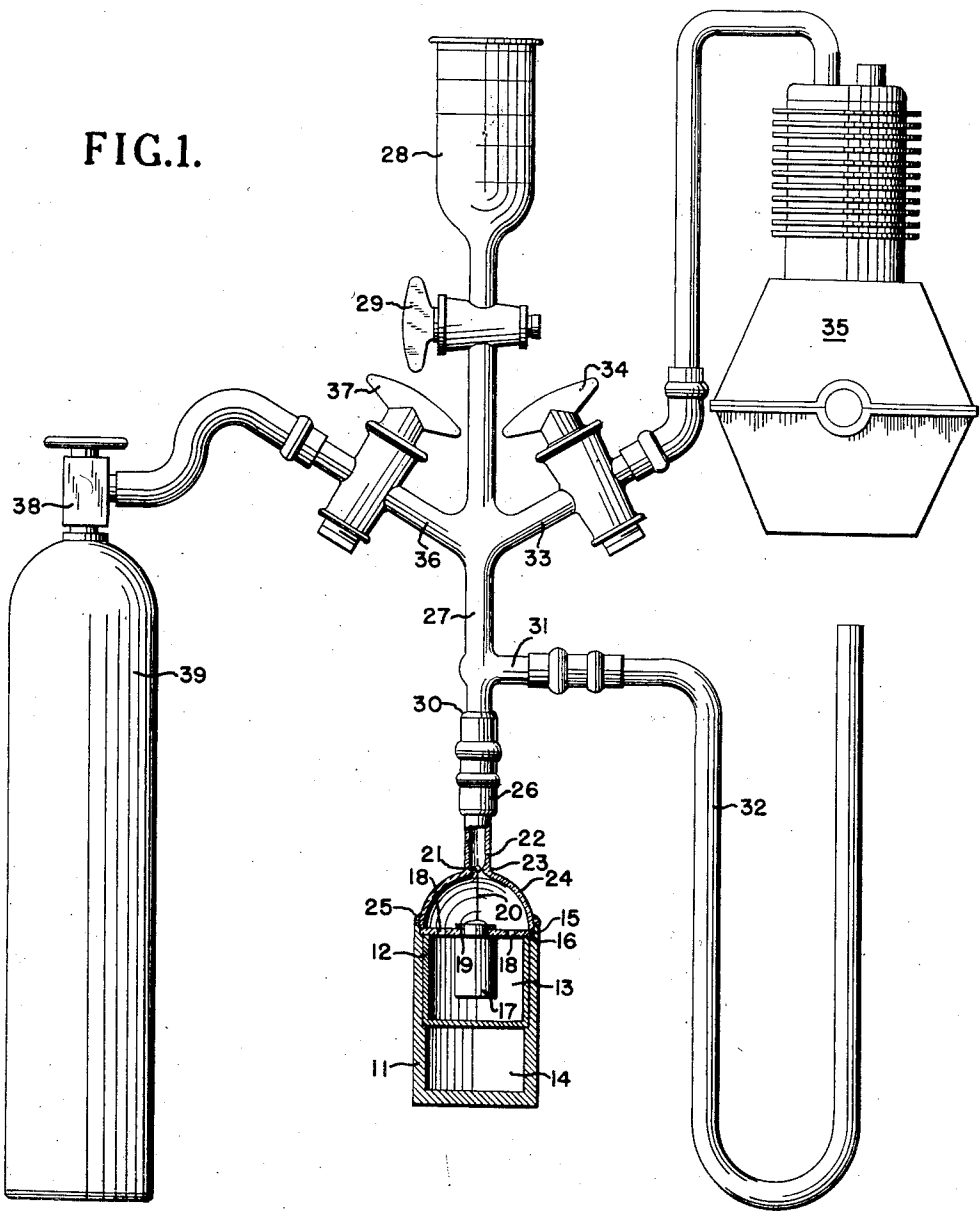
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INERTIA SWITCH

2,768,259

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2 Sheets-Sheet 1

FIG. 1.



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2 Sheets-Sheet 2

FIG.2.

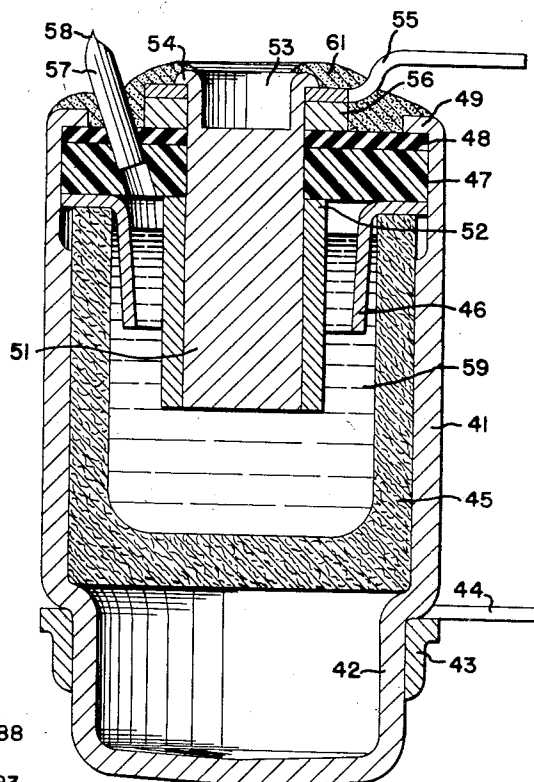


FIG.3.

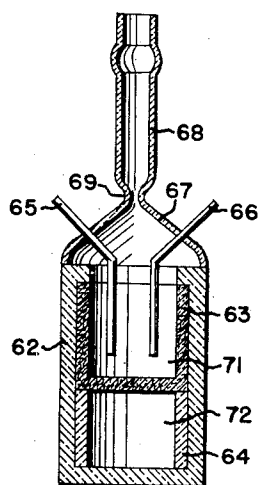
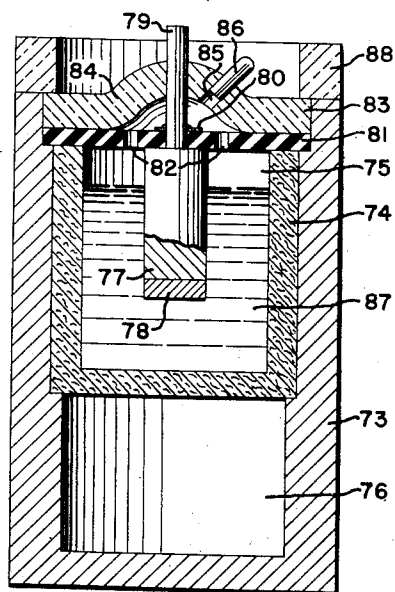


FIG. 4.



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1

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INERTIA SWITCH

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8 Claims. (Cl. 200—80)

(Granted under Title 35, U. S. Code (1952), sec. 266)

This invention relates to inertia switches and more particularly to centrifugal unshorting switches for use in the firing circuits of projectiles at extremely low temperatures, and method and apparatus for making same.

Inertia switches, which have been previously proposed, utilized a fluid conducting medium such as mercury which was forced by some inertia force such as centrifugal force through a sintered metal cup from one chamber to another for the purpose of making or breaking an electrical circuit between two contacts within one of the chambers. These devices, however, would not operate satisfactorily at temperatures near or below the freezing temperature of mercury, and in centrifugal unshorting switches scum formation often-times maintained a short across the contacts, after the mercury had passed through the sintered metal into the other chamber.

The switch of the present invention which is illustrated by several different modifications comprises essentially a container which may or may not be formed of a conducting material, a sintered metallic cup or disc which forms a porous partition dividing the container into two separate chambers, two separate contacts within one of the chambers one of which may be the inner surface of the outer shell of the container, and a fluid body providing a conducting path between the contacts and preferably comprising a mercury-thallium eutectic amalgam or alloy which has a freezing point substantially below the freezing point of pure mercury. One chamber of the container is partially filled with the liquid alloy, after the air has been evacuated from the container which is subsequently hermetically sealed. The remaining space within the container may be filled with an inert gas prior to sealing, if desired.

An object of the present invention is to provide an improved inertia switch which is operable and maintains uniform timing characteristics at extremely low temperatures.

Another object of the present invention is to provide an improved centrifugal unshorting switch which is operable at extremely low temperatures and is so constructed that oxidation, corrosion and scum formation are reduced to a minimum.

A still further object of the present invention is to provide a novel method of constructing, evacuating and filling an inertia switch with a mercury-thallium eutectic amalgam and, if desired, an inert gas.

A still further object of the present invention is to provide a novel apparatus for constructing, evacuating and filling an inertia switch with a mercury-thallium eutectic amalgam and, if desired, an inert gas.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a schematic view with parts in section illustrating one preferred form of apparatus for filling and form-

2

ing one preferred modification of the inertia switch of the present invention;

Fig. 2 is an enlarged sectional view illustrating another preferred form of inertia switch constructed in accordance with the present invention;

Fig. 3 is an enlarged sectional view of another modification; and

Fig. 4 is an enlarged sectional view illustrating a still further modification of the present invention.

Referring now to the drawings in detail, Fig. 1 illustrates one preferred apparatus and method for filling a novel inertia switch which comprises an outer shell or container 11 containing a porous cup 12 formed of a sintered metal such as nickel, oxidized nickel, iron, or stainless steel which divides the outer shell 11 into an upper chamber 13 and a lower chamber 14. A washer 15 preferably formed of a suitable insulating material such as a phenolic resin rests in an annular recess 16 formed in the top of the outer shell 11 and supports a center contact or electrode 17 within the upper chamber 13. Contact 17 is preferably formed of "Monel" metal or other conducting material and may be clad with copper or other similar material which forms a low resistance contact surface. The washer 15 is provided with two or more openings 18 which facilitate evacuation of the air from the container and partially filling the upper chamber 13 with the mercury-thallium eutectic amalgam (not shown).

The center contact 17 is swaged over a steel washer 19 to secure it in position on the washer 15 and may be suitably connected to a rod 20, preferably formed of tungsten, Kovar, copper or similar conducting material, by welding or other conventional means. Rod 20 is provided with a glass bead 21 formed of a heat resistant type of glass such as "Pyrex" bonded thereto for a purpose to be described infra. A glass tube 22 is also preferably formed of heat resistant glass such as "Pyrex" and is pinched in at 23 adjacent the glass bead 21. The lower portion of the tube 22 is flared out to form a bell shaped portion 24 which is suitably bonded or secured to the top of the metal shell 11 above the washer 15 and is preferably hermetically sealed by an annular ring of suitable glass to metal cement 25 such as those wax base cements known commercially as "Pyseal" and "Saureisen."

The upper portion of the tube 22 is attached by suitable means such as a rubber tube 26 to the lower end of a dispenser which comprises a vertical tube 27 terminating at its upper end in an enlarged portion 28 constituting a container for the mercury-thallium alloy, the flow of which is controlled by a pet cock 29. The ends of rubber tube 26 are preferably sealed with rings of suitable cement 30, such as "Pyseal" or "Saureisen" mentioned supra. A branch line 31 extending from the vertical tube 27 is suitably connected to a manometer 32 and another branch line 33 is suitably connected through a pet cock 34 to a vacuum pump 35. If desired, another branch line 36 may be provided which is connected through a pet cock 37 to a control valve 38 which is attached to a bottle or cylinder 39 containing some inert gas such as nitrogen or carbon dioxide under pressure.

In completing the inertia switch illustrated in Fig. 1, the air is first evacuated therefrom by means of the vacuum pump 35, until the desired degree of vacuum is obtained, as indicated on the manometer 32. The pet cock 34 is then closed, and the pet cock 29 is opened to admit a predetermined quantity of mercury-thallium alloy into the chamber 13. If desired, suitable capillary measuring means (not shown) may be incorporated in the tube 27 to facilitate accurate measuring of the minute quantities involved, since the switch shown in Fig. 1 is three to five times the usual size of the actual device. After pet cock

3

29 is closed, the pet cock 37 may be opened, if desired, to admit sufficient inert gas to fill chamber 14 and the balance of the container 11 which does not contain the eutectic alloy. The portion 23 is further pinched in under heat and pressure, until a fusion is obtained between the glass tube 22 and the glass bead 21 which hermetically seals the inertia switch. The upper portion of the tube 22 may then be removed just above the pinched-in portion 23 thus exposing the upper end of the tungsten rod 19 for suitable connection in an electrical circuit. In this modification the metallic shell 11 provides the other contact within the chamber 13 as well as the other terminal which may be suitably connected to any desired terminal in the electrical circuit. The same method of filling may obviously be utilized with the other modifications illustrated in Figs. 2, 3 and 4.

Another preferred embodiment is illustrated in Fig. 2, wherein an outer shell 41 is provided with a lower portion 42 of reduced diameter around which is suitably secured an annular ring 43 provided with an outwardly extending lug 44 forming a ground terminal. A porous cup 45 is seated within the upper portion of the shell 41 and is preferably formed of a sintered metal such as nickel, etc., as described supra. A copper eyelet 46, a gasket 47 and a sealing ring 48 bear against the top of cup 45 and are retained by an inwardly turned flange 49 on the outer shell 41. Gasket 47 and ring 48 are preferably one banded unit which may be cut from a sheet of phenolic resin with a layer of neoprene or a similar natural or synthetic resilient material calendered thereon. A center post 51 may be formed of copper clad "Monel" metal and is provided with a shoulder 52 which bears against the gasket 47. The hollow upper portion 53 of post 51 is turned over to form a flange 54 which forces terminal 55 against a steel washer 56 and helps retain the parts in assembled relation. A glass tube 57 extends through the ring 48 and gasket 47 into the upper chamber and is suitably pinched off at 58, after the switch has been evacuated and filled with the mercury-thallium eutectic amalgam 59. The upper portion of the switch is covered and hermetically sealed by a layer of wax cement 61 such as "Pyseal" or "Saureisen."

Another modification is shown in Fig. 3, wherein the outer shell 62 is formed of a heat resistant glass such as "Pyrex" and the porous cup 63 formed of sintered nickel or other suitable metal is supported within the outer shell by a cylindrical spacer 64 which may also be made of heat resistant glass similar to the outer shell. Two tungsten rods 65 and 66 bent at an angle as shown extend through the wall of the bell shaped lower portion 67 of a glass tube 68 similar to the tube 22 shown in Fig. 1 and likewise pinched in at 69. The outwardly extending ends of rods 65 and 66 constitute the two terminals for connecting the switch as desired in an electrical circuit. The opposite ends extend into the upper chamber 71 and constitute the contacts which are bridged by the pool of mercury-thallium amalgam (not shown) which may be introduced in a similar manner to that described with reference to Fig. 1. Tube 68 is also preferably formed from a heat resistant glass, and the lower bell shaped portion 67 may be suitably fused or otherwise connected to the outer shell 62 to provide a hermetically sealed switch, after the unit has been evacuated and filled, and the pinched portion 69 has been sealed off with heat and pressure and severed. The lower chamber 72, which is evacuated with the rest of the unit and may be filled with an inert gas, is adapted to receive the liquid amalgam when it is forced through the porous cup by centrifugal force.

Still another modification is illustrated in Fig. 4, wherein the outer shell 73 is formed of conducting material, so that the outer surface serves as a terminal and the inner surface serves as one of the contacts. A sintered metal cup 74 similar to those previously described is seated within the upper recessed portion of the outer shell 73

4

and divides the switch into an upper chamber 75 and a lower chamber 76 which are likewise similar in function to those described with reference to Figs. 1, 2 and 3. A center contact 77 is formed of an alloy such as Kovar and is provided with a copper tip 78 and a reduced diameter terminal 79 which extends upwardly through a gasket 81 having two or more openings 82 and through a top plate 83 having a dome shaped portion 84 with an opening 85 therethrough. As shown, the terminal 79 may be secured to the gasket 81 by a portion swaged over the steel washer 80. A small glass tube 86 securely inserted in the opening 85 is utilized for evacuating and filling the switch with the mercury-thallium amalgam 87 in a manner similar to that described with reference to tube 57 on the switch shown in Fig. 2. A protective ring 88 may be secured to shell 73 to protect dome 84 which can be of glass, if desired.

The mercury-thallium alloy or amalgam utilized in carrying out the present invention is preferably the eutectic alloy which has a composition of 8.5% thallium and 91.5% pure mercury which has a freezing point of -60° C. or -76° F., however, a very careful control in preparing the alloy is required to obtain a composition having the lowest possible eutectic freezing point, but eutectic alloys varying from 6 to 10% thallium are satisfactory for most purposes, since the freezing point in this range is below -50° C. and is substantially below the freezing point of pure mercury which is -39° C. Any mercury alloys containing from 0.1 to 12.4% thallium would be operative to depress the freezing point below that of mercury to an appreciable extent. In the present specification and claims the term "eutectic" is to be construed as meaning—an alloy that has a lower freezing point than its components have by themselves.

Indium and other known metals might also be alloyed with mercury in place of thallium, but they are less soluble in mercury, some are more expensive, and they are limited in the extent of their effect in lowering the freezing point of mercury.

While the mercury-thallium alloy oxidizes on exposure to air, the oxide floating on the surface protects the mass of the liquid from further oxidation, and it is not necessary to store the material under sealing liquids or in special atmospheres, for instance, while in the container 28 during filling of the inertia switch. When the switch is evacuated or filled with an inert atmosphere, there is no visible reaction, after the switch is filled with the mercury-thallium alloy, which maintains a clear and shiny surface similar to that of pure mercury. The viscosity and surface tension of the eutectic alloy are apparently very close to that of pure mercury.

While certain specific materials and details of construction have been disclosed with reference to a particular modification, it will be obvious that many of these features may be used interchangeably, and in any of the modifications a disc of sintered metal may be substituted for one of the cup shaped elements 12, 45, 63 and 74.

The metal, "Kovar," which comprises 29% nickel, 17% cobalt, 0.3% manganese and 53.7% iron+impurities, may be utilized advantageously in any construction where glass and metal are used, since the coefficients of thermal expansion are substantially the same for "Kovar" and glass, and they are readily bonded.

The metal commercially known as "Monel," which comprises 67% nickel, 28% copper and 5% iron+impurities such as manganese, may be advantageously used for the contacts with or without a copper clad tip or sides, although other metals which have high conductivity such as tungsten, platinum and silver may also be used. The layer of copper has been found to limit amalgamation at the surface of the contacts, which may continue under certain circumstances with other metals, until a permanent short is formed by a solid amalgam bridge between contacts, after a long period of time.

The specific compositions of "Pyseal" and "Saureisen"

5

cements are not disclosed by the manufacturers, but they are known to have a wax base, and any suitable glass to metal cement may be utilized in lieu thereof, which will provide an adequate hermetic seal.

Obviously many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An inertia switch comprising a container, a sintered metal member positioned within said container and forming a porous partition dividing said container into two separate chambers, contact means within said container having terminal means extending outwardly thereof, and a pool of mercury-thallium eutectic alloy having a freezing point below -39° C. and substantially filling one of said chambers, said alloy consisting of 6 to 10 percent thallium and the remainder mercury said container having been gas evacuated prior to the inclusion therein of said alloy, and means hermetically sealing said container.

2. An inertia switch comprising a container, a sintered metal member positioned within said container and forming a porous partition dividing said container into two separate chambers, contact means within said container having terminal means extending outwardly thereof, a pool of mercury-thallium eutectic alloy having a freezing point below -39° C. and substantially filling one of said chambers, said alloy consisting of 6 to 10 percent thallium and the remainder mercury, means hermetically sealing said container, said container having been gas evacuated prior to the inclusion therein of said alloy, and an inert gas occupying the remaining volume of said container.

3. An inertia switch as set forth in claim 1 wherein said container has one open end, and a heat resistant glass member is secured to said container across said open end.

4. An inertia switch as set forth in claim 1 wherein

6

an insulating member is mounted in said container and supports one element of said contact and terminal means centrally in spaced relation to the inner wall of said container, said container forms another element of said contact and terminal means, said container has one open end, and a heat resistant glass member is secured to said container across said open end with said central element extending therethrough.

5. An inertia switch as set forth in claim 1 wherein said contact means comprises an electrode, an insulating member is mounted in said container and supports said electrode centrally in spaced relation to the inner wall of said container, said container forms another contact and terminal, said container has one open end, and said sealing means comprises a heat resistant glass member bonded to said container across said open end with said central electrode extending therethrough.

6. An inertia switch as set forth in claim 1 wherein said container is open at one end and is formed of metal having a coefficient of thermal expansion substantially the same as glass, a heat resistant glass member is bonded to said container across said open end, and said terminal extends through said glass member, and a protective ring secured to the open end of said container and surrounding said glass member.

7. An inertia switch as set forth in claim 1 wherein said container is closed and formed of heat resistant glass, and said contact means comprises a pair of spaced rods extending through said container into one of said chambers.

8. An inertia switch as set forth in claim 1 wherein said container is formed of heat resistant glass, said contact means comprises a pair of spaced rods extending through said container into one of said chambers, said sintered member forms a cup, and a glass spacer supports said cup.

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