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PROTECTIVE PACKAGING OF DELICATE MECHANISMS

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FIG. 1

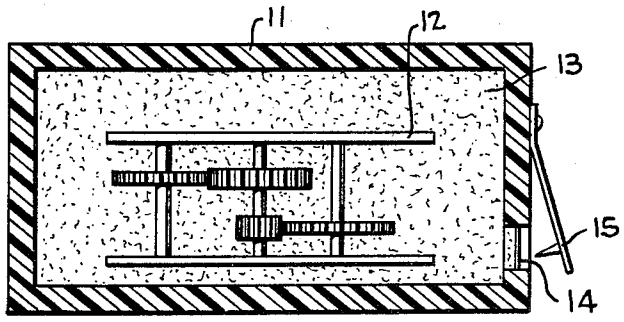
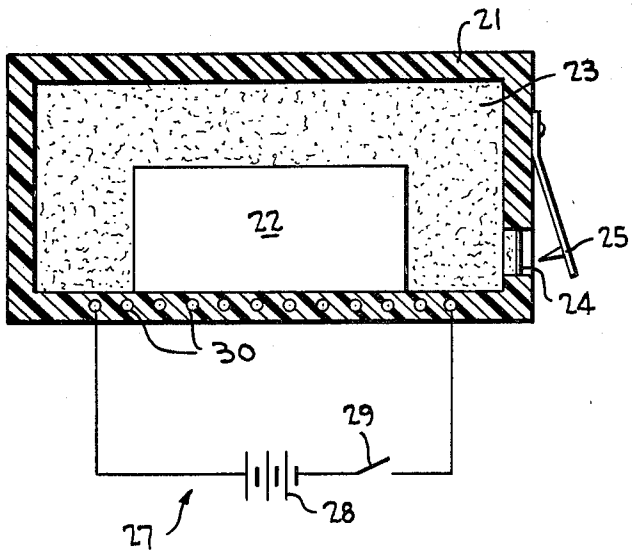


FIG. 2



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PROTECTIVE PACKAGING OF DELICATE MECHANISMS

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This application is a continuation-in-part of my application Serial No. 278,809, filed May 6, 1963, for Fugitive Potting, now abandoned.

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 to me of any royalty thereon.

This invention relates to the protective packaging of apparatus, and more particularly to a method and material for the non-permanent potting of delicate mechanisms.

Modern warfare and space technology require that sufficient ruggedness be designed into a mechanism so that it will function properly under its operational environment and that it will live through violent transportation and handling situations, severe acceleration forces of launching or firing, and in certain applications enormous deceleration forces generated by impact.

In space exploration for example, unmanned landings on the moon and the nearby planets are contemplated. In such situations it is desirable to place delicate measuring and testing devices on the surface with their own telemetering equipment to relay information that is gathered after the landing to the earth or orbiting space stations. In certain military applications, it is necessary to remotely emplace mines and similar weapons by means of shell, rocket or ballistic missile delivery. The sensing mechanisms, timers and the like used in these weapons would therefore have to withstand tremendous inertial and gravitational forces prior to their activation.

While it is possible to build reliable mechanisms which employ moving parts to withstand these severe conditions, they are impractical because their cost of construction is very high and the devices themselves become extremely heavy.

The most satisfactory solution to this problem is to pot the arming mechanism or the delicate instrument, to prevent relative movement between its parts before it is transported, in a solid material that can easily be removed just prior to the operation of the device. The potting material must be non-corrosive, have good dielectric properties, be solid over a wide range of temperatures, specifically in the military storage range of −65° F. to +160° F., have the property of being able to be melted and poured into a cavity containing a delicate device, then solidifying to completely fill the void, and most important, be easily and completely removable from the cavity and from the device just before the device is required to operate.

With the above potting technique, the design of the mechanism need only be rugged enough to assure proper functioning under the operational environment, since the ruggedness to survive the transportation, firing, etc., will be provided by the potting material.

It is therefore an object of this invention to provide a method and material for potting delicate mechanisms so that they will be protected from high "g" forces before operation.

Another object of the invention is to provide a potting media and method for protecting sensitive devices with a material that is a solid substance when confined and which will evaporate when released.

A further object of the instant invention is the provision of a method and material for the non-permanent potting of delicate mechanisms having moving parts with a fugitive chemical compound. i.e. one that is likely to evaporate or disappear.

Still a further object of the present invention is to provide a fugitive potting technique that utilizes a chemical compound that is economical to manufacture and is easy to prepare in pure form.

According to the present invention, the foregoing and other objects are attained by positioning the mechanism to be protected in a container, completely filling the cavity with a molten fugitive potting material that will sublime from the solid to the vapor state, sealing the container and then allowing the potting material to solidify. The potted mechanism is now able to be safely transported to its intended site. When it is desired to put the mechanism in operation, the container is opened, the solid potting material sublimes or evaporates and the mechanism is completely free to function in its intended manner.

The specific nature of the invention, as well as other objects, aspects, uses and advantages thereof, will clearly appear from the following description and from the accompanying drawing, in which:

FIG. 1 is a partial sectional view showing a gear train mechanism potted in accordance with the teachings of this invention; and

FIG. 2 is a partial sectional view showing an alternate means of potting a device according to the instant invention.

Referring now to the drawing and particularly to FIG. 1, there is shown a gear train mechanism **12**, completely surrounded by a fugitive potting compound **13** and housed within a container or casing **11**. Device **12** is shown as being a simple gear train mechanism for ease of explanation purposes only. While the potting method and material of this invention has special utility with this type of mechanism it is in no way limited thereto. Other sensitive devices such as clocks, timers, measuring and testing instruments, triggering mechanisms or the like may be potted in the manner taught by the instant invention. The container **11** which may be a mine or bomb casing or the shell of a missile is sealed by suitable means, such as a frangible member **14**, and is provided with a means **15** to break the seal when desired. The pointed striker means **15** provides a simple and convenient arrangement for breaking the seal, but obviously any other means to break the seal may be employed.

The potting material **13** surrounding the delicate device **12** is denominated a fugitive potting compound because it is capable of evaporating or disappearing from the solid state directly to the vapor state under certain temperatures and pressures. The process by which a chemical composition passes directly from the solid state to the vapor state is commonly termed sublimation. It is absolutely essential that the fugitive potting **13** sublime when the seal is broken in order to assure that the gear mechanism **12** or other device that is potted is completely free to operate. Also, in the case of remotely emplaced articles as mentioned above, it is necessary that the potting compound be self expelling from the casing **11** since the article will be untended at the point of use. The potting compound **13** should also sublime rapidly at standard temperature and pressure because many devices to be potted will be operated under normal or near normal atmospheric conditions and it is often desirable that they become operational in the shortest possible time.

After the rigidly potted mechanism **12** and its casing **13** reach the intended site, striker **15** is actuated by any suitable means (not shown)to break seal **14**. Fugitive pot-

ting 13 will then sublime and leave the gear train 12 free to function.

In situations where it is necessary to add heat to bring about sublimation of the fugitive potting or to increase its rate of sublimation, such as when the ambient conditions at the point of use of the mechanism would prevent the compound from subliming or when the compound is a type that will not sublime rapidly enough at the site, means to raise the temperature of the compound are provided as shown in the embodiment of FIG. 2.

In this embodiment, a delicate mechanism 22 is rigidly potted in a sublimable compound 23 within a container 21 provided with heating means 27, seal 24 and seal breaking means 25. The means 27 for heating the fugitive potting is illustrated for simplicity as consisting of a simple electrical circuit having a power supply 28, a switch 29 and heater 30. When the seal 24 is broken, switch 29 is closed to bring about the desired heating of the fugitive potting. By heating the compound 23 in the manner disclosed or by any other suitable means, sublimation thereof will be assured regardless of the surrounding temperature.

In order to fully protect sensitive devices 12 and 22 from shock damage from forces as high as 50,000 g and to protect them from any harmful chemical changes due to the presence of moisture or other corrosive agents that could be encountered before they are to be activated, the fugitive potting must completely surround the devices including their intricate parts, it must completely fill the container, and it must remain a solid throughout the storage period. For military applications, to which this invention especially applies, the compound must be solid up to 160° F.

To accomplish the above objectives this invention utilizes a bi-cyclic compound as the fugitive potting material 12 and 23 chosen from the following group:

Compound	Melting Point (° C.)	Boiling Point (° C.)
Bi-cycloheptane (2,2,1)	87	105
Camphor	176	204
Naphthalene	80.22	217.9

The above compounds will sublime at standard atmospheric conditions and are solids above the top of the military storage range of 160° F. or 71° C. as is evident from the above tabulation. These compounds also readily lend themselves to liquid encapsulation under standard atmospheric pressure because their vapor pressures at their melting points are substantially below one atmosphere or 760 mm. Hg, and their boiling points are sufficiently above their melting points to allow pouring of the compound in liquid form without virtual boiling. By heating any of these fugitive potting compounds to a temperature slightly above its melting point it can be easily poured or injected into the container to completely fill the cavity and surround the mechanism. Furthermore, these bi-cyclic compounds are prepared in pure form and therefore their chemical and physical properties or predictable and uniform.

The specific bi-cyclic compound that is particularly useful as the fugitive potting material for military purposes is bi-cycloheptane (2,2,1). In addition to having good pouring qualities needed for feasible liquid encapsulation it has the desirable characteristics of being an excellent dielectric material, chemically inert, non-corrosive and non-toxic, and economical to produce.

In the practice of my invention, the delicate device 12 to be protected is first placed or otherwise positioned within its container 11. A quantity of bi-cycloheptane as the fugitive potting compound 13 is then heated slightly above its melting point and is poured or injected into the container until it is completely filled. The container is then closed by sealing means 14 and the bi-cycloheptane is allowed to cool and solidify. The gear train mechanism 12 is now completely protected from its environment and it will remain in this safe condition throughout the extreme temperature conditions that it may encounter within the military storage range. At the point of use, the seal 14 is broken by striker means 15 and the fugitive potting sublimes at the ambient temperature and pressure leaving the mechanism 12 free to operate.

It will be apparent that the embodiment shown and described are only exemplary and that various modifications can be made in construction and arrangement within the scope of the invention as defined in the appended claims.

I claim as my invention:

1. Apparatus for protecting a delicate mechanism against adverse environmental conditions, comprising:
   (a) rigid casing means enclosing said mechanism for transporting said mechanism to its operating site,
   (b) said casing being provided with means for sealing the interior of said casing from the ambient atmosphere before transportation,
   (c) seal-breaking means secured to said casing,
   (d) heating means secured to said casing,
   (e) a sublimable solid potting compound completely occupying the space within said casing not taken by said mechanism and by said seal-breaking means and by said heating means,
   (f) said mechanism being held rigidly in an inoperable position by said potting compound, and
   (g) means for activating said seal-breaking means and said heating means, thereby causing said potting compound to sublime and rendering said mechanism operable.

2. Apparatus according to claim 1, said potting compound being chosen from the group of bi-cyclic compounds of bi-cycloheptane, camphor, and naphthalene.

3. Apparatus according to claim 2 wherein the potting compound is bi-cycloheptane.

4. Apparatus according to claim 2 wherein the potting compound is camphor.

5. Apparatus according to claim 2 wherein the potting compound is nahpthalene.

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