

United States Patent

Evans et al.

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[54] **EXPLOSIVE ASSEMBLY
INCLUDING A BODY PORTION AND A
CLOSURE HAVING A COVERING OF
ELASTOMERIC MATERIAL**

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[58] Field of Search **260/2.5 F, 889; 102/105**

[56]

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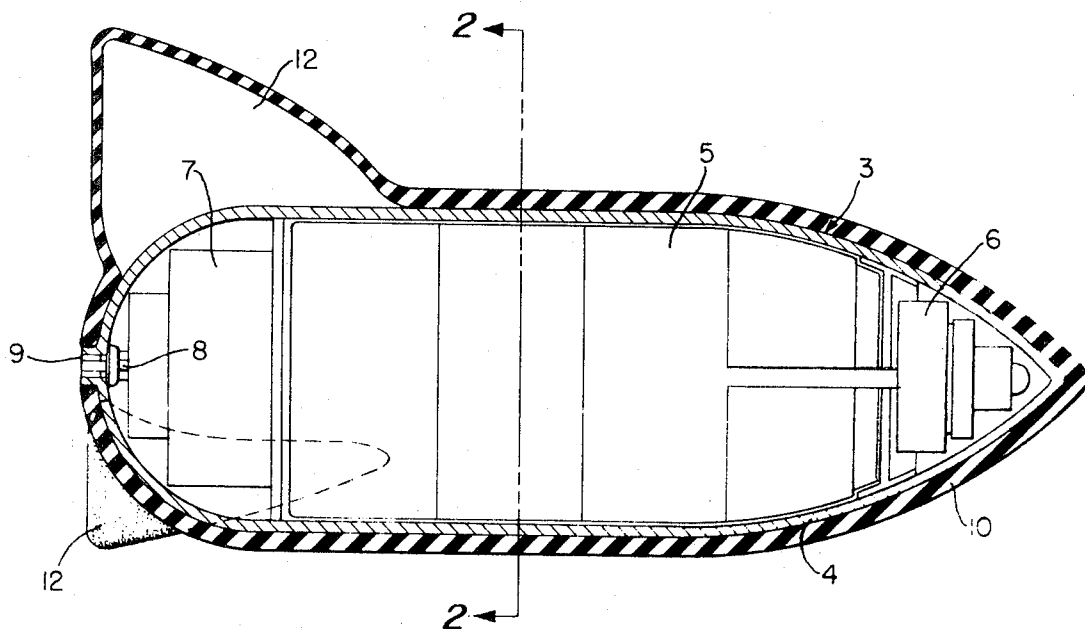
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[57]

ABSTRACT

This invention relates to an explosive assembly having a body portion and closures therefor, the body portion and closures having a covering of an ablative elastomeric material where the elastomeric material is polybutadiene acrylonitrile, polychloroprene and mixtures thereof with polyvinyl chloride that is compounded with a curative, plasticizer and a burn resistant agent, preferred plasticizers being phenol formaldehyde resin or polyethylene of 8,000 to 15,000 molecular weight.

4 Claims, 2 Drawing Figures



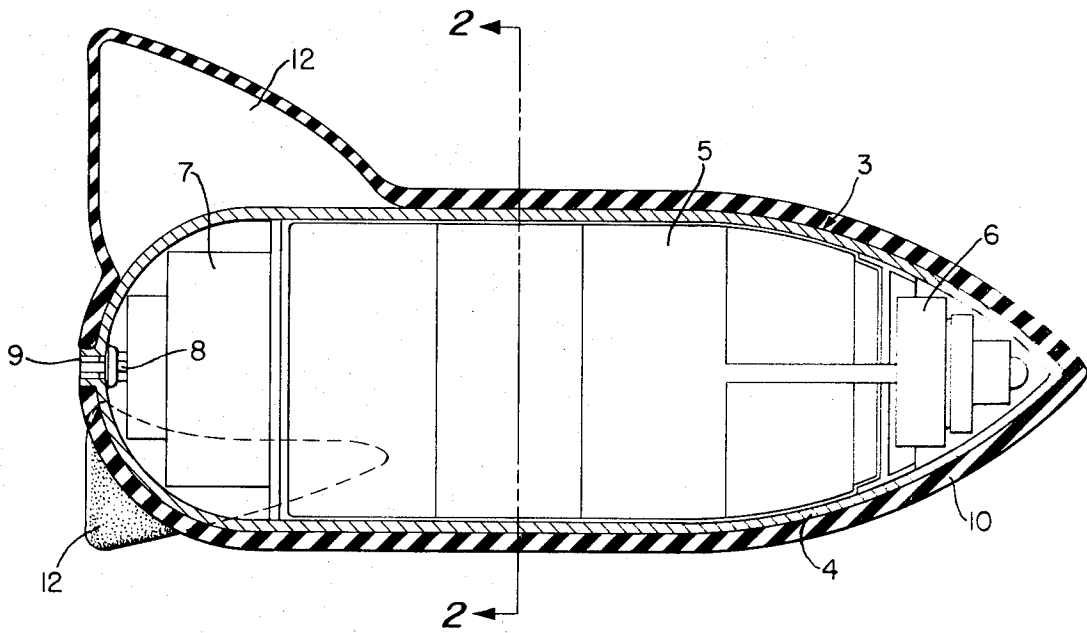


FIG. 1

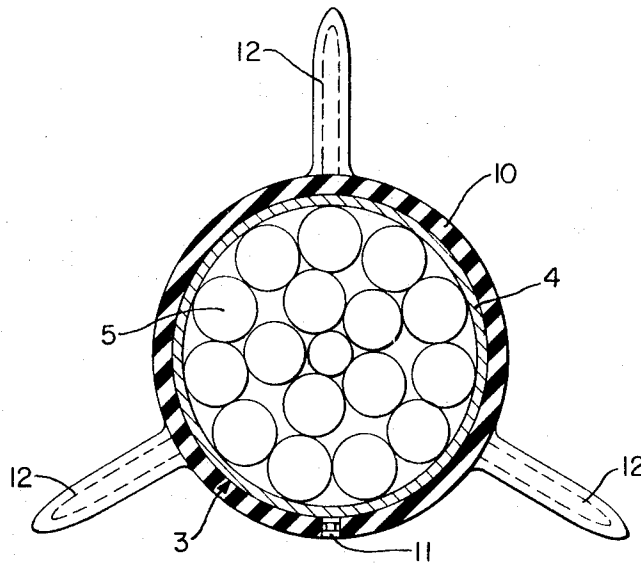


FIG. 2

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EXPLOSIVE ASSEMBLY INCLUDING A BODY PORTION AND A CLOSURE HAVING A COVERING OF ELASTOMERIC MATERIAL

This invention relates to a protective cover for apparatus and equipment to be protected from high temperature. More particularly, this invention relates to protective covers for fuel or solvent storage tanks and container-type explosives including bombs and rockets and to the method of making and providing the protective cover for said shells or equipment including the protective compositions.

Shells, bombs and other container-loaded explosives have to be handled and stored until they are used and this storage and handling presents a safety problem. This safety problem is particularly aggravated when fire breaks out in the vicinity of the ammunition or fuel storage area. It is particularly desirable that some means be provided to protect fuel, shells or bombs from immediate ignition or explosion upon contact with fire, for instance, if a few minutes protection is provided it frequently provides sufficient time to isolate the fire or to confine the hazard of the explosive from the fire.

Therefore, an object of this invention is to provide a protective cover for apparatus or equipment, shells, bombs, rockets and related container filled explosives to protect them from fire to thereby increase the time available to isolate the fire hazard.

This object and other advantages of this invention can more readily be seen by reference to the drawings wherein

FIG. 1 is a longitudinal cross-sectional view through a bomb and

FIG. 2 is a cross-sectional view along the line 2—2 of FIG. 1.

In the drawing, numeral 3 represents in general a shell or bomb having a metal casing 4, an explosive mixture 5 therein and a detonating means 6 at the end of the shell. Normally a covering 13 of asphalt, wax or resin is applied to the inside of the casings to protect the explosive from shock, etc. Numeral 7 represents a cap member containing a firing or aiming mechanism with electrical lead-in or lines 8 and plug-in 9 for the lines. Thus, in general it can be said that the explosives of FIGS. 1 or 2 represent a typical shell or bomb. Numeral 10 designates the protective coating which encapsulates the metal casing 4 of the shell. Referring to FIG. 2 it will be noted that the protective covering 10 in this embodiment has a zipper-type means 11 to open the protective cover and permit its removal from the shell just prior to the time the shell is to be fired or used. Alternately, the protective cover may be adhered tightly to the shell and may be fired with the protective cover around the shell except this embodiment may have a tendency to reduce the impact or fragmentation velocity upon explosion of the shell. Likewise, the protective covering may reduce the scatter where a fuel storage tank explodes or burns.

The protective cover may be fabricated as an envelope, as indicated above, and thus be wrapped or taped tightly around the shell or ultimately it may be equipped with zipper-type means or even buttons or other fastener means to permit the cover to be placed on the shell and attached to the shell with the desired degree of rigidity.

The protective cover in one embodiment is prepared by compounding suitable elastomeric materials with suitable compounding agents to give a protective cover which has sufficient burn resistance to insulate the shell or bomb from heat or burning therethrough for several minutes and preferably for 5 to 10 minutes when exposed to a flame such as that of an ordinary laboratory gas burner. The compounding of the rubber may be achieved on a mill or a banbury and then the compounding material is sheeted out on a calendar, preferably to a thickness of about one-sixteenth to one-half of an inch with the preferred thickness being about one-eighth to three-sixteenth of an inch. This sheeted material then is cut to appropriate dimensions for the size shell or bomb to be covered. This sheeted material is then wrapped around the shell and pressed into tight contact around the shell in the various curved or tapering portions to obtain a tight fit in the well-known manner of laying up of rubber sheet over a form. In this instance it should be emphasized that the shell serves as a form

in laying up the rubber to achieve the desired contact and fit of the protective cover on the shell.

In those instances where the shell and the protective cover are not to be separated it is desirable to place the protective cover on the metal casing of the shell and then the protective cover is cured around the shell with the desired accessory opening such as for adding fuses or electrical plug-ins, in the instance of a bomb. With the shell containing the protective cover cured thereon the shell then can be filled in the normal manner with the explosive. The filling opening of the shell containing a protective cover is closed in the usual manner with a cap or plate, preferably the cap or plate also contains a covering of this protective material to insulate or protect it from the fire.

Where the missile is in fact a bomb, with fins 12 to stabilize its fall or flight, it is preferred that the fins also be covered with the protective material as part of the protective cover for the missile.

Representative of materials that can be used for making the protective cover are those showing in the following representative examples where all parts are by weight unless otherwise designated.

EXAMPLE I

The ingredients in the recipes of table I were compounded in a Banbury mill and then the stock was fed to a calendar mill to form the stock into sheets 0.030 inches by 13 inches wide and wrapped on a 3½ inch O.D. aluminum mandrel covered with cellophane foil to give a covering having 0.60-inch oversize gauge. The covering was then wrapped with a wet nylon curing tape and cured in an autoclave for 30 minutes at 325° F. Since the protective cover on the aluminum mandrel was oversize it was turned down on a lathe to give a protective cover of 0.125 inches thick. The rubber sleeve or protective cover was removed from the mandrel and placed or mounted on a 3½ inch O.D. by 12-inch steel pipe having thermocouple leads placed therein to measure the temperature of the pipe during the fire testing of the cover. The steel pipe with protective cover was then subjected to a jet fuel fire test where heat input to the protective cover was 40,000 B.t.u. per hour per square foot and the time to reach explosive temperature measured with a thermocouple.

TABLE I

Recipe Number	25	32	C-2	C-3	C-4	C-17
Neoprene (GNA) rubber	100.00	100.00	100.00	100.00	100.00	100.00
Butadiene acrylonitrile rubber			100.00			
Stearic acid	1.50	1.50	2.00	1.50	1.50	1.50
Carbon black	30.00	30.00				
Zinc oxide	10.00	10.00	5.00	5.00	5.00	5.00
Magnesium oxide	10.00	10.00		5.00	5.00	5.00
Sym-di-B-Naphthyl phenylene diamine	2.00	2.00		2.00	2.00	2.00
Phenyl beta naphthylamine	2.00	2.00		2.00	2.00	2.00
Durez resin:						
12687			120.00	120.00	120.00	120.00
11578		75.00				
Chlorinated wax	40.00	40.00			30.00	30.00
Antimony oxide	25.00	25.00			15.00	
Oncor 23A ¹						15.00
Boracic acid			80.00	80.00	80.00	80.00
Tetra methyl thiuram disulfide			3.00			
Total	220.50	295.50	310.00	315.50	380.50	380.50

¹ The chlorinated wax in these examples had a 40% chlorine content whereas the chlorinated wax used in the other samples had a 70% chlorine content.

² Oncor 23A is a mixture of 50% antimony oxide with silicon oxide precipitated thereon.

The jet fuel fire test results are shown in table II:

Table II

Recipe No.	Protection time, minutes
25	6
32	6
C-2	6
C-3	6
C-4	6
C-17	6

EXAMPLE II

The compound recipe of table I and table III were formed and sheeted out. Tensile sheets were cut from these sheets and subject to burn test described in table IV to determine seconds required for tensile sheet to reach 288° F. The results of these tests are shown in table IV.

TABLE III.—COVER COMPOUND FORMULATIONS

Recipe Number.....	C3-I	C4-I	C39	C40
Neoprene GNA.....	100.0	100.0	100.0	100.0
Stearic acid.....	1.5	1.5	1.5	1.5
Durez resin 12687.....	120.0	120.0	120.0	120.0
Magnesium oxide.....	5.0	5.0	5.0	5.0
Zinc oxide.....	5.0	5.0	5.0	5.0
Syn-di-B-naphthyl phenylene diamine.....	2.0	2.0	2.0	2.0
Phenyl-B-naphthylamine.....	2.0	2.0	2.0	2.0
Boric acid.....	80.0	80.0	80.0	80.0
Oncor 23A.....	15.0	15.0	15.0	15.0
Chlorinated oil.....		30.0		
Chlorinated polyethylene.....			20.0	10.0
Total.....	330.5	360.5	350.5	340.5

EXAMPLE III

Test samples were made by compounding the ingredients according to recipe numbers shown in table V in a Banbury mill and sheeting. The test specimen (4.5"×4.5"×0.070") were cut from the sheet and subjected to a burn test in a Fisher burner at a flame temperature of 1,600° F. and timed to reach 288° F. as indicated by a 288° F. thermal stick, was observed. The results of these burn tests are tabulated in table V. It should be noted that the protective efficiency of the covering has been more than double where the recipe contains a thermoplastic phenol formaldehyde resin. For instance, compare the burn tests on samples 47 to 50 with those for samples 25 or C-3. Thus, the use of 10 to 60 parts of a two-stage thermoplastic phenol formaldehyde resin, preferably without a phenol formaldehyde curative, with each 100 parts of Neoprene compounded with curing agents, fillers and extenders for said Neoprene, gives a protective cover which offers improved protection from the sudden heat rises occasioned by exposure to a fire.

TABLE V

Recipe Number.....	47	48	49	50	51	52	53	54	55	56	57	58
Neoprene GNA.....	100.0											
Stearic acid.....	1.5											
Magnesium oxide.....	5.0											
Zinc oxide.....	5.0											
Phenyl beta naphthylamine.....	2.0											
Oncor 23A.....	15.0											
2-mercaptimidazoline.....	0.5											
Chlorinated wax.....	30.0											
Durez 13037.....	45.0	30.0	60.0									
Boric acid.....					21.0	80.0						
Sym-B-naphthyl-p-phenylene-diamine.....	2.0											
Durez 11504.....				30.0								
Polyethylene, low m.w.....						3.0	60					
Chlorinated polyethylene.....								5.0	10.0	10.0		
Chlorinated wax.....										15.0	30.0	45.0
Burn test, seconds:												
Trial Number:												
1.....	68.0	68.5	68.8	72.9		104.3	59.3	56.0	61.9			
2.....	64.3	65.2	66.0	69.9		99.8	63.2	56.5	61.2			

Recipe No.

Polyvinyl chloride.....	50.0
67/33 Butadiene acrylonitrile polymer Mooney 70.....	50.0
Barium cadmium zinc vinyl stabilizer.....	1.4
Hydrogenated soya fatty acid.....	0.2
Vinyl stabilizer.....	0.2
Epoxy soya oil plasticizer.....	1.5
Tricresyl phosphate.....	25.0
Oncor 23A.....	10.0
Boric acid.....	50.0
Carbon black.....	1.0
	189.3

BURN TEST RESULTS

The burn test was conducted in a 1,600° F. flame of a Fisher burner. Results in the table are "seconds to 288° F." Burn test sample was a 0.075"-0.079" thick tensile sheet of the respective compounds. A 288° F. Tempil stick was used to mark the tensile sheets and indicate the temperature. It should be noted that the burn test sheets had been cured for 60 minutes at 324° F. before being subjected to the burn test.

Table IV

Recipe No.	Seconds to 288° F.	Time
25		13.8
32		15.9
C2		23.4
C3		23.4
C3-I		23.9
C4		21.0
C4-I		24.5
C14		21.95
C15		23.9
C16		24.15
C39		31.4
C40		33.2

EXAMPLE IV

The sample specimens 4.5"×4.5"×0.070" were made on the stocks identified as recipes No. 25 and C-17. These samples were marked with a 288° F. Tempil stick (a temperature-indicating crayon) and placed in the flame of a Fisher burner at a temperature of 1,600° F. and the time in seconds required for the samples to reach 288° F. was noted.

Another group of these sample specimens were placed in a hot air oven at 325° F. for one hour to cure. The sample specimen expanded to 7"×7.5"×0.350". The cooled cured samples were subjected to the burn test and time required for the samples to reach 288° F. noted. The results of these tests are shown in table VI.

Table VI

Recipe No.	25	C-17
Burn test, Sec.		
Before cure	14	24
After cure	330	200

This burn test data indicates approximately a 10-fold improvement in burn resistance was achieved by the cure treatment. Since the samples expanded on curing it was observed that they were porous in nature and the improved burn resistance was attributed to this induced porous nature of the cured samples (example V). To further enhance this burn resistance runs 20 and 21 were made with the recipes of Nos. 20 and 21 of table VII. When the burn test data for the samples

made using recipes Nos. 18 and 19 are compared with Nos. 20 and 21 it will be noted that the curing of samples 20 and 21 with a blowing agent such as azidocarbonamide gave approximately a 50 percent improvement in burn resistance. Thus, use of about 0.5 to 10 parts and preferably one to seven parts of a blowing agent such as azobisformamide, azobisisobutyronitrile, diazoaminobenzene, N,N'-dimethyl-N,N'-dinitrosoterephthalamide, N,N'-dinitrosopentamethylenetetramine, benzenesulfonyl-hydrazide, toluene-(4)-sulfonyl hydrazide, benzene-1,3-disulfonyl hydrazide, diphenylsulfon-3,3'-disulfonyl hydrazide, 4,4'-oxybis(benzenesulfonyl hydrazide), or the lower boiling solvents in the protective cover enhances the degree of porosity of the cured or finished cover and thus improves the cover's protective ability relative to fire.

TABLE VII

Recipe Number	BC 14	BC 15	BC 16	17	18	19	20	21
Polyvinyl chloride	50.0							
67/33 butadiene acrylonitrile polymer	50.0							
Barium cadmate zinc vinyl stabilizer	1.4							
Hydrogenated soya oil plasticizer	0.2							
Vinyl stabilizer	0.2							
Epoxy soya oil plasticizer	1.5							
Tricresyl phosphate	25.0	25.0						
Chlorinated polyethylene				10.0	20.0	30.0	25.0	25.0
Oncor 23A	10.0							
Boric acid	25.0							
Carbon black	1.0							
Azodicarbonamide							4.0	6.0
Burn trial at 1,600° F., seconds to 300° F.:								
No. 1	22.1	24.0	24.2	28.7	21.9	19.0	30.1	32.6
No. 2	21.8	23.8	24.1	28.9	22.0	19.4	29.8	32.0

TABLE VIII

Recipe Number	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Neoprene GNA		100														
Stearic acid								1.5								
Durez 12687					25.0			120.0								
Magnesium oxide			4.0					5.0								
Zinc oxide			5.0					5.0								
Sym-B-naphthyl-p-phenylene diamine								2.0								
Phenyl-B-naphthylamine								2.0								
Boric acid								2.0								
Durez 11578				25.0			25.0	80.0								
Carbon black, SRF		5.0														
Hydrite alumina		20.0	30.0	40.0	30.0	30.9	30.0									
Sodium borate		10.0														
Boric anhydride							4.0									
Antimony oxide			15.0													
2-mercaptoimidazoline			0.5													
Poly-B-chloroethyl triphosphonate								10.0	20.0	30.0						
Chlorinated polyethylene																
Oncor 23A											**10.0	**20.0	10.0	20.0	**10.0	**20.0
275° F. trial	19.1	16.3		19.8	18.8	17.8	17.4	20.7	24.8	26.2	25.1	26.4	27.9	32.0	35.6	27.6
300° F. trial	14.8	12.6		16.4	14.9	13.7	14.0	18.3	20.8	21.2	22.3	22.8	23.6	31.0	31.0	21.5

The chlorinated polyethylene (in table VII) marked ** contained 25 to 30 percent chlorine, whereas others contained 10 to 20 percent.

The foregoing examples and disclosure indicates an ablative elastomer of about 50 to 400 mils, and preferably 100 to 300 mils, on a metallic body such as steel, copper, bronze, aluminum and related body materials reduces the heat transmission and thus delays the time an explosive mixture reaches the explosive limit from heat.

While certain representative embodiments and details have been shown for the purpose of illustrating the invention, it will be apparent to those skilled in this art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

What is claimed is:

1. An explosive assembly including a body portion and closures therefor, said body portion and closure having a covering of 50 to 400 mils of elastomeric material on the outside surface thereof, said covering material being characterized by a burn resistance sufficient when a specimen 4.5''x4.5''x0.070'' is subjected to a flame of about 1,600° F. from a Fisher burner, the time for the side opposite the flame to reach 288° F. being 13.8 seconds or longer, said elastomeric material being selected from the class of

A. a copolymer of acrylonitrile-butadiene,

B. polychloroprene, and

C. mixtures of (A) with polyvinyl chloride.

2. The assembly of claim 1 wherein the elastomer is compounded with a two-stage phenol formaldehyde resin.

3. The assembly of claim 1 wherein the elastomeric material is porous.

4. The assembly of claim 1 wherein the elastomer is compounded with about 1 to 6 percent by weight of a polyethylene of 8,000 to 15,000 molecular weight.