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(54) **Energetic gun propellant coating.**

(57) A method for fabricating (10) a gun propellant coating by weighing (12) a quantity of propellant and mixing it with glycidyl azide polymer (GAP) (14). A catalyst may also be added before consolidating (18) the coated propellant.

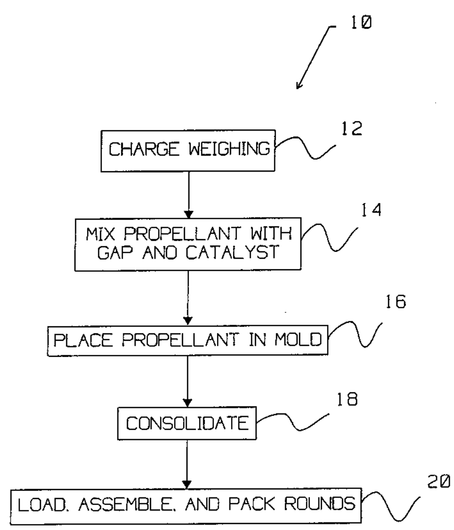

Fig. 2

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1. Field Of The Invention

The present invention relates to the field of cased telescoped propellant and, in particular, an energetic gun propellant coating employing Glycidyl Azide Polymer (GAP) and a method of manufacturing an energetic gun propellant coating.

2. Discussion Of The Prior Art

Methods of the prior art disclose a gun propellant coated with polyvinyl acetate or polyvinyl nitrate (PVN) which is consolidated in a heated die. Such a heated die is shown in Figure 1. The die comprises top and bottom punches or rams 1 and 4, respectively, and spray nozzles 7 for spraying solvent 6 onto a propellant 5. The die itself comprises a top member 2 and a bottom member 3 for containing and compressing the propellant 5 in cooperation with the punches 1, 4 which press inwardly against the propellant and solvent mixture under heat treatment.

Modern techniques employ methods and apparatus which consolidate a propellant using a reduced amount of solvent. Unfortunately, the fact that solvent must be used at all requires an extra process step which takes a significant amount of time to complete. Further, once added, the solvent must later be removed which also significantly increases the process time for coating a propellant.

In contrast to the prior art, for the first time, the invention offers a method for coating a cased telescoped propellant which does not require the use of solvent. As a result, the method of the present invention reduces processing time for labor intensive solvation, and compaction and drawing processing which may take up to eight days.

Further, in contrast to the prior art, which does not address hygroscopicity or insensitive ammunition advantages, the GAP coated propellant of the present invention offers a new material for deterring propellants. The method of the present invention inhibits water penetration into the propellent, offers insensitive ammunition advantages, and produces better ballistic performance. Thus, the performance of GAP coated propellants is improved over, for example, the PVN coated propellants of the prior art.

The present invention provides a method for fabricating an energetic gun propellant coating. The method includes the step of weighing a quantity of propellant. The quantity of propellant is mixed with Glycidyl Azide Polymer (GAP). The mixed propellant is placed in a mold and consolidated.

SUMMARY OF THE INVENTION

In contrast to the prior art, the present invention provides a method for fabricating a gun propellant coating by weighing a quantity of propellant and mixing it with glycidyl azide polymer (GAP). A catalyst may also be added before consolidating the coated propellant.

In one aspect of the invention, a catalyst is added to the mixture of propellant with GAP.

In another aspect of the invention the catalyst may consist of a material selected from the group including triphenyl bismouth, dibutyl tin laureate, stannous octalate, and methyl di-aniline.

Other objects, features and advantages of the invention will become apparent to those skilled in the art through the claims, description of the preferred embodiment and drawings herein wherein like reference characters refer to like elements.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a propellant mold of the prior art used for coating and compacting gun propellant.

Figure 2 illustrates a slow cure method in accordance with the method of the invention for curing a gun propellant without the need for solvation.

Figure 3 shows an alternative fast cure approach for curing a gun propellant without the need for a solvation step in accordance with the method of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Glycidyl Azide Polymer (GAP) is an energetic material available from 3M Corporation of St. Paul, Minnesota. By applying a 3% mixture of GAP to a propellant with a catalyst, the material forms a coating on the propellant. The coated propellant, prior to cure, may be compacted to achieve a higher density propellant charge than may be accomplished through standard loading methods. Ballistic tests of the coated propellant show that the GAP coating acts as a surface deterrent. Its energetic nature, however, does not effect the underlying propellant ignition which is critical for rapid fire guns. Initial tests also show that GAP coated propellant produces superior ballistic performance.

The GAP coated propellant of the present invention also has other significant advantages. The coating greatly reduces the hygroscopicity of the propellant. This is significant because lower hygroscopicity extends the life and improves handling characteristics of propellants as compared to the current state of art. One gun propellant performance characteristic which may be improved over the prior art is moisture sensitivity. The present invention provides a reduction in hygroscopicity which may allow more ammunition to be packed without requiring metallic cartridge cases.

The GAP coated propellant as provided by the present invention also has improved insensitive munition properties. The coating does not substantially propagate burning at ambient pressure. Therefore, if a cartridge case is adequately designed to open under low pressures when outside of the gun chamber, the propellant is resistant to burning.

Referring now to Figure 2, a slow cure process in accordance with the method of the invention for coating propellant is shown. In the slow cure method 10 shown in Figure 2, the fabrication process for the GAP propellant grains includes the steps of charge weighing at step 12, mixing the propellant with GAP and a catalyst at step 14, placing the propellant in a mold at step 16, consolidating the propellant at step 18, and loading, assembling and packing rounds at step 20. Charge weighing at step 12 may be accomplished using a known method of weighing grains of propellant in accordance with weight specifications required by the cartridge being manufactured. For example, propellant grains may be weighed in quantities of 50 grams for some applications.

After weighing, the propellant is mixed with GAP and a catalyst using any conventional mixing apparatus. For example, a propellant may be mixed in batches with GAP and stirred or, as another example, GAP may be sprayed onto a layer of propellant on a conveyor belt with a conventional catalyst.

The charge consolidation at step 18 may be carried out by conventional means. For example, each grain of propellant may receive a load of about 14,000 pounds or more for about 3 minutes, ± .2 minutes, on a single compacting press. After consolidation, the propellant is prepared to be loaded, assembled and packed into rounds at step 20.

Referring now to Figure 3, an alternative fast cure approach for curing a gun propellant without the need for a solvation step in accordance with the method of the present invention is shown. The alternative method 30 comprises charge weighing at step 12, mixing propellant with GAP at step 34, placing propellant in a mold at step 36, spraying catalyst through the propellant at step 38, consolidation of separate propellant at step 18 and loading, assembling and packing into rounds at step 20. Note that the charge weighing at step 12, consolidation at step 18, and loading, assembling and packing rounds at step 20 are substantially the same as discussed hereinabove with reference to Figure 2. The process differs after the charge weighing step wherein the propellant is mixed with GAP at step 34. However, in a departure from the slow cure process of Figure 2, the catalyst is not yet introduced at this point in the fast cure method. The propellant mixed with GAP is then placed in a mold at step 36. After the propellant has been placed in the mold, a spraying apparatus is used to spray the catalyst throughout the propellant while the propellant is residing in the mold. The mold may be any conventional mold as is known by those skilled in the art. The spraying apparatus may be any conventional spraying apparatus and the catalyst may be sprayed in amounts in accordance with the desired set time. The spray is adjusted until the desired set time is achieved.

Possible catalysts for use in any of the methods described herein include triphenyl bismouth, dibutyl tin laureate, stannous octalate, and methyl di-aniline. The triphenyl bismouth and dibutyl tin laureate may be used as recommended by the GAP manufacturer. Stannous octalate may be used as a cure for curing in about 5-10 minutes when used in 2 parts stannous octalate to 100 parts polymer. Methyl di-aniline may be used as a cure for curing in less than 5 minutes when used in 12 parts methyl di-aniline to 100 parts polymer. Methyl di-aniline has been used in spray applicators as a pure solution and also diluted in methyl ethel ketone (MEK). However, the use of MEK as a diluent is not preferred because the MEK is a solvent which must be removed downstream in the process. Use of methyl di-aniline may result in an almost immediate cure as the MEK is removed by vacuum, for example.

Tests were conducted by Alliant Techsystems, Inc. of Edina, Minnesota on GAU-8 munitions. GAU-8 munitions are 30 mm rounds for use in a Gatling type gun employed on the A-10 Fairchild aircraft. The results of the GAU-8 tests are shown in the summary table below. As GAP coated propellant was added, the ballistic performance decreased. The performance decrease is believed due to a mixture of 2.83% GAP coating (and 97.17% propellant by weight) replacing more energetic components in the 150 gram propellant charge load. More significantly, the GAP coating appears to deter the propellant burning process. The GAP coated propellant did not appear to inhibit ignition at 70 °F. This is demonstrated by the consistent standard deviations and linear response to adding more GAP coated propellant.

In the table:

N is defined as the number of rounds,

S is the standard deviation, sigma, and

BS-1368 is a lot number designating a particular propellant manufactured by Hercules Corporation.

GAU-8 GAP Test Result Summary				
	N	Muzzle Velocity	Case Mouth Pressure	Action Time
Reference Rounds	5	3373 fps s = 5.0	53.3 Kpsi s = 0.4	4.441 msec s = 0.036
150g BS-1368	3	3408 fps s = 7.3	48.3 Kpsi s = 0.6	4.715 msec s = 0.017
75g BS-1368 + 75g GAP Coated BS-1368	3	3316 fps s = 14.0	42.9 Kpsi s = 0.8	5.300 s = 0.066
150g GAP Coated BS-1368	3	3211 s = 10.8	37.3 s = 0.6	5.929 s = 0.063

A software program called GUNS was also used to predict the response of GAP coated propellant, treating GAP for simulation purposes as if it acted as a common deterrent such as methyl centralite, or Hercote (Hercote is a trademark of Hercules Corporation). GUNS is a software modeling program developed to model case telescoped ammunition.

The results below show that the GAP coated propellant exhibits higher velocity and lower pressure than expected. These results highlight the differences between GAP, which is a surface deterrent, and standard compositions, which serve as a distributed deterrent throughout the propellant grain. The GAP coating produces a more rapidly burning progressive grain.

GUNS Predictive Model Based GAP Acting Like Deterrent Coating		
	Muzzle Velocity	Case Mouth Pressure
150g BS-1368	3426 fps	48.5 Kpsi
75g BS-1368 + 75g GAP Coated BS-1368	3258 fps	44.0 Kpsi
150g GAP Coated BS-1368	2985 fps	38.8 Kpsi

The invention has been described herein in considerable detail in order to comply with the Patent Statutes and to provide those skilled in the art with the information needed to apply the novel principles and to construct and use such specialized components as are required. However, it is to be understood that the invention may be carried out by specifically different equipment and devices, and that various modifications, both as to the equipment details and operating procedures, may be accomplished without departing from the scope of the invention itself.

Claims

1. A method for fabricating (10) a propellant comprising the steps of:

(a) weighing a quantity of propellant (12);
(b) mixing the quantity of propellant with Glycidyl Azide Polymer (GAP) and a catalyst (14);
(c) placing the quantity of mixed propellant into a mold (16); and
(d) consolidating the quantity of mixed propellant (18).

2. The method of claim 1 for fabricating (10) a propellant, further comprising the steps of loading, assembling, and packing rounds (20) using the consolidated propellant.

3. The method of claim 2 for fabricating (10) a propellant wherein the step of mixing propellant with GAP and a catalyst (14) further including the step of spraying (38) as the catalyst one of a group of materials including triphenyl bismouth, dibutyl tin laureate, stannous octalate, and methyl di-aniline.

4. The method of claim 1 wherein stannous octalate is employed as a catalyst (38) in a solution of 2 parts to 100 parts polymer.

5. The method of claim 1 wherein methyl di-aniline is used as a catalyst (38) in a solution of 12 parts to 100 parts polymer.

6. A propellant (5) comprising a propellant (5) coated with Glycidyl Azide Polymer (GAP) (34).

7. The propellant (5) of claim 6 comprising at least a 2.8% mixture of GAP (34) to propellant (5) by weight.

8. A method for fabricating (30) a propellant comprising the steps of:
(a) weighing a quantity of propellant (12);
(b) mixing the quantity of propellant with Glycidyl Azide Polymer (GAP) (34);
(c) placing the quantity of mixed propellant into a mold (36);
(d) applying a catalyst through the mixed propellant (38); and
(e) consolidating the quantity of mixed propellant (18).

9. The method of claim 8 for fabricating (30) a propellant (5), further comprising the steps of loading, assembling, and packing rounds (20) using the consolidated propellant (5).

10. The method of claim 8 for fabricating (30) a propellant wherein the step of applying a catalyst further includes the step of spraying as the catalyst (38) one of a group of materials including triphenyl bismouth, dibutyl tin laureate, stannous octalate, and methyl di-aniline.

11. The method of claim 8 wherein stannous octalate is employed as a catalyst (38) in a solution of 2 parts to 100 parts polymer.

12. The method of claim 8 wherein methyl di-aniline is used as a catalyst (38) in a solution of 12 parts to 100 parts polymer.

13. A propellant (5) comprising a propellant (5) coated with Glycidyl Azide Polymer (GAP) (34) made according to the method of claim 1.

14. The propellant (5) of claim 13 wherein the GAP (34) comprises at least a 2.8% mixture of GAP (34) to propellant (5) by weight.

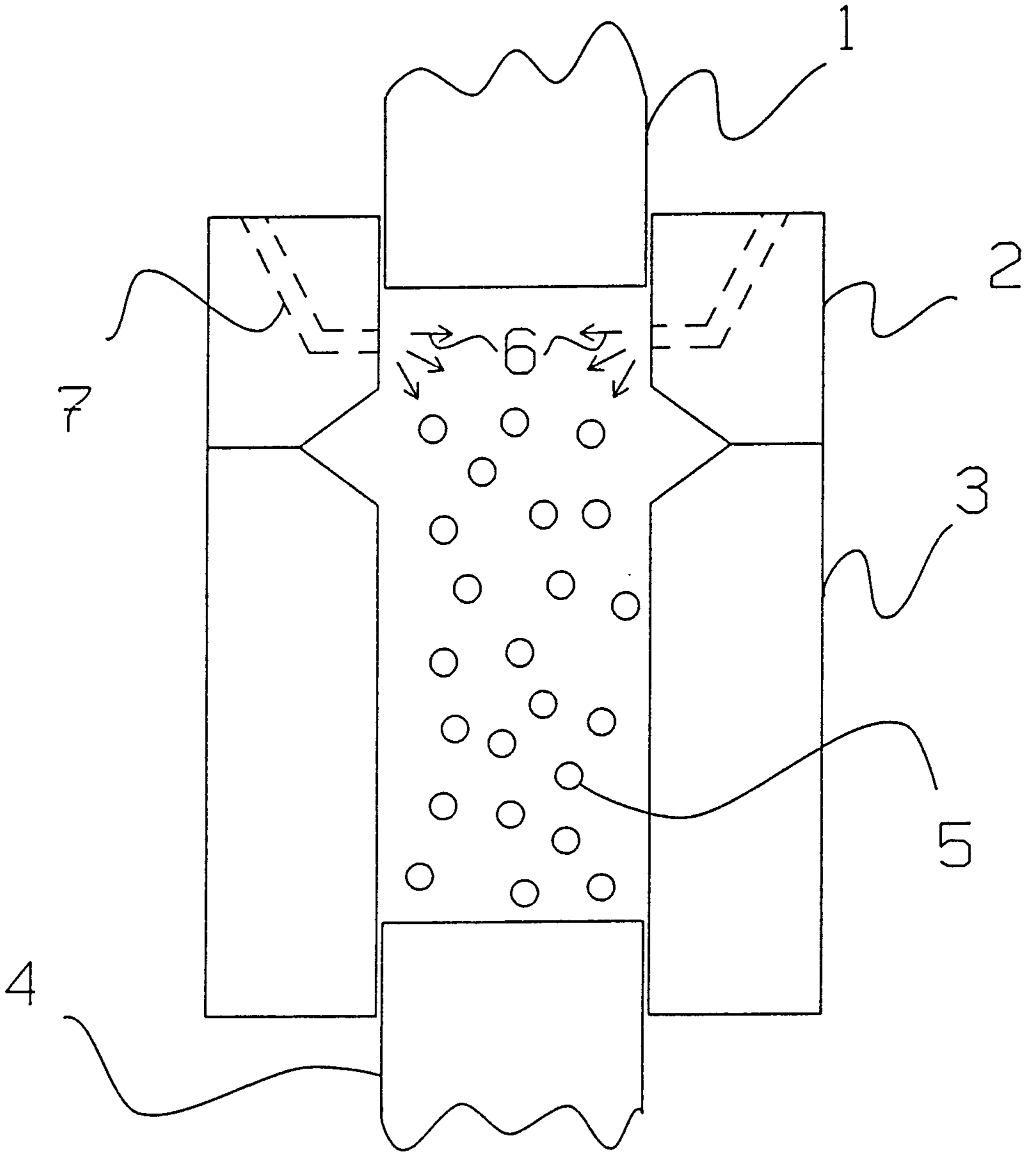

Fig. 1

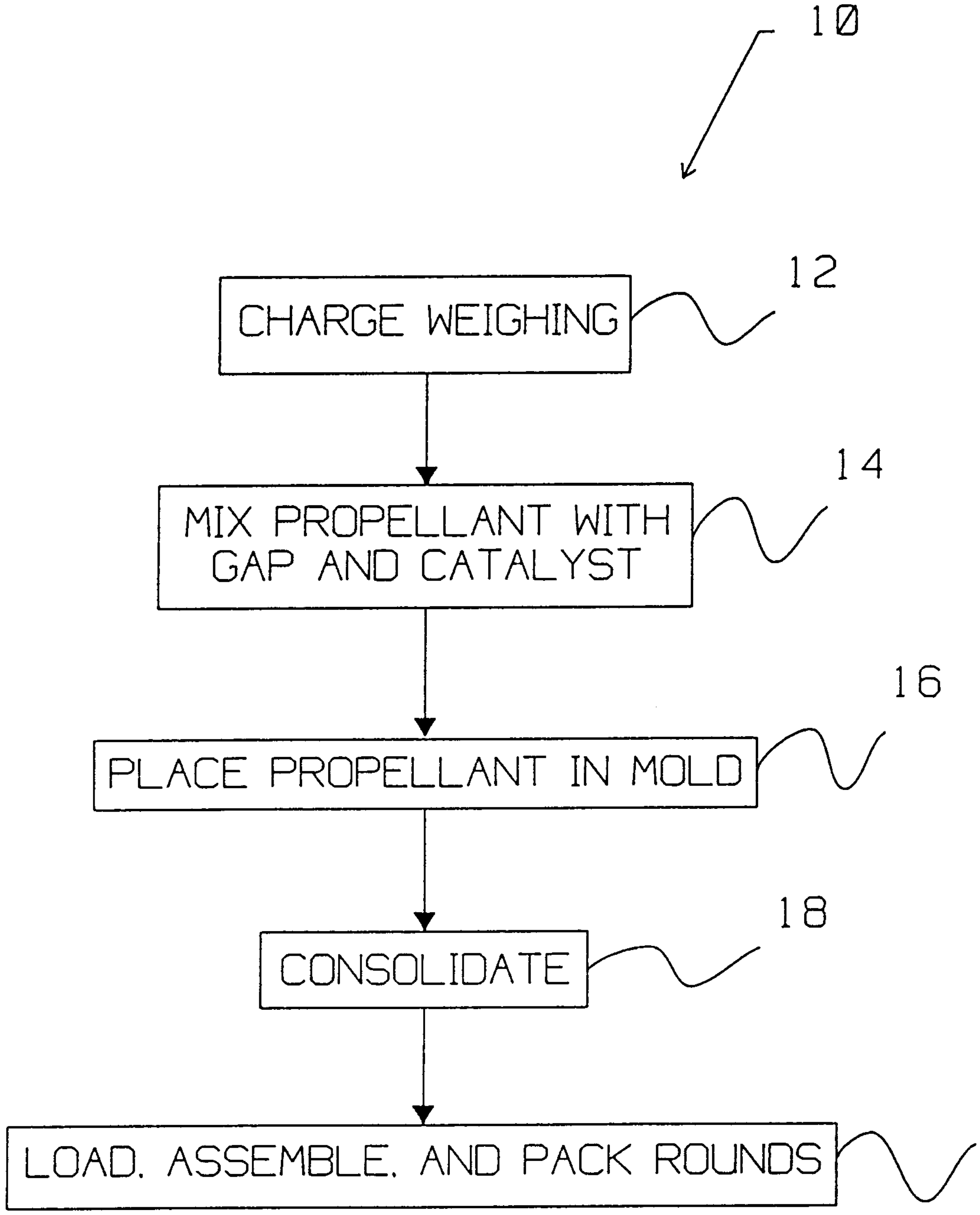
10
CHARGE WEIGHING
12
MIX PROPELLANT WITH GAP AND CATALYST
14
PLACE PROPELLANT IN MOLD
16
CONSOLIDATE
18
LOAD, ASSEMBLE, AND PACK ROUNDS
20

Fig. 2

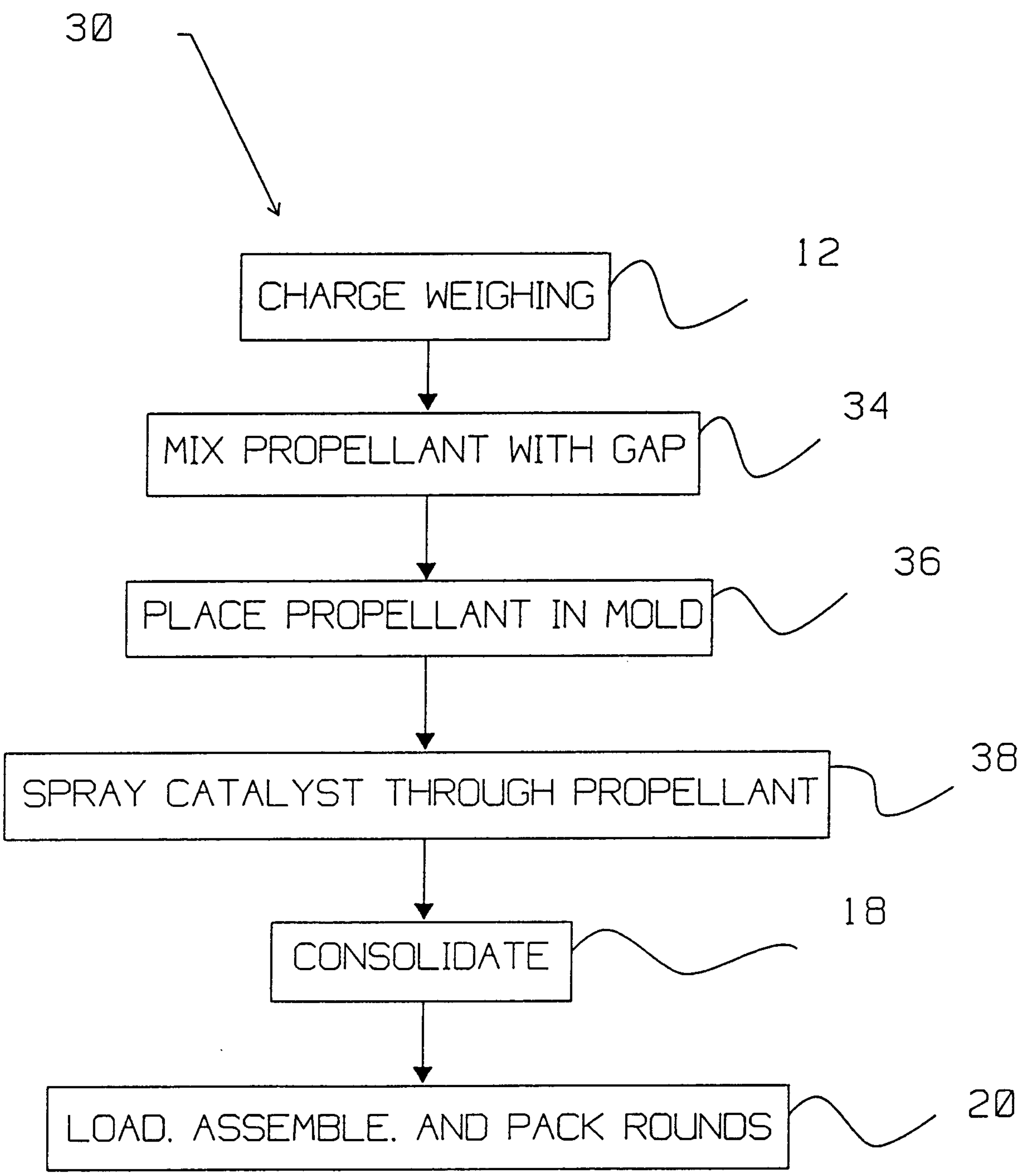
30
CHARGE WEIGHING
12
MIX PROPELLANT WITH GAP
34
PLACE PROPELLANT IN MOLD
36
SPRAY CATALYST THROUGH PROPELLANT
38
CONSOLIDATE
18
LOAD, ASSEMBLE, AND PACK ROUNDS
20

Fig. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 10 6584

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	US-A-5 164 521 (A.P. MANZARA ET AL.) * column 15, line 37 - column 16, line 63 *	1,6,8,13 2-5,7, 9-12,14	C06B45/10 C06B45/02 C06B21/00
Y	EP-A-0 446 085 (SOCIETE NATIONALE DES POUDRES ET EXPLOSIFS) * page 1 *	1-14	
Y	US-A-3 655 836 (H.C. DEHM ET AL.) * column 1, line 27 - line 34; claims * * column 1, line 52 - column 2, line 34 * * column 2, line 70 - column 3, line 4 *	1-14	
Y	EP-A-0 002 968 (SOCIETE NATIONALE DES POUDRES ET EXPLOSIFS) * page 1, line 7 - line 17; claims * * page 3, line 4 - line 17 * * page 4, line 20 - column 5, line 6 *	2,7,9,14	
Y	US-A-4 379 903 (R. REED, JR. ET AL) * column 3, line 28 - column 4, line 11; claims *	3-5, 10-12	**TECHNICAL FIELDS SEARCHED (Int.Cl.6)**
A	JOURNAL OF PROPULSION AND POWER, vol.8, no.3, May 1992, WASHINGTON, DC,US pages 560 - 563 M.B. FRANKEL ET AL. 'Historical Development of Glycidyl Azide Polymer' * table 1 *	1,6,8,13	C06B
A	US-A-3 682 726 (L. STIEFEL) * column 3, line 1 - line 52 *	1,8	
A	DE-A-24 49 777 (ROCKWELL INTERNATIONAL CORP.) * page 4, line 25 - page 5, line 36; claims *	1,8	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 November 1994	Schut, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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E : earlier patent document, but published on, or after the filing date
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