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(54) Titre : POUDRE PROPULSIVE POUR ARMES A CANON  
(54) Title: PROPELLENT CHARGE POWDER FOR BARREL-TYPE WEAPONS

(57) Abrégé/Abstract:

By virtue of the use of the dinitro diaza plasticiser the invention permits the production and use of propellant charge powder with a low temperature coefficient.

Abstract

By virtue of the use of the dinitro diaza plasticiser the invention permits the production and use of propellant charge powder with a low temperature coefficient.

(single Figure)

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## 10 Propellant charge powder for barrel-type weapons

The invention relates to a propellant charge powder for barrel-type weapons as set forth in the classifying portion of claim 1.

15 DE 35 00 068 C1 concerns a monobasic or polybasic propellant charge powder using 0,0'-dioxy azobenzene for the purposes of improving mechanical properties at down to -55°C. No information is given about temperature coefficients. In addition no diaza compound is used.

20 DE 33 16 676 C2 describes a propellant composition based on nitrocellulose with hexogen, a blasting oil and plasticiser or softener as well as nitroglycerine. No mention is made of a diaza compound however and there is also no information about temperature coefficients.

25 DE 30 33 519 C2 concerns a rocket propellant for a usually low pressure range upon combustion. No information is given about the pressure range which is relevant for propellant charge powder of over 3000 bars. Admittedly, some indications are afforded in regard to mechanical properties in a wide temperature range. There is however no information about temperature coefficients, dependency of the gas pressure on the temperatures of the propellant charge powder. The energetic plasticiser or softener is blasting oil such or Ng1 but no diaza compound.

30 A further known propellant charge powder as disclosed in DE 22 60 259 A involves a propellant composition for rockets and not a propellant charge for

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barrel-type weapons. That propellant charge, like generally  
all

dibasic propellants, is heavily temperature-dependent in the temperature range which is of interest.

US No 4 567 296 A describes an energetic plasticiser or softener on the basis of a fluorine-bearing aza compound. That aza compound, more specifically 1-fluoro-1,1,5-trinitro-3-oxa-5-azahexane is not suitable for use in barrel-type weapons and propellant charge powders. Upon combustion in a weapon, the steel is destroyed, particularly at the usually high pressures and temperatures. In addition that compound gives rise to a major disposal problem. The starting material 2-nitro-2-aza-1 propanol is chemically basically different from the dinitro diaza compounds according to the invention.

A better plasticisable propellant charge powder, in accordance with US-A-4 457 791, is based on a plasticiser DMMD. Further plasticisers as additives to that specified are not provided. There is no indication that the temperature coefficient upon combustion is positively influenced.

Transformation or the gas-generation rate of conventional monobasic and polybasic propellant charge powders is highly temperature-dependent. The greater the initial powder temperature, that much faster is combustion of the propellant charge powder. That property is substance-specific and can be described for example to a good degree of approximation by the combustion law as follows:

$$\gamma = \beta \cdot \left( \frac{p}{p_0} \right)^\alpha \cdot e^{\tau T}$$

with T as the temperature of the propellant charge powder. In that equation  $\tau$  denotes the so-called temperature coefficient of the propellant charge powder, which is of different values for the various powder compositions and which represents a substance constant. In addition  $\gamma$  denotes the velocity with which the combustion front progresses,  $\beta$  and  $\alpha$  represent substance constants and p is the pressure under which the propellant charge powder is, wherein  $p_0$  is atmospheric pressure.

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As a result of the temperature-dependency of the combustion speed of the propellant charge powder, the maximum gas pressure which occurs when firing munition with conventional monobasic and polybasic propellant charge powder from an armament, in the charge chamber of the weapon, and thus also the projectile launch velocity are also severely temperature-dependent.

The pressure and the velocity of 120 mm KE-munition rise from  $-40^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$  by about 1500 bars and 165 m/s, that is to say 10% of the reference or target speed at normal temperature of  $+21^{\circ}\text{C}$ . On the basis thereof, on the one hand the armament operational gas pressure cannot be fully utilised at normal temperature, which would result in a high velocity, and on the other hand, because of the only inaccurately known current powder temperature and thus the initial projectile velocity the hit probability is markedly reduced or measures must be taken to ascertain the current projectile velocity in order not to suffer a loss in terms of hit accuracy.

The object of the present invention is to propose a propellant charge powder for barrel-type weapons, which has a low temperature coefficient in the temperature range of  $-50^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$  so that in that way the specified ballistic values of maximum pressure and projectile velocity depend only slightly on the powder temperature.

According to one aspect of the present invention, there is provided a gun propellant composition comprising: an explosive charge powder; and 2-55%, by weight, based on the total weight of said gun propellant composition, of a liquid plasticizer comprising a mixture of at least two chemically different dinitro diaza hydrocarbons selected

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from the group consisting of dinitro diaza alkanes, dinitro diaza alkenes, dinitro diaza alkynes and mixtures thereof, wherein said gun propellant composition has a low temperature coefficient in the range of  $-50^{\circ}$  to  $70^{\circ}$  C.

5           According to another aspect of the present invention, there is provided the gun propellant composition described herein wherein said explosive charge powder is selected from the group consisting of solid nitramine and nitrocellulose; solid nitramine and an energetic or  
10 non-energetic plastic binder; and nitrocellulose.

          According to still another aspect of the present invention, there is provided the gun propellant composition described herein wherein said solid nitramine is selected from the group consisting of hexogen nitramine and octogen  
15 nitramine.

          According to yet another aspect of the present invention, there is provided the gun propellant composition described herein wherein said energetic plastic binders are selected from the group consisting of methyl-*n*-ena,  
20 ethyl-*n*-ena and butyl-*n*-ena.

          According to a further aspect of the present invention, there is provided the gun propellant composition described herein wherein said energetic plastic binders are selected from the group consisting of poly-3-nitratomethyl-  
25 3-methyloxetan (PolyNIMMO), poly-glycidyl nitrate ester (Polyglyn), glycidyl azide polymer (GAP), poly-3-azidomethyl-3'-methyloxetan (AMMO), poly-3,3'-bis-azidomethyloxetan (BAMO) and mixtures thereof.

          According to yet a further aspect of the present  
30 invention, there is provided the gun propellant composition

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described herein wherein said non-energetic plastic binders are selected from the group consisting of polybutadienes with terminal hydroxyl groups (HTPB), cellulose acetate butyrate (CAB) and mixtures thereof.

5           According to still a further aspect of the present invention, there is provided the gun propellant composition described herein wherein said explosive charge powder is selected from the group consisting of  
1,3,3-trinitroazetidine (TNAZ), ammonium dinitramide (ADN),  
10 triaminoguanidine nitrate (TAGN), hexanitro-hexa-aza-iso-wurzitan (CL-20) and mixtures thereof.

          According to another aspect of the present invention, there is provided the gun propellant composition described herein wherein said explosive charge powder is a  
15 blasting oil.

          According to yet another aspect of the present invention, there is provided the gun propellant composition described herein wherein said plasticizer comprises a mixture of: 40 ± 10%, by weight, 2,4-Dinitro-2,4-  
20 diazapentane; 45 ± 10%, by weight, 2,4-Dinitro-2,4-diazaheptane; 15 ± 10%, by weight, 3,5-Dinitro-3,5-diazaheptane.

          According to a further aspect of the present invention, there is provided the gun propellant composition  
25 described herein, further comprising one or more stabilizers or a combination of one or more stabilizers and one or more combustion moderators.

          According to yet a further aspect of the present invention, there is provided a gun propellant composition  
30 comprising: an explosive charge powder wherein said

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explosive charge powder is selected from the group consisting of solid nitramine and nitrocellulose; solid nitramine and an energetic or non-energetic plastic binder; nitrocellulose; and other explosives besides a solid  
5 nitramine; and 2-55%, by weight, based on the total weight of said gun propellant composition, of a liquid plasticizer comprising a mixture of at least two chemically different dinitro diaza hydrocarbons selected from the group consisting of dinitro diaza alkanes, dinitro diaza alkenes,  
10 dinitro diaza alkynes and mixtures thereof, wherein said gun propellant composition has a low temperature coefficient in the range of  $-50^{\circ}$  to  $70^{\circ}$  C.

By virtue of the use of a particular plasticiser or softener the invention makes it possible to produce and  
15 use propellant charge powder with a low temperature coefficient. In other words: a propellant charge powder of that kind makes it possible to fire armament munition with almost constant values of maximum pressure and projectile velocity in the entire temperature range of  $-50^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .

20 Embodiments of the invention are set out hereinafter, a diagram illustrating the temperature characteristics of a conventional propellant charge powder and a propellant charge powder according to the invention.

The invention concerns the following propellant charge powders:  
 glycidyl azide polymer (GAP)-,  
 hydroxy-terminated polybutadiene (HTPB), polybutadiene with terminal  
 hydroxyl groups- and  
 5 cellulose acetate butyrate (CAB)-  
 bound nitramine propellant charge powders with the dinitro diaza  
 plasticiser mixture according to the invention and nitrocellulose  
 propellant charge powders, NC, which comprise nitramines, nitrocellulose  
 and dinitro diaza plasticiser or nitrocellulose and dinitro diaza  
 10 plasticiser with or without blasting oil such as nitroglycerine (Ngl) or  
 diglycol dinitrate (DEGN).

	PCP-formulation						
	% by weight						
RDX or HMX	70±15	70±15	70±15	40±15	60±20		40±15
Plasticiser DNDA- mix (3 components)	10±8	10±8	15±10	30±25	20±12	30±25	
GAP with isocyanate	20±5						
GAP without isocyanate							30±20
HTPB with isocyanate		20±5					
CAB			15±5				
NC + stick				30±5	20±12	70±25	30±15
blasting oil						0+40	

The abbreviations RDX = hexogen and HMX = octogen, while PCP is used  
 to mean propellant charge powder.

15 With nitrateethyl nitramine (NENA), poly-3-nitratomethyl-3'-  
 methyloxetan (PolyNIMMO) and poly-glycidyl nitrate ester (Polyglyn) as  
 energetic polymer binder, a comparable temperature behaviour occurs insofar  
 as the plasticiser according to the invention is used in the above-  
 specified quantitative proportion. In the case of Polyglyn the azide group  
 20 of GAP is replaced by - O - NO<sub>2</sub>.

The dinitro diaza plasticiser comprises the following components:

2,4-Dinitro-2,4-diazapentane 40±10 % by weight

2,4-Dinitro-2,4-diazaheptane 45±10 % by weight

3,5-Dinitro-3,5-diazaheptane 15±15 % by weight

The diagrammatically illustrated graph sets out the pressure configuration on the ordinate 2 when the weapon is fired in relation to the temperature on the abscissa 1.

In the case of a propellant charge powder in accordance with the state of the art the pressure changes very severely in the specified temperature range of -50°C to +70°C in accordance with the rising curve 5.

In comparison the pressure remains almost constant as indicated by the curve 6 in the specified temperature range. The curve 6 initially rises and then falls somewhat from the reversal point 7. The optimum is an almost horizontal configuration corresponding to the curve 15.

If the propellant charge powder in accordance with the invention is altered by conventional measures such as altering the grain geometry in such a way that the original curve 6 lies as curve 6.1 with its reversal point 7.1 against the pressure limit 10, that denotes a considerable increase in power or performance of 10 to 20% with respect to the usual propellant charge powder as indicated by curve 5.

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CLAIMS:

1. A gun propellant composition comprising:  
an explosive charge powder; and  
2-55%, by weight, based on the total weight of  
5 said gun propellant composition, of a liquid plasticizer  
comprising a mixture of at least two chemically different  
dinitro diaza hydrocarbons selected from the group  
consisting of dinitro diaza alkanes, dinitro diaza alkenes,  
dinitro diaza alkynes and mixtures thereof, wherein said gun  
10 propellant composition has a low temperature coefficient in  
the range of -50° to 70° C.
2. The gun propellant composition of claim 1 wherein  
said explosive charge powder is selected from the group  
consisting of solid nitramine and nitrocellulose; solid  
15 nitramine and an energetic or non-energetic plastic binder;  
and nitrocellulose.
3. The gun propellant composition of claim 2 wherein  
said solid nitramine is selected from the group consisting  
of hexogen nitramine and octogen nitramine.
- 20 4. The gun propellant composition of claim 2 or 3  
wherein said energetic plastic binders are selected from the  
group consisting of methyl-nena, ethyl-nena and butyl-nena.
5. The gun propellant composition of claim 2 or 3  
wherein said energetic plastic binders are selected from the  
25 group consisting of poly-3-nitratomethyl-3-methyloxetan  
(PolyNIMMO), poly-glycidyl nitrate ester (Polyglyn),  
glycidyl azide polymer (GAP), poly-3-azidomethyl-3'-

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methyloxetan (AMMO), poly-3,3'-bis-azidomethyloxetan (BAMO) and mixtures thereof.

6. The gun propellant composition of claim 2 or 3 wherein said non-energetic plastic binders are selected from the group consisting of polybutadienes with terminal hydroxyl groups (HTPB), cellulose acetate butyrate (CAB) and mixtures thereof.

7. The gun propellant composition of claim 1 wherein said explosive charge powder is selected from the group consisting of 1,3,3-trinitroazetidine (TNAZ), ammonium dinitramide (ADN), triaminoguanidine nitrate (TAGN), hexanitro-hexa-aza-iso-wurzitan (CL-20) and mixtures thereof.

8. The gun propellant composition of claim 1 wherein said explosive charge powder is a blasting oil.

9. The gun propellant composition of claim 1 wherein said plasticizer comprises a mixture of:

40 ± 10%, by weight, 2,4-Dinitro-2,4-diazapentane;

45 ± 10%, by weight, 2,4-Dinitro-2,4-diazaheptane;

20 15 ± 10%, by weight, 3,5-Dinitro-3,5-diazaheptane.

10. The gun propellant composition of any one of claims 1 to 9, further comprising one or more stabilizers or a combination of one or more stabilizers and one or more combustion moderators.

25 11. A gun propellant composition comprising:

an explosive charge powder wherein said explosive charge powder is selected from the group consisting of solid

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nitramine and nitrocellulose; solid nitramine and an energetic or non-energetic plastic binder; nitrocellulose; and other explosives besides a solid nitramine; and

2-55%, by weight, based on the total weight of  
5 said gun propellant composition, of a liquid plasticizer comprising a mixture of at least two chemically different dinitro diaza hydrocarbons selected from the group consisting of dinitro diaza alkanes, dinitro diaza alkenes, dinitro diaza alkynes and mixtures thereof, wherein said gun  
10 propellant composition has a low temperature coefficient in the range of  $-50^{\circ}$  to  $70^{\circ}$  C.

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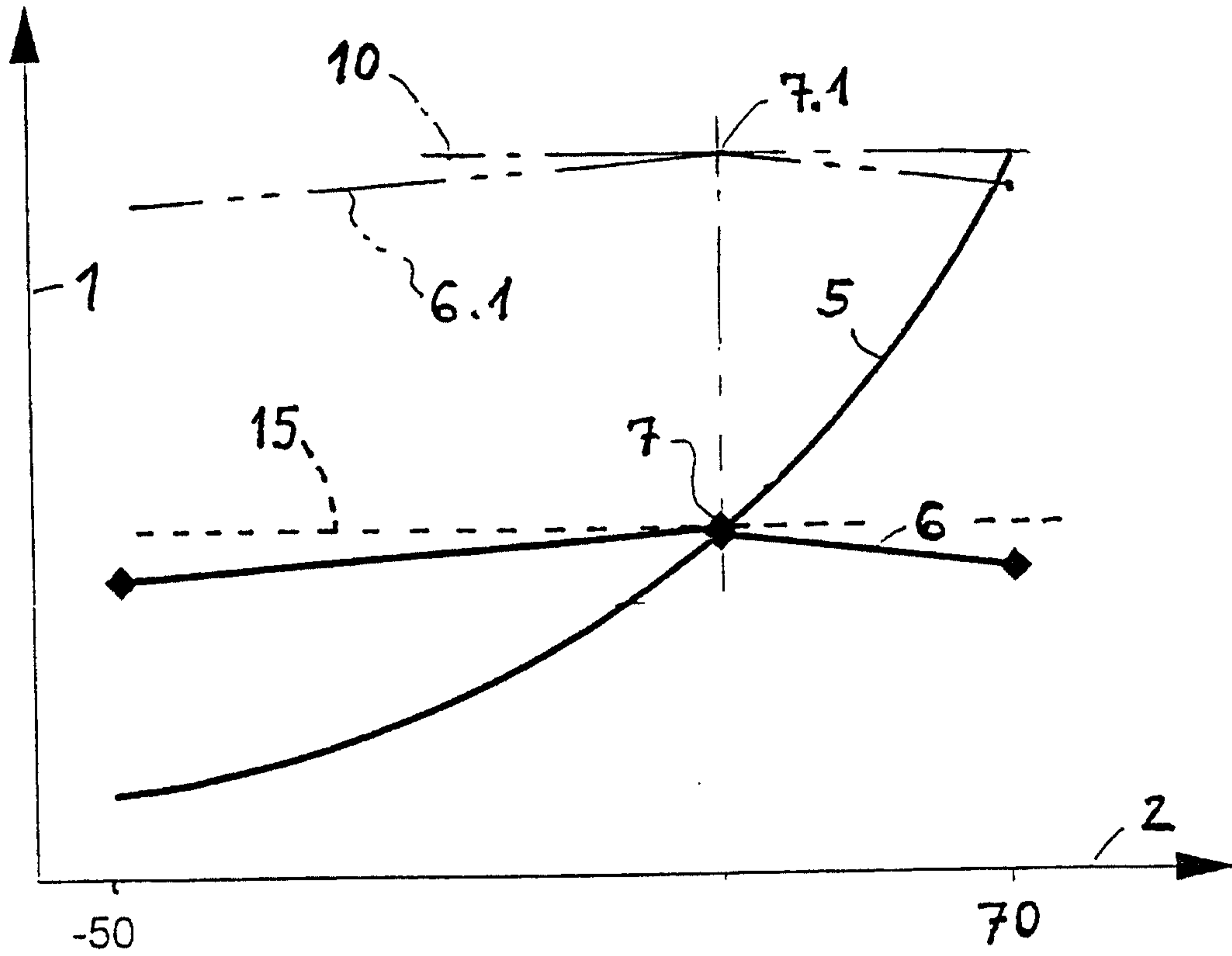


FIG. 1