



159159

PROJECTILES POSSESSING HIGH PENETRATION AND LATERAL EFFECT WITH INTEGRATED DISINTEGRATION ARRANGEMENT

BACKGROUND OF THE INVENTION

The present invention relates to a highly effective and also inert active penetrator, an active projectile, an active airborne body or an active multipurpose projectile with a constructively adjustable or settable relationship between penetrating power and lateral effect. The end ballistic total effect which is obtained from the penetrating depth and covering the surface / stressing of the surface is initiated in an active case by means of a releasable arrangement (installation) which is independent of the position of the active body. This is achieved through the intermediary of a suitably inert transfer medium, for example, such as a liquid, a pasty medium, a plastic material, a material which is constituted of a combination of a plurality of components or a plastically deformable metal, within which, by means of pressure generating / detonative arrangement (also without any primary explosives) there is built-up with an integrated or functionally specified triggering initiation with integrated detonating safety a quasi-hydrostatic or, respectively, hydrodynamic pressure field, and which is transmitted to the surrounding, fragment forming or sub-projectile emitting casing.

For end ballistically active effective carriers, one usually distinguishes between:

- inertial projectiles (KE projectiles, spin or aerodynamically stabilized arrow or slender projectiles);
- hollow charges (HL projectiles, flat conical charges, preferably aerodynamically stabilized) with a triggering device;
- explosive projectiles with triggering device;
- inert fragmentation projectiles, for example, PELE (penetrator with increased lateral effects) or with disintegration charge possessing a triggering device;
- so-called multipurpose projectiles/hybrid projectiles (explosive and/or fragmentation effect with; for example, HL effect acting radially or in the direction of flight (ahead);



G00002

- tandem projectiles (KE, HL or combined);
- warheads (mostly with HL and/or fragmentation/explosive effect); and
- penetrators or sub-penetrators in airborne bodies or warheads.

Furthermore, for a series of the above-mentioned active body types there are available corresponding special constructions. These unfold as a rule, certain, constructively or technologically (material-type) specified effects. An effectively optimised configuration is however, mostly connected with a serious limitation in the effective range. In order to correspond with the requirements of a combat area, one mostly reaches back to a combination of a plurality of (two or three) separate effective carriers (for example separately supplied ammunition, mixed ammunition belts, and so forth). In a simplified manner, one combines; for example, inertial projectiles (KE effect) with explosive and fragmentation projectiles.

The simplification of the ammunition palette without any restriction in the effective spectrum is thus a constantly sought after path for a solution. In the area of inertial projectiles there is achieved a decisive advance by means of the laterally acting penetrators (PELE penetrators). Such types of PELE penetrators are disclosed, for example, in DE 197 00 349 C1. This effective or active carrier combines the KE penetrating effect with a fragment or, respectively sub-projectile generation in such an advantageous manner that for an entire series of applications this ammunition concept in itself is sufficient to fulfil the set tasks. The decisive restriction in this functional principal consists of in that, for initiating the lateral effects, it is necessary to provide an interaction with the target, only then will there be built up a suitable internal pressure, through which the end ballistically active projectile casing can be laterally accelerated, or respectively disintegrated.

Through the present invention there is disclosed a way by means of which, with the least possible restrictions in the range of the effectiveness, there can be joined not only the power spectrum of purely inertial projectiles with those of explosive / fragmentation / multipurpose / tandem projectiles, but also the function of heretofore not combinable separate types of ammunition can be integrated therewith. Thereby, it becomes possible to combine the properties of the most different types of ammunition concepts in a single active carrier. This does not only lead to a

significant improvement in the heretofore known multipurpose projectiles, but also to an almost unlimited broadening of the conceivable spectrum of utilization against ground, air and sea targets, and in the defense against airborne bodies.

The invention does not intend to utilize pyrotechnic powder or explosive materials alone as casing disintegrating or fragment accelerating elements. Such types of projectiles are known in the most different types of embodiments with and without triggering devices (referring, for example, to DE 29 19 807 C2). Also, DE 197 00 349 C1 already mentions this capability, for example, in combination with an expansive medium as a individual component.

From US-A-4,625,650 there is known an explosive incendiary projectile which is equipped with a hollow cylindrical as well as aerodynamically configured copper jacket, with a tubular penetrator consisting of heavy metal with an explosive charge. With consideration to the relatively small caliber (12.7mm) a sufficient penetrating effect with additional lateral effect is alone not achievable due to physical reasons. Its active components in their functioning manner also do not provide the subject matter which is represented within the scope of this invention.

A further projectile is known from US-A-4,970,960 which essentially encompasses a projectile core, as well as therewith associated and thus connected tip with a formed on mandrel, whereby the inner mandrel is arranged in a bore in the projectile core. It can be constituted of a pyrophoric material; for example, zirconium, titanium or their alloys. This projectile is also not active; and as well does not contain any expansion medium.

From DE-A-32 40 310 there is known an armour rupturing projectile, by means of which there should be attained a conflagration effect in the interior of the target, whereby the projectile encompasses a cylindrical metal member which is extensively shaped as a solid body with a thereto attached tip, as well as an incendiary charge arranged within the hollow space of the metal member which charges, for example, is formed as a solid cylindrical body or as a hollow cylindrical casing. With regard to this projectile, the outer shape remains unchanged during penetration, in the interior there should be produced an adiabatic compression with an explosive-like

combustion of the incendiary charge. Also in this instance, there are no active components present, and there are also no means for achieving a dynamic expansion of the metal body acting as a penetrator and its lateral disintegration or fragmentation.

In an extremely broader embodiment of all heretofore known solutions for the generation of lateral effects, there should be mostly provided basically as auxiliary means a sufficient internal pressure generating chemical / pyrotechnic aide, and not only minimized, but through its embedding in pressure transmitting media, under the lowest possible pyrotechnic demand or, respectively, volumetric use, there is achieved an optimum disintegration of these surrounding, fragment or sub-projectile producing or emitting casings or segments. Through this separation of the functions of pressure generation or pressure propagation or, respectively, pressure transfer there for the first time opens itself the heretofore in all arrangements known spectrum of application for individual active elements, projectiles or warheads. As examples, there should here serve expelled elements from large calibered ammunition externally or internally of a target, for expel airborne bombs for the attacking of shelters, for warheads up to TBM (tactical ballistic missile) defense, and for utilization in the so-called killer satellites, and finally in the utilization in super cavitating torpedoes (highest speed torpedoes).

In DE 197 00 349 C1 there are disclosed projectiles or warheads which, by means of an internal arrangement for the dynamic formation of expansion zones, produce sub-projectiles or fragments with an intense lateral effect. Principally, this hereby relates to the interaction of two materials upon striking against armoured targets, or during the penetration into or through homogeneous or structured targets in such a manner whereby the internal dynamically damaged material builds up a pressure field relative to material surrounding it, with a higher speed of an in or through penetrating material, and thereby imparts to the outer material a lateral velocity component. This pressure field is determined through the projectile, as well as through the target parameters: Since such types of penetrators, in their initial form as well as their individual components (fragments, sub-projectiles) should possess a greatest possible end ballistic effect, for the casing there affords itself steel or preferably tungsten-heavy metal (WS). From the intended disintegration at specified

target parameters there is then obtained a palette of suitable expansion media. In accordance with the selected combination, there are already produced impact speeds at some 100 m/s expansion pressures which afford a dependable disintegration of the projectile or warhead. Technical or material specific auxiliary means or aids, such as for example, the configuring or, respectively, the partial weakening of the surface, or the selection of brittle materials as the casing material are basically not prerequisites; however, they expand the scope of configurations and the spectrum of use for these so-called PELE penetrators.

SUMMARY OF THE INVENTION

The present invention relates to a further developed active effective body comprising the features of claim 1.

The active effective body pursuant to the present invention possesses an internal inert pressure transfer medium, an active body casing, a pressure-generating arrangement which borders an inert pressure transmitting medium or is introduced into the latter, and an activatable initiating or triggering arrangement. The pressure-generating arrangement hereby possesses one or more pressure generating elements, whereby the mass of the pressure generating arrangement is low in relation to the mass of the inert-pressure-transmitting medium. It has been evidenced that for such kind of assembled active member with a low mass ratio between the pressure-generating arrangement and the pressure transmitting medium, by means of a pressure impulse which is initiated by a triggering signal a detonator can effect a lateral disintegration of such an active body.

The active effective body pursuant to the present invention distinguishes itself from the classically usual explosive material projectiles and the fragment modules which are to be disintegrated by means of an explosive, especially through the basic concept of a penetrator which disintegrates into sub-penetrators or which forms sub-penetrators, whereby the sub-penetrators possess a main velocity component in the direction of flight of the projectile. The pressure-generating arrangement takes up only a small component of the projectile or warhead, so that increased significance is imparted to the pressure-transfer medium. The pyrotechnic energy of the pressure-generating arrangement is transmitted without any measures optimally

and without loss to the active body casing. Also, in contrast with the different usual systems, there can be eliminated any damming of the explosion energy of the pressure-generating arrangement, for example, through the introduction of a damming material between the explosive material and the fragment jacket.

The as a low designated ratio of the mass of the pressure-generating arrangement relative to the mass of the inert pressure-transmitting medium comprises preferably maximum of 0.6, and especially preferably comprises a maximum of 0.5. There can also be selected still lower ratio values of a maximum of about 0.2 to 0.3.

Furthermore, it is advantageous that the ratio of the massive pressure-generating unit relative to the total mass of the pressure-transmitting medium and the active body casing be limited to a maximum of 0.1 or a maximum of 0.05. Especially preferred is the ratio of ≤ 0.01 , whereby there can also be a selected still lower values.

The pressure-transmitting medium consists preferably entirely or partially of a material which is selected from the group of lightweight metals or their alloys, plastically deformable metals or their alloys, duroplastic or thermoplastic synthetic materials, organic substances, elastomeric materials, glass-like or pulverous materials, pressed bodies of glass-like or pulverous materials, and mixtures or combinations thereof. Moreover, the pressure-transmitting medium can be constituted of pyrophoric or other energetically positive, meaning for example, combustible or explosive materials. The pressure-transmitting medium can, in addition thereto, also be a pasty, jelly-like or, respectively, gelatinous or liquid, or respectively liquidous.

The present invention relates to an active projectile or an active effective body, whereby the end ballistic penetrating effect is combined with an either programmed and/or through the target which is to be attacked specified sub-projectile and/or fragment formation. Thereby, the entire effective spectrum is covered for different targets in a heretofore unknown manner, in that a technically basically universally conceived penetrator, through a changing of individual projectile parameters, reaches the intended effects or target coverings in the best possible mode, in that

the concept determined by the invention is extensively independent of the type of the projectile or airborne body or, respectively, their stabilization (for instance, spin or aerodynamically stabilized guidance mechanism, form stabilization or otherwise deployed into the target) and, respectively the caliber (full caliber, subcaliber) and, respectively, with regard to the deployment or acceleration type (for instance, cannon accelerated, rocket accelerated), designed as a projectile / warhead or integrated therein. The inventive arrangement (projectile or airborne body) basically also does not require any inherent or own speed for triggering its function. However, its inherent speed determines the end ballistic speed in the direction of flight. Thus it is to be particularly effectively combinable in combination with the active component and the point-in-time of triggering.

The universal possibilities of the inventive arrangement thereby comes into expression in that, on the one hand without any change in the basic principle, it can pertain to an arrow or slender projectile with the highest penetrating power, with additional arrangements which over the entire length or in partial regions, can relate to arrangements forming fragments or sub-projectiles, and, on the other hand, preferably pertains to a projectile container which is filled with a (e.g. pyrotechnic) active element, which again can limit sub-projectiles or fragments along the entire length or only partial regions. This is basically achieved along the trajectory, upon approach to a target, upon impact, at the beginning of the penetration, during passage through the target, or first only after an effected penetration.

The inventive penetrator (projectile or airborne body) besides its active properties possesses a constructively adjustable relationship between penetrating power and lateral effect. The basically inert active mode is thereby initiated by means of a position-determined or independently of the position of the active body initiatable arrangement or installation for the triggering or supporting of the lateral effectiveness (the lateral active effects, respectively). This is achieved by means of a suitable inert transfer medium, such as a liquid, a pasty medium, a plastic material, a polymer material or a plastically deformable metal a quasi hydrostatic or, respectively, a hydrodynamic pressure field producing pyrotechnic / detonative arrangement (also without any primary explosive) with a built in or function-specified triggering initiation with integrated triggering safety.

Figs. 1A and 1B illustrate such types of active laterally effective penetrators ALP (active laterally effective penetrator), Fig. 1A in a shorter (e.g. spin stabilized), and Fig. 1B in a lengthier (e.g. aerodynamically stabilized) constructional manner with an outer ballistic hood or tip 10. The encompassing casing body 2A, 2B, which due to its material properties mass and velocity is end-ballistically effective forms the central KE components. This either entirely or partially closed body 2A, 2B encompasses an internal portion 3A, 3B which, in the region of a desired active lateral effect, is filled with a suitable transmitting medium 4, which then by means of a controllable pyrotechnic arrangement 5 transmits the generated pressure to the encompassing body 2A, 2B, and thereby causes a disintegration into fragments of sub-projectiles with a lateral motion component.

At the build up of the pressure field in the inert medium 4 and upon its effect on the surroundings, the mutually acoustic resistance of the adjoining media (density $\rho \times$ longitudinal speed of sound c) is of significance. This is because it determines the degree of the reflection and thereby also the energy which can be imparted by the inert medium 4 to the encompassing casing 2A, 2B. This interrelationship is explained, for example, in the ISL-report ST 16/68 by G. Weihrauch and H. Müller "Untersuchungen mit neuen Panzerwerkstoffen".

Upon an imbalance of the acoustic resistances, the quotient $(\rho_1 \times c_1) / (\rho_2 \times c_2)$ can be designated as m (with $m > 1$), and one then defines as a reflective coefficient α the expression $\alpha = (m-1) / (m+1)$. This consideration is not only of interest for the pressure-transmitting medium, but then can also be utilized when for example, two casings or media should come in combination into use (refer to Figs. 13, 15 16A, 16B, 23 and 24).

From the above definition there is obtained that for liquids ($c \approx 1500$ m/s) or similar materials, as a rule over 95% of the incident shock energy is reflected at the boundary surface between pressure-transmitting medium/casing (steel or WS). However, also for a lightweight metal, such as aluminium, with a WS casing there still reflected over 70%, for a light weight metal compared to a steel casing, approximately 50%. A particularly broader operative play region is obtained with the

utilization of plastic materials and polymers. There the sound propagating speeds fluctuate between 50 m/s and 2000 m/s, the densities between about 1 and 2.5 g/cm³. Obtained thereby in the combination with duraluminium as the casing and plastic/polymer as the pressure-transmitting medium, for example, for an arrangement with double-jacket or a practice projectile, is a reflective degree of 60% or higher. This determines decisively the efficiency of the pressure-transmitting medium with respect to speed (time), the pressure-transmitting and thereby the sensitivity (spontaneity) of the lateral expansion or also relative to the axial pressure build up as a function of location and time.

Concerning the inert medium 4, this relates as a rule to a material which is in a position, without any greater damping losses, to dynamically transmit pressure forces. However, in instances it is also contemplatable that there are desired damping properties, such as for specified disintegration tasks or for achieving particularly slow disintegration speeds. The inner medium can furthermore be configured variably throughout its length or, respectively in its material properties (e.g. different speeds of sound) and thereby produce different lateral effects. However, it is also thinkable that through different damping properties of the pressure transmitting medium 4 there can be effect axially different disintegrations of the casings 2A, 2B. Furthermore, this medium 4 can also possess other properties, for example effectiveness-enhancing or effectiveness-supporting properties. The elements which are introduced or moulded into the inert medium 4, or into the inner space 3A, 3B bounding inner casings or assemblies (e.g. inserted subprojectiles) prevent neither the PELE nor its ALP properties inherent to the system.

The active pyrotechnic unit 5 can be constituted of a single, in relation to the size of the active body, small electrically ignitable detonator 6, which is connected with a simple contact reporter, with a timing element, a programmable module, a receiver component and a safety component as an activatable triggering device 7. This activatable triggering device 7 can be arranged in the region of the tip region and/or tail end region of the penetrator and can be connected by means of a conductor 8.

The tip 10 can be constructed hollow or solidly. Thus, for example, it can serve as a housing for auxiliary arrangements such as sensors or triggering and respectively, safety elements for the active pyrotechnic unit 5. It is also possible that the tip has integrated therein power supporting elements (e.g. as in Figs. 43A through 43D).

In the aerodynamically stabilized version 1B there is indicated a rigid guidance mechanism 12. Also this can contain in a central region auxiliary installations as indicated hereinabove. It is also basically comtemplatable that the active body contains an electronic component in the sense of a data processing unit (so-called "on board-systems").

In the present invention it does not relate to an explosive projectile or an explosive body or an explosive/fragment projectile of the usual constructional type, and also does not relate to a projectile with a fuse or detonator of the usual constructional type with the necessary and extremely complex (primary/secondary explosive material separating) safety devices. It also does not relate to a projectile which basically possesses a PELE construction pursuant to DE 197 00 349 C1. However, it can be extremely advantageous, and in most cases application it can also be combined with ALP tasks when, for example, in an active combination or for the assurance of a lateral effect also in an inert instance in intended and particularly advantageous applications, there can be integrated the properties of a passive lateral penetrator of the known PELE constructional type.

Further features, details and advantages can be ascertained from the following description of preferred embodiments of the invention, having reference to the accompanying drawings; in which:

- Fig. 1A illustrates a spin stabilized version of an ALP;
- Fig. 1B illustrates an aerodynamically stabilized version of an ALP;
- Fig. 2A illustrates examples for the positions of auxiliary arrangements for the control, or respectively triggering and safety of the pressure-generating arrangements for arrow projectiles;

- Fig. 2B illustrates examples for positions of the auxiliary arrangements for the control or, respectively triggering and safety of the pressure generating components for spin stabilized projectiles;
- Fig. 3A illustrates a first example for a tail/guidance mechanism shape (e.g. for receiving the auxiliary installations) in the form of a rigid wing guidance mechanism;
- Fig. 3B illustrates a second example of a tail/guidance mechanism shape (e.g. for receiving of the auxiliary arrangements) in the form of a conical guide mechanism;
- Fig. 3C illustrates a third example for a tail/guidance mechanism shape (e.g. for receiving of the auxiliary arrangements) in the form of a star guidance mechanism;
- Fig. 3D illustrates a fourth example for a tail/guidance mechanism shape (e.g. for receiving of the auxiliary arrangements) in the form of a guidance mechanism with a mixed construction;
- Fig. 4A illustrates a first embodiment of an arrangement of pressure-generating elements in the form of a compact pressure-generating unit in the forward centre portion;
- Fig. 4B illustrates a second embodiment of an arrangement of pressure-generating elements in the form of a compact unit in a tail end region;
- Fig. 4C illustrates a third embodiment of an arrangement of pressure-generating elements in the form of a compact unit in the region proximate the tip;
- Fig. 4D illustrates a fourth embodiment of an arrangement of pressure-generating elements in the form of a compact unit located in the tip;
- Fig. 4E illustrates a fifth embodiment of an arrangement of pressure-generating elements in the form of an expanded slender unit in the forward region of the penetrator;
- Fig. 4F illustrates a sixth embodiment of an arrangement of pressure-generating elements in the form of a through extending slender unit;
- Fig. 4G illustrates a seventh embodiment of an arrangement of pressure-generating elements in the form of three uniformly distributed compact units;

- Fig. 4H illustrates a eighth embodiment of an arrangement of pressure-generating elements in the form of a combination of a compact unit in the region proximately the tip with a slender unit;
- Fig. 4I illustrates a ninth embodiment of an arrangement of pressure-generating elements in the form of a two-part projectile with a compact unit in the rearward portion;
- Fig. 4J illustrates a tenth embodiment of an arrangement of pressure-generating elements in the form of a two part projectile with compact elements in both parts;
- Fig. 4K illustrates an eleventh embodiment of an arrangement of pressure-generating elements in the form of a two part projectile with a compact unit in the projectile tip and with a slender unit in the rearward projectile part;
- Fig. 5A illustrates an example of an ALP projectile with a control / safety / triggering unit in the tip region with a control and signal line leading to the second unit;
- Fig. 5B illustrates a further example of an ALP projectile with a control / safety / triggering unit in the tail region with a control and signal line leading to a second unit;
- Fig. 6A illustrates different examples of geometries for pressure-generating elements;
- Fig. 6B illustrates further examples of geometries for pressure-generating elements;
- Fig. 6C illustrates still further examples of geometries for pressure-generating elements;
- Fig. 6D illustrates further examples of geometries for pressure-generating elements with conical tips and roundings;
- Fig. 6E illustrates an example for a combination of two pressure-generating elements of different geometries with a transition region;
- Fig. 7 illustrates different examples of hollow pressure generating-elements;
- Fig. 8A illustrates an example of an arrangement for interconnected pressure-generating elements;
- Fig. 8B illustrates an example of the arrangement of a central penetrator connected with external pressure-generating elements;

- Fig. 9A illustrates the principal construction of an ALP projectile with three active zones positioned behind each other;
- Fig. 9B illustrates a schematic representation for explaining the operation of the ALP projectile of Fig. 9A, in which all three active zones are activated prior to reaching the target;
- Fig. 9C illustrates a schematic representation for explaining the operation of the ALP projectile of Fig. 9A in which only the forward active zone (occasionally also the rearward active zone) is activated prior to reaching of the target;
- Fig. 9D illustrates a schematic representation for explaining the operation of the ALP projectile of Fig. 9A in which all three active zones are only activated upon reaching the target;
- Fig. 10 illustrates a representation of a numerical 2D-simulation of the pressure-generation by means of a slender fuse cord-similar detonator pursuant to Fig. 4F;
- Fig. 11 illustrates a representation of a numerical 2D-simulation of the pressure generation by means of two different pressure-generating units pursuant to Fig. 4H;
- Fig. 12 illustrates a further embodiment of an ALP projectile pursuant to the invention with two axial zones A and B of different geometrical configurations;
- Fig. 13 illustrates an embodiment of an active effective body pursuant to the invention with symmetrical construction, a central pressure-generating element as well as an internal and external pressure-transmitting medium, shown in cross-section;
- Fig. 14 illustrates an embodiment of an active effective body pursuant to the invention with an eccentrically positioned pressure-generating element, shown in cross-section;
- Fig. 15A illustrates an embodiment of an active effective body pursuant to the invention with an eccentrically positioned pressure-generating unit as well as an internal efficient pressure-distributing medium and an external pressure-transmitting medium, shown in a cross-sectional view in accordance with Fig. 13;

- Fig. 15B illustrates, in cross-section, a similar embodiment of the active body pursuant to the invention as in Fig. 13, however, with a pressure-generating element in the outer pressure-transmitting medium and with an internal medium forming a reflector;
- Fig. 16A illustrates a cross-sectional view of an embodiment of an active effective member according to the invention with a central penetrator having pressure-generating elements in the penetrator and in the outer pressure-transmitting medium which, for example, can be separately actuatable;
- Fig. 16B illustrates an embodiment of an active effective member pursuant to the invention with a central penetrator with pressure-generating elements in the outer pressure-transmitting medium, shown in cross-section;
- Fig. 17 illustrates a standard assembly of an ALP projectile, shown in cross-section, which is also a reference standard for further embodiments;
- Fig. 18 illustrates an embodiment of an ALP assembly pursuant to the invention with a central penetrator with a star-shaped cross-section and a plurality of pressure-generating elements, shown in cross-section;
- Fig. 19 illustrates a cross-sectional view of an embodiment of an ALP assembly pursuant to the invention with a central penetrator with rectangular or quadratic cross-section and a plurality of pressure-generating elements;
- Fig. 20 illustrates a cross-section of an embodiment of an ALP assembly according to the invention, in accordance with Fig. 9A with four casing segments;
- Fig. 21 illustrates an embodiment of an ALP assembly pursuant to the invention with two laterally arranged pressure-transmitting media, shown in cross-section;
- Fig. 22 illustrates an embodiment of an ALP assembly pursuant to the invention with a segmented pressure-generating element, shown in cross-section;
- Fig. 23 illustrates an embodiment of an ALP assembly pursuant to the invention with two different laterally arranged casing shells, shown in cross-section;
- Fig. 24 illustrates, in cross-section, an embodiment of an ALP assembly pursuant to the invention in accordance with Fig. 17 with an additional external jacket;

- Fig. 25 illustrates, in cross-section, an embodiment of an ALP assembly pursuant to the invention with a non-circular cross-section;
- Fig. 26 illustrates an embodiment of an ALP assembly pursuant to the invention with a six-sided central part according to Figure 17, and a split ring of preformed sub-projectiles or fragments with non-circular cross-section (e.g. also with PELE assembly);
- Fig. 27 illustrates an embodiment of an ALP assembly pursuant to the invention, similar to Fig. 26; however, with a further casing;
- Fig. 28 illustrates an embodiment of an ALP projectile with four penetrators (e.g. in PELE constructional mode) and a central pressure-generating unit;
- Fig. 29 illustrates an embodiment of an ALP projectile with three penetrators (e.g. in a PELE constructional mode) and three pressure-generating units which are arranged in an inert transmitting medium;
- Fig. 30A illustrates an embodiment of an ALP construction with a solid central penetrator of suitable cross-section, and three pressure-generating units which are arranged in an inert transmitting medium;
- Fig. 30B illustrates an embodiment of an ALP construction similar to that of Fig. 30A, however, with a solid segment forming penetrator having a triangular cross-section;
- Fig. 30C illustrates an embodiment of an ALP assembly in cross-section similar to that of Fig. 30B, however, with a triangular hollow shaped body;
- Fig. 30D illustrates an embodiment of an ALP assembly in cross-section with a cross-shaped internal element;
- Fig. 31 illustrates a further embodiment of an ALP assembly with a central penetrator of suitable cross-section, which in itself is again constructed as a ALP;
- Fig. 32 illustrates an embodiment of a pressure generating unit with a non-circular cross-section;
- Fig. 33 illustrates an embodiment of an ALP projectile with a plurality (here three) unit (segments) across the cross-section, which for example are separately actuatable;
- Fig. 34 illustrates different embodiments of dammings;

- Fig. 35 illustrates an embodiment of a penetrator with a fragmentation head (concurrently damming for the initiation of triggering) and a conical jacket;
- Fig. 36 illustrates an embodiment of a penetrator with damming (for the initiation of triggering) and conical pressure-generating element;
- Fig. 37 illustrates an embodiment of an ALP projectile with a modular internal construction which, for example, is designed as a container for fluids;
- Fig. 38 illustrates an embodiment of an ALP assembly with a casing segments which, for example, are separately actuatable;
- Fig. 39 illustrates an embodiment of an ALP assembly with a jacket consisting of sub-projectiles;
- Fig. 40A illustrates a representation of an embodiment of a three-part ALP projectile which illustrates the base construction, whereby the active part is provided in the region of the tip;
- Fig. 40B illustrates a representation of a three-part ALP projectile similar to Fig. 40A, whereby the active part is provided in the centre region;
- Fig. 40C illustrates a representation of a three-part ALP projectile similar to Fig. 40A, whereby the active part is provided in the tail end region;
- Fig. 40D illustrates a further embodiment of a three-part ALP projectile with an active tandem arrangement;
- Fig. 41 illustrates an exemplary representation for explaining an ALP projectile;
- Fig. 42A illustrates an embodiment of a tip configuration of an ALP projectile with a PELE penetrator;
- Fig. 42B illustrates a further embodiment of a tip configuration of an ALP projectile, with an ALP assembly;
- Fig. 42C illustrates an embodiment of a tip configuration of an ALP projectile as a solid active tip module;
- Fig. 42D illustrates a further embodiment of a tip configuration of an ALP projectile with a tip filled with an active medium;
- Fig. 42E illustrates an embodiment of a tip configuration of an ALP projectile as a tip with set-back pressure-transmitting medium (hollow space);
- Fig. 42F illustrates an embodiment of a tip configuration of an ALP projectile as a tip with forwardly displaced pressure-transmitting medium;

- Fig. 43A illustrates a representation of a 3D-simulation, which illustrates an ALP projectile pursuant to the invention with a compact pressure-generating unit and a liquid as a pressure-transmitting medium (corresponding to Fig. 4C) as well as an WS jacket;
- Fig. 43B illustrates a representation of a 3D-simulation of a dynamic disintegration of the arrangement pursuant to Fig. 43A, 150 μ s after triggering;
- Fig. 44A illustrates a representation of a 3D-simulation of an ALP projectile with a slender pressure generating unit, a WS jacket and a liquid as a pressure-transmitting medium, corresponding to Fig. 4E;
- Fig. 44B illustrates a representation of a 3D-simulation for a dynamic disintegration of the arrangement pursuant to Fig. 44A, 100 μ s subsequent to triggering;
- Fig. 45A illustrates a representation of a 3D-simulation of a principal ALP assembly according to Fig. 4H, with diverse pressure-transmitting media;
- Fig. 45B illustrates a representation in a 3D-simulation for a dynamic disintegration of an arrangement pursuant to Fig. 45A, 150 μ s after triggering whereby a liquid is utilized as a pressure-transmitting medium;
- Fig. 45C illustrates a representation of a 3D-simulation of a dynamic disintegration of an arrangement pursuant to Fig. 45A, 150 μ s subsequent to triggering, whereby a polyethylene (PE) is utilized as pressure-transmitting medium;
- Fig. 45D illustrates a representation of a 3D-simulation for a dynamic disintegration of an arrangement pursuant to Fig. 45, 150 μ s subsequent to triggering, whereby aluminium is utilized as the pressure-transmitting medium;
- Fig. 46A illustrates a representation of a 3D-simulation of an ALP assembly with an eccentrically positioned pressure-generating element (cylinder);
- Fig. 46B illustrates a representation of a 3D-simulation for a dynamic disintegration of an arrangement pursuant to Fig. 46A, 150 μ s subsequent to triggering, whereby a liquid is utilized as a pressure-transmitting medium;
- Fig. 46C illustrates a representation of a 3D-simulation for a dynamic disintegration of an arrangement pursuant to Fig. 46A, 150 μ s subsequent

to triggering, whereby aluminium is utilized as a pressure-transmitting medium;

- Fig. 47A illustrates a representation of a 3D-simulation of an ALP assembly with a central penetrator and with an eccentrically positioned pressure-generating element (cylinder);
- Fig. 47B illustrates a representation of a 3D-simulation of a dynamic disintegration of an arrangement pursuant to Fig. 47A, 150 μ s after triggering;
- Fig. 48A illustrates an embodiment of a three-part, modular spin-stabilized projectile (or airborne body);
- Fig. 48B illustrates an embodiment of a four-part modular aerodynamically-stabilized projectile (or airborne body);
- Fig. 48C illustrates an embodiment of an ALP projectile with cylindrical or conical portion in the active part for an intensive lateral acceleration;
- Fig. 48D illustrates an enlarged representation of the cylindrical/conical part of the ALP projectile of Fig. 48C;
- Fig. 49A illustrates a representation of an experiment which illustrates a WS cylinder jacket prior to and subsequent to the active disintegration;
- Fig. 49B illustrates a double-illuminated X-ray flash image of the accelerated fragments;
- Fig. 50A illustrates an aerodynamically stabilized projectile, designed as an active effective body;
- Fig. 50B illustrates an example of an aerodynamically stabilized projectile with a centrally positioned active effective body;
- Fig. 51 illustrates an example of an aerodynamically stabilized projectile with a plurality of active effective bodies;
- Fig. 52A illustrates an asymmetric opening of an active with a bundle of active effective bodies;
- Fig. 52B illustrates an asymmetrical opening of an active stage with a bundle of active effective bodies;
- Fig. 53 illustrates an example of an aerodynamically stabilized projectile with a plurality of excessively connected active sub-projectiles;
- Fig. 54 illustrates an end phase guided, aerodynamically stabilized projectile with an active effective body;
- Fig. 55A illustrates a practice projectile, formed as an active body;

- Fig. 55B illustrates an example for a practice projectile with a plurality of modules, singularly designed as an actively disintegratable, low effective body;
- Fig. 56 illustrates a warhead with a central active effective bodies;
- Fig. 57 illustrates an example of a warhead with a plurality of active effective stages;
- Fig. 58 illustrates a rocket-accelerated guided airborne body with an active effective body;
- Fig. 59 illustrates an example of a rocket-accelerated airborne body with a plurality of active effective body stages;
- Fig. 60 illustrates an underwater body (torpedo) with an active effective body;
- Fig. 61 illustrates an example for a torpedo with an active effective body bundle;
- Fig. 62 illustrates an example of a torpedo with a plurality of sequentially connected active stages;
- Fig. 63 illustrates a further example of a torpedo with a plurality of sequentially connected active stages;
- Fig. 64 illustrates a high velocity-underwater body with an active effective component;
- Fig. 65 illustrates an example of a high velocity-underwater body with an active effective body bundle;
- Fig. 66 illustrates an aircraft-supported airborne body, designed as an active effective unit;
- Fig. 67 illustrates an example of a self-flying airborne with an integrated active effective body;
- Fig. 68 illustrates an example of an airborne body with a plurality of active effective stages;
- Fig. 69 illustrates an example of an ejection container with an active effective bundle; and
- Fig. 70 illustrates an example of a dispenser with a plurality of active effective body stages.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

In DE 197 00 349 C1 there are set forth possibilities for the configuration of the space within the casing which is to be disintegrated also in combination with different materials. All of these configuration features can be integrated basically in

an active part in accordance with the present invention. In an explanation thereof, hereby should also be mentioned the conical configuration of the pressure-generating internal space, referring to Figs. 12, 34 and 42B, and the division of the cross-sectional surface into segments with, for example, different pressure-transmitting materials, as in Fig. 33. Moreover, inasmuch as the pressure build-up is separately undertaken, the palette of the materials which are to be employed is practically unlimited. This is comparably valid also for the dimensions (thicknesses) of the various components which are employed herein.

In DE 197 00 349 C1 there are furthermore mentioned a few examples of the configuration of the fragments or, respectively, the sub-projectile producing or emitting casing in combination with a dispersing medium - also in combination with a central penetrator. This technologically widely employable and extremely variant range of laterally active projectiles or warheads can be expanded up to the most extreme situations or applications through the utilization of pressure-generating pyrotechnic arrangements. This is particularly applicable to large calibered ammunition and to warheads.

As already mentioned, the range of utilization for active laterally effective penetrators is practically unlimited. Thereby, the pressure-generating components and the eventually therewith associated auxiliary installations are of particular significance. It is also a special advantage of the present invention that the effectiveness of an ALP (active laterally effective penetrator) can be advantageously utilized even with technically relatively simple arrangements.

With regard to the technical construction for the initiation of the pressure-generating elements, there must be distinguished between a simple contact ignition, which are already employed for projectiles of different types of configurations and therefore stand available, a delayed ignition (also known), a proximity ignition (e.g. through radar or infrared technology) and a remote-controlled ignition along the trajectory, for example through a timer element.

It is a further advantage of the present invention that the latter is not bound to specified systems, or to their states of development. In contrast, through its

universal applicability and through the technological configuration capabilities, it compensates for the properties of specified system extensively in accordance with their states of development. Furthermore, it is additionally advantageous to regard to the present invention that with to significant advances which were accomplished within the last few years concurring the miniaturization of triggering devices in connection with electronic improvements and new developments. Thus, for example, systems such as electric foil initiation (EFI) and an ISL technology are known, which fulfil such functions with extremely small dimension (a few millimetres in diameter up to 1 to 2 centimetres in length) and small masses at a low energy requirement. The lowest energy demand is necessitated above all by the simplest ignition systems. Thus, it must be provided a balance between necessary safety and demand.

Basically, the tip sets forth an essential parameter which is necessary for the power capability of a projectile. In DE 197 00 349 C1 this point of view is extensively treated. However, it is also applicable for the scenario in the utilization of the extensively discussed and included as the possible area for utility of the present invention. In this connection, imparted to the projectile tip besides the reduction of the external ballistic rather are previously positive (supportive) functions than those which are negative; for example, the penetration or the initiation of a function hindering properties. As positive examples there can be mentioned, among others: the tip as constructional space, ejectable tip, a tip as a pre-positioned penetrator.

The active principle in accordance with the present invention is also adapted for the controlled projectile disintegration / spatial limitation of the effective distance; to the for example, upon missing a target or during the design of practice projectiles. Hereby it can be advantageously employed densified or compressed materials (compressed powder, plastic materials or fiber materials) as the casing material, which are subjected either a fine distribution upon being subjected to pressure, or can be end ballistically divided into practically ineffective particles. There can also be disintegrated / laterally accelerated only a portion of the projectile / penetrator, such that the remainder of the projectile / penetrator basically remains still capable of functioning. Thus, for example, during flight there can be emitted a plurality of fragment planes, as illustrated in Fig. 9B, or there can be sprung away a certain

number, thereof immediately directly prior to impact, for example, as illustrated in Fig. 9C.

The ALP principle is consequently particularly adapted for projectiles / warheads with self-destruct installations. Thus, with a relatively low requirement or, respectively extremely small demand on additive volume or, respectively, loss of volume, there can be achieved an assured self-destruction. Thereby, it is even basically possible that even for slender KE projectiles there can be provided a system for limiting the penetrating depth.

Projectiles of this type also suited in a special manner for the attacking of oncoming threats, for example, such as warheads or TBMs (tactical ballistic missiles) or also battle or surveillance drones. The last mentioned are imparted an increased significance in the field of combat. They are only difficult to combat with direct hits. Also, usual fragmentation projectiles are practically low efficient on the basis of opposing situations with drones and fragment distribution. The effective manner of the present invention in combination with a corresponding triggering unit here, however, promises an extremely effective possibility of utilization.

A projectile conception in accordance with the proposed invention is also adapted in a specific measure for use in penetrators accelerated by means of rockets (boosters) or as the active components of rocket like airborne bodies. These, for example, besides the classical range of application, can be employed with large caliber barrelled weapons which are employed in the attacking of sea targets and as on board rockets for combat aircraft.

In Figs. 2-9 and 12-41 there is illustrated a multiplicity of embodiments. These have the task of not only to explain the capabilities of the effective principle in accordance with the present invention, but also to impart to one skilled in the art a multiplicity of technological solution possibilities in the conception of active laterally-effective penetrators.

In Figs. 2A and 2B there are shown examples for the positions of auxiliary installations of the active component. The aerodynamically stabilized version shown

in Fig. 2A is divided into two separate modules so as to explain that especially for lengthier penetrators or comparable active carriers, such as rocket-accelerated penetrators, it is also possible to provide a subdivision of the active components or a mixture with other active carriers, as also indicated in Figs. 48A and 48B.

Preferred positions are here in the tip region 11A, the forward region of the first active laterally effective projectile module 11B, the rear region of the active laterally projectile module 11E, the forward 11F, central 11C, and the rearward region 11D of the second active laterally active projectile module or, respectively, the projectile tail-end or the centre region between the modules 11G.

In the fin-stabilized version illustrated in Fig. 2B, the positions of the auxiliary arrangements are located preferably in the tip region 11A, in the forward projectile region 11B, or in the tail end region 11E. Furthermore, there can also be arranged a receiver unit (auxiliary installation) in the space 11H between the ALP and the outer casing.

In both projectile versions, the remaining part of the tip can be either hollow or filled (such as with an active material). For a sub-caliber design of the active part, the intermediate space up to the outer skin can also be employed for additional active carriers or as a constructional space for auxiliary arrangements.

Through the utilization of specialized guidance geometries there can be created greater volumes for the integration of the auxiliary installations. In Figs. 3A to 3D, there are set up a number of examples. Thus, Fig. 3A illustrates, especially for comparative purposes, the installed wing guidance mechanism 13A. Fig. 3B shows a conical guidance mechanism 13B, Fig. 3C a star guidance mechanism 13D, and Fig. 3D a mixture consisting of wing and conical guidance mechanism 13D. It is also possible to contemplate an apertured conical guidance mechanism, as well as guidance mechanisms constituted as ring surfaces or other types of stabilizing arrangements.

In Figs. 4A to 4K, there are illustrated basic positions and structures of the pressure-generating element or, respectively, pressure-generating elements of active laterally-effective penetrators. Thus, Figs. 4A and 4B illustrate those types of pyrotechnic

arrangements in a compact construction (see embodiments in Figs. 6A, 6B and 6D) in the forward central region or respectively in the rearward projectile region or, respectively, in the tail end region, and in Figs. 4C and 4D proximate the tip or, respectively, in the tip region. In Fig. 4E there extends a slender pressure-generating element somewhat through the forward half of the penetrator, in Fig. 4F over the entire penetrator length. The arrangement of Fig. 4C corresponds to the simulation example in Figs. 43A/B, the arrangement of Fig. 4E to the simulation example in Figs. 44A/B.

Fig. 4G represents the case in which a plurality of pressure-generating elements are located in a penetrator / projectile / warhead, as is also the case in the illustrations of Fig. 9.

In Fig. 4H there are located in the single-part ALP, two different pressure-generating elements (see numerical simulations in Figs. 46A to 46D).

Figs. 4I to 4K represent a two-part ALP projectile. Thus, Fig. 4I represents, as an example, a two-part ALP with an active part in the rearward element / module, whereas in Fig. 4J there are located compact pressure-generating elements in both projectile parts. These can be activated either separately or also individually. Fig. 4K illustrates mixed pressure-generating elements (a compact pressure-generating unit in a tip and a slender unit in a rearward part) so as to achieve specified dis-integrations, which as a rule is determined by the type of the target which is to be attacked and the intended effect.

Naturally, the number of the active modules which are to be connected behind each other is basically not limited and is only specified through constructive conditions, such as constructional length which stands available, the scenario of utilization as well as preferably fragment or sub-projectile emitting and the type of projectile or warhead.

Due to reasons of a simple manufacturer as well as handling, and especially due to the practical suitable possibilities of configuration, there are employed primarily explosive material modules as pressure-generating elements. However, it is also

possible to contemplate basically other types of pressure-generating installations. For example, there must be mentioned herein a method of chemical pressure-generation through an air bag gas generator. Also it is possible to contemplate the combination of a pyrotechnic module with a pressure or, respectively, volumetric generating element.

Illustrated in Figs. 5A and 5B are examples for the interjoining / connection of diverse pressure-generating elements in a single projectile. This connection 44 can be effected, for example, by means of a signal line (transmission charge / initiation line / fuse cord or wireless with or without a time delay. Understandably, illustrated herein are only a few representative possibilities, the various combination capabilities are practically unlimited.

Thus, in Figs. 4A to 4K there are illustrated examples for the arrangement of pressure-generating elements for active laterally effective penetrators, consequently, the combination capabilities of the examples which are represented in Figs. 6A to 6E for pressure-generating elements are still correspondently broadened. Due to reasons of clarity, the pressure generating elements are illustrated, in comparison with their constructions, in an enlarged scale.

Thus, Fig. 6A illustrates four examples for compact, locally concentrated elements (also detonators), for example a spherically-shaped part 6K, a short cylindrical part 6A in the magnitude of length L to diameter D of $L/D \approx 1$; part 6G illustrates as a further example a short truncated conical member, and part 6M a tipped slender cone. Fig. 6B illustrates as examples a pressure-generating element 6B with L/D of between 2 and 3, and a slender pressure-generating element 6C. This can relate, for example, to an explosive cord or a fuse cord similar detonator (L/D more than about 5).

As a further example, in Fig. 6C there is illustrated a disk-shaped element 6F. Naturally, there are also contemplatable combinations with the illustrated or with further elements, as shown by example 6P.

In Fig. 6D there are illustrated exemplary embodiments for the case in that, by means of a suitable configuration, the pyrotechnic elements especially in the forward part of a penetrator or in the tip region of the encompassing parts can be imparted a preferably radial velocity component. This is preferably implemented by means of a conical configuration of the tip of the pressure-generating element 6H, 6O, 6N, or through a rounded portion 6Q.

It can also be of particular advantage that in accordance with the desired effectiveness or disintegration of a projectile, a plurality of pressure-generating elements are permitted to act together. Thus, Fig. 6E illustrates the combination of a short intensely laterally acting cylinder 6A with a slender, lengthy element 6E through a transition part 6I. By means of such arrangements there can be produced, in accordance with selected pressure transition media, different lateral velocities also in a cylindrical projectile part.

Fig. 7 illustrates examples of hollow pressure-generating / pyrotechnic components. Hereby this can relate to a ring shaped element 6D or a hollow cylinder. These can be open (6E) or partially closed (6L).

Basically, it is also possible to proceed from the standpoint that for the full unfolding of the effect / disintegration, only a solid small part of a mass of a pressure-generating medium is required. Thus numerical simulation as well as the implemented experiments have proven that, for example, for large caliber projectiles (penetrator diameter > 20mm) only a few millimetre thick explosive cylinders in combination with a liquid or with a PE are sufficient for an extremely efficient disintegration.

A further possibility of configuration of active laterally effective projectiles or warheads through the accelerating components is represented by Figs. 8A and 8B.

Thus, in Fig. 8A there is illustrated a cross section 142 as an example for 4 pressure-generating elements 25A (e.g. in an embodiment in accordance with 6C) which are located externally of the centre of a pressure-transmitting medium 4, and which are connected through a conduit 28. That type of capability is viewed in

combination with Figs. 15, 16B, 18, 19, 29, 30-30D and also 31, and respectively, 33.

In Fig. 8B, as a cross-sectional view 43 there is represented an example for a central pressure-generating module 26, which by means of the lines 27 is connected through the cross-sectional positioned pressure-medium transmitting medium further pressure-generating elements 25B.

Clarified through the examples shown in Figs. 2 to 7 and explained in connection therewith for the axial projectile construction and the variation capabilities for the pressure-generating elements, there can also be clarified at this point, meaning without any special consideration further parameters such as diverse pressure-transmitting media, such as media, especially radial structures or constructively specified details of the significant advantage of active laterally effective penetrators, as shown for example in Figs. 9A to 9D.

In the considerations in conjunction with active laterally-effective penetrators it is expedient that suitable distance ranges be defined relative to the target, inasmuch as from the literature there cannot be ascertained any generally determined values. It can be distinguished between the immediate proximate region (distance to the target of less than 1 metre), the region close to the target (1 to 3 metres), the region approaching the target (3 to 10 metres), the intermediate range of distance (10 to 30 metres), greater distances to the target (30 to 100 metres), remoter distance to the target (100 to 200 metres), and even greater distances to the target (greater than 200 metres).

Fig. 9A illustrates the reference projectile 17A, which is illustrated in enlarged and not to scale. It should be assembled in a cylindrical part of three in close approximation equally designed active modules 20A, 19A, and 18A (ref. to Fig. 4G) which are initiated in different positions relative to the three selected target examples 14, 15 and 16.

In Fig. 9B there is illustrated the case in which the projectile 17 is activated in a closer region ahead of the target (here approximately 5 projectile lengths) in such a

manner that the three stages 18A, 19A and 20A disintegrate in a tight sequence subsequent to each other. The remaining penetrator 17B subsequent to the disintegration of the module 18A still constitutes the two active modules 20A and 19A, whereas the forward module 18E has been disintegrated into a fragment ring 18B. After a further approach into a target 14, which here for example consists of three individual plates, in the remaining projectile 17C the fragmentation range 18B has expanded to the ring 18C and the module 19A has already formed the fragment or sub-projectile ring 19B. The right-side partial image represents the point-in-time in which there has been formed the ring 18D from the fragment ring 18C through a further lateral expansion, and from the fragment ring 19B of the second stage 19A the fragment ring 19C, and from the stage 20A of the remaining projectile 17 there has been formed the fragment or sub-projectile ring 20B. Eventually, the fragment densities are hereby reduced in accordance with a geometric ratios.

Thereby, this example illustrates the large lateral power capacity of those types of active laterally effective penetrator in accordance with the present invention. From the heretofore represented technical details there can be easily derived that, for example, through the triggering distance or through a suitable configuration of the accelerating elements, that there can be covered a much larger surface. Moreover, for example, the disintegration can be installed in such a manner that a desired remaining penetrating power by at least the central fragments is still assured. Such constructed penetrators are in particular adapted for relatively light target structures, for example, against aircraft, unarmoured or armoured helicopters, unarmoured or armoured naval vessels and lighter target / vehicles in general, especially also expanded ground targets.

Fig. 9C illustrates a second representative example for a controlled projectile disintegration. Hereby, the projectile 17A is first activated at a close range to the target, which here consists of a thin pre-armouring 15A and a thicker main armouring 15. The forward active part 18A of the projectile 17A has already formed a fragment or sub-projectile ring 18B; which during a further course windows towards the ring 18C, which fully impacts the surface of the forward plate 15A. The remaining penetrator 17B strikes against the pre-armouring 15A. It can act, for example, as an inert PELE-module and then forms a crater 21 in the main armouring 15 which uses

up the second part 19A. The remaining projectile module 20A can now penetrate through the hole 21A formed by the penetrator part 19A, and - either inertly or actively - penetrates to the interior side of the target through the crater 21B. Hereby, there are also formed larger crater fragments and accelerated into the interior of the target.

In Fig. 9D, the projectile 17A strikes directly against the target 16 which in this example is assumed as being solid. Hereby, the module 18 should be designed so as to be active for the immediate proximate region (e.g. triggering through contact by the tip) so as to form a crater 22A which is comparably larger with regard to that shown by example in Fig. 9C. Through this, for example, the following module 19A can travel through into the interior of the target. In the indicated crater picture there is assumed that also the third module 20A upon striking or being activated through a delay element and thusly forms as an extremely large crater diameter 22B, and produces corresponding residual effects (effects subsequent to the penetration).

It has been experimentally proven, for example, that for inert PELE-penetrators, in contrast with slender homogeneous arrow projectiles, at a penetrating power of the inventive ALP corresponding plate thickness, there can be displaced a greater crater volume by a factor of approximately 7 to 8 times. This recognition was explicitly disclosed for example in the ISL report S-RT 906/2000 (ISL: German-French Research Institute St. Louis).

At an active module, this value can become significantly greater. Hereby there must above all be considered that in accordance with the Craz's Model Law, the displaced crater volume for each energy unit is constant in a first approximation. This signifies that a high lateral effect is, as a rule, connected with a loss of penetrating depth. Overall, however, in the majority of the encountered instances, there is already obtained a generally positive balance, alone in that the large surfaced target stressing in proximity to the impact hole (due to an unstressing emanating from the rear side), in contrast with the displacement in the interior target, has energetically a much more advantageous stamping as a result. Especially with thinner multiple plate target there can be achieved hereby a total penetrating power (through-penetrating total target plate thickness), which absolutely is comparable with the penetrating

power of more compact or even more massive penetrators in homogeneous or quasi-homogeneous targets. However also for homogeneous target plates, there can be calculated for laterally effective penetrators with a comparably high penetrating power, since the punching out or stamping out in the region of the crater is expedited or initiated earlier.

Also here it is again apparent that with projectile constructions in accordance with the invention there is a practically suitable palette available in order to achieve the desired effects in accordance with the present or the expected target scenarios in an heretofore unknown range spectrum.

As already mentioned, the selection of pressure transmitting media opens a further parameter field with respect to an optimum design not only for a specified target spectrum, but also with respect to a projectile concept with basically the greatest possible width of range in application. Thereby in the herein listed examples and corresponding explanations there is proceeded from inert pressure-transmitting media, however, understandably, in certain instances reaction capable materials or the lateral effect supporting active media can assume such types of functions.

Besides the already mentioned inert pressure-transmitting media, coming into consideration are also materials with special behaviours under pressure loads such as for example, glass-like or polymer materials.

In this connection, it is also possible to point out the comments in DE197 00 349 C1. These, in the present instance, are not only to be accepted in their full context but also with respect to the particularities of the present invention, there comes into question a still greater palette of work materials such as, for example, ductile metals of higher density up to heavy metals, organic substances (e.g. cellulose, oils, fats, or biologically decomposable products) or to a certain extent, compressible materials of different strengths and densities. Some materials can also provide additional effects, such as an increase in volume due to unstressing in the case of glass. Understandably it is also possible to contemplate mixtures and compounds, as well as compressed powder or materials with pyrotechnic properties and the introduction of embedding of further materials or bodies into the region of transmitting medium

or, respectively the pressure-transmitting media, to the extent that thereby the functional dependence is not impermissible restricted. Through the type, mass and configuring of the pressure-generating media, the room for changing configuration is thereby practically unlimited.

Fig. 10 illustrates ten partial images of a numerical 2D simulation of the pressure propagation for a slender pressure-generating element (explosive cylinder) 6C in a penetrator assembly according to Fig. 1B (partial image 1), compared with Figs. 4F and 44A/B. The detonation front 265 runs through the explosive material cylinder (detonation cord) 6C and expands in the liquid 4 as a pressure build up wave (pressure propagation front) 266 of (partial images 2 to 5). The angle of the pressure-propagation front 266 is determined by the speed of sound in the pressure-transmitting medium 4.

After the cylinder has been detonated therethrough the wave 266 expands further at the speed of sound of the medium 4, (here significantly slower, refer to partial images 6 and 7). From partial image 5 on, there can be recognized the waves 272 which are reflected from the inner wall of the casing 2B. Due to the waves 272 which are reflected from the casing 2B, this leads to a rapid pressure balance (partial images 8 to 9), a forward extended pressure compensation 271 is recognizable from partial image 10 on. As the reaction begins, the casing wall expands elastically, at a sufficient wave energy, in effect, a corresponding pressure build up, it expand plastically 274. The dynamic material properties hereby decide themselves through the type and manner of the casing deformation such as the formation of different fragment sizes and sub-projectile shapes.

The illustrated simulation example with a relatively thin explosive material cylinder demonstrates clearly the dynamic build-up of a pressure field in the pressure-transmitting medium for casing disintegration in accordance with the present invention. With the geometric configuration, the selection of the pressure-generating element and the employed materials, there is available a multiplicity of parameters for achieving optimum effects.

Fig. 11 illustrates ten partial images of a numerical 2D simulation of the pressure propagation for an assembly of the pressure-generating element pursuant to Fig. 4H (partial image 1) - ref. Figs. 6B, 6E and 45A to 45D. Through this example there should be illustrated the influence of different explosives geometries and their interplay.

Partial image 2 illustrates the detonation front 269 of the explosive material cylinder 6B and the pressure wave 266 which is propagates in the medium 4. In partial image 3, the detonation from 265 runs within the here extremely slender explosive material cylinder 6C. Recognizable from part images 4 and 5 is the transition 270 of the pressure waves of the short cylinder 267 and the pressure wave of the explosive cord 268. Just as well, the wave 272 which already ran back from the casing inner wall. In the partial images 6 to 10 there is effected the reaction on the side of the explosives cord, as is described in Fig. 10. Due to the smaller diameter of the explosives material cylinder or, respectively, the explosives cord, the wave image is more defined, and the pressure balance is effected in a manner extending in time. The partial images similarly illustrate that the pressure field which is formed by the shorter, thicker explosive material cylinder 6B remains limited localized over the entire represented time interval, and that merely a pressure front 267 runs towards the right through the inner space. This can be employed, at a suitable design, understandably also alone for certain disintegration effects in the right part of the casing. Correspondingly, located on the outside of the casing 2B is a clearly defined bulging 275 which can be already clearly recognized at this point in time. As to whether the stressing for a tearing open of the casing is adequate, can be tested, for example, by means of a 3D simulation (ref. to Figs. 45A to 45D).

Through a pasty, at least during the introduction of a quasi-fluidly or, for instance, a polymeric or otherwise at least transitionally plastic or flowably rendered pressure-transmitting medium, in a technically especially simple manner there can be implemented practically any suitable internal form and/or structure. Also connected therewith are considerable constructive or manufacturing technological advantages such as the embedding, moulding or casting in of fuses, detonators or active components in a manner which in a mechanical art was frequently not at all be possible ("rough" inner cylinder, deformation on the inside, and the like). For the

formation of the inner surfaces, e.g. on the basis of manufacturing view points, Figs. 18 to 21 with the related parts of the specification or description text in patent document DE 197 00 349 C1 can be employed herein.

Embodiments within the context of the present invention are possible in a lateral as well as in an axial direction. Hereinbelow, in the following description there are set forth examples for both cases, whereby it is also possible to contemplate advantageous combinations.

Fig. 12 illustrates, as an example, an active laterally effective projectile 23 with two axial zones A and B connected behind each other, with respectively each having a pyrotechnic element 118, 119, a (e.g. different) pressure-transmitting medium 4A, 4B and the (also each his own) fragment / sub-projectile producing casings 2C, 2D in a different configuration, as well as a third zone C. The zone C represents, for example, a reducing casing 2E with a correspondingly configured pyrotechnic elements 6G in the rearward region which, for instance, can be encompassed by the pressure-transmitting medium 4C, or also a reduction in the transitional region towards the tip of a projectile.

The embodiments illustrated in Fig.12, are thereby technologically of interest, inasmuch as they illustrate a capability that the tail end which usually counts as a dead weight or the tip can be configured as a fragmentation module. In consideration of the fact that for usual projectile geometries the tip length as well as the conical tail end region can consist of throughout two penetrator diameters / flight diameters, through a suitable design there can be imparted an efficient power conversion to a significant portion of the projectile.

Fig. 13 represents for an embodiment 144 with a cross-section and symmetrically assembly, a central explosive material cylinder 6C, as well as an inner 4D and an outer pressure-transmitting medium 4E, and a fragment / sub-projectile producing or emitting casing 2A/2B. Hereby it is also thinkable throughout that especially through a variation of the internal components 4D there can be achieved special effects. Thus, for instance, the medium 4D can act in a delayed manner on the pressure-transmitting, or also acceleratingly or respectively in accordance with the selected

materials, support the pressure effect. Furthermore, through the distribution of the surface between 4D and 4E, the average density of these two components can be varied, which can be of significance in the design of projectiles.

Not least due to manufacturing technological viewpoints, there is set the question concerning necessary tolerances or other cost intensive (e.g. due to technically difficult or complex) details. It is furthermore an important advantage of the present invention that with regard to the herein utilized materials, as well as with regard to manufacturing tolerances, insofar as it relates at least to the effectiveness, that only set minor requirements must be set. A further particular great advantage in this connection can be ascertained in that, for a series of pressure-transmitting media, the position of the pressure generating module (at least for a sufficient thickness of the surrounding pressure transmitting medium) can be selected in an almost any suitable manner.

Thus, Fig. 14 illustrates an example 145 for an eccentrically positioned pressure-generating pyrotechnic element 84 (ref. to numerical 3D simulations in Figs. 46A through 46C).

Fig. 15 illustrates, by way of example, an ALP-cross section 30 and analogue to Fig. 13, however, with an eccentrically positioned pressure-generating element 32 (e.g. the explosive material closest cylinder 6C) as well as an inner (4F) and an outer pressure-transmitting medium and a fragment / sub-projectile producing or emitting casing 2A/2B. The inner component 4F should be preferably constituted of a good pressure-distributing medium, for example, a liquid or PE (see explanations with regard to Fig. 31). Otherwise, concerning the two components there are applicable the conditions which have been already explained with regard to Fig. 13. At a suitable design of the medium 4G it can, however, also be of interest to achieve controlled asymmetrical effects. This can be achieved, for instance, in that the heavier mass side of the inner pressure-transmitting medium 4 acts as a damming for the pressure-generating element 32, and thereby achieved is a directional orientation (ref. also to the comments concerning Fig. 30B and Fig. 33).

It is now apparent that by means of this known advantage there can be followed two concepts, for instance, an extensive pressure balance or a locally desired pressure distribution. Especially for a plurality of pyrotechnic elements at the perimeter there are obtained hereby technologically-effective interesting possibilities.

Fig. 15B accordingly illustrates a construction 31 similar to Fig. 13, however, with a pressure-generating unit (e.g. corresponding to 6C) in the inner pressure-transmitting medium 4H and pressure-generating elements 35 (e.g., here three in number) in the outer pressure-transmitting medium 41, which for example, can be separately activated. Understandably, it is also possible to contemplate constructions without the central components.

It is of particular advantage that for projectile or penetrators in accordance with the present invention, large lateral effects can be combined with relatively high penetrating powers. This can be basically achieved through an overall high specific cross-sectional loading (limiting instance is the homogeneous cylinder corresponding density and length) or over the surface the partially effected high cross-sectional loads. Examples for this are massive / thick walled casings or inserted, preferably centrally positioned penetrators with high degree of slenderness (for increasing the penetrating power most possible of materials of high hardness, density and/or strength, such as hardened steel, hard and heavy metal). It is also contemplably that the central penetrator be constructed as a (sufficiently pressure resistant) container with which special parts, materials or fluids can be brought into the interior of the target. In special instances, the central penetrator can also be replaced by a centrally positioned module to which there can be imparted particular effects acting in the interior of the target.

In the following embodiments there are implemented a series of formulaic solutions for the introduction of such types of end ballistic power carriers with respect to their penetrating capabilities (ref., for example, to Figs. 16A, 16B, 18, 19, 30C and 31).

Fig. 16A illustrates a construction 33 with a central hollow penetrator 137. Located in the hollow space 38 of the penetrator 137 can be effect-supporting materials such as including masses, respectively pyrotechnic technical materials or com-

bustible fluids. Between the casing 2A/2B and the central hollow penetrator 137 there is arranged the pressure-transmitting medium 4. The pressure build up can be carried out, for example, through a ring-shaped pressure-generating element 6E.

As a further example for an inserted central penetrator, illustrated in Fig. 16B is a cross-section 29 with four symmetrically positioned pressure-generating elements 35 in a pressure-transmitting medium 4 which encompasses a central massive or solid penetrator 34. This penetrator 34 not only achieves high end ballistic penetrating powers, but it is also adapted to serve as a reflector for the explosive material cylinder 35 which is located on its surface (or in proximity to the surface). Further examples bring this effect particularly clearly into validity (ref., for example, to Figs. 18, 19, 30A and 30B).

For the following figures, Fig. 17 should serve as a standard embodiment of an ALP cross-section 120 in the simplest inventive configuration.

Fig. 18 illustrates an ALP construction 36 with a central penetrator 37 of star-shaped cross-section and four symmetrically arranged pressure-generating elements 35. This star-shaped cross-section (as, for example, also the quadratic / rectangular cross-section in Fig. 19 and the triangular cross-section in Fig. 30A), serves for suitable cross-sectional shapes.

Fig. 19 illustrates an ALP construction 38 with a central penetrator 39 with a rectangular or quadratic cross-section and four symmetrically distributed pressure-generating elements 35. These elements (e.g. explosive material cylinder) for achieving a directed effect can be introduced, for instance, either completely or partially into the central penetrator (see the partial view).

Fig. 20 illustrates an ALP construction 40 in accordance with Fig. 17 with two respectively oppositely arranged casing segments 41 and 42 as an example for possible different material coverings over the circumference or also for a different geometric configuration of the casing segments over the circumference. Due to external ballistic reasons, the different segments can also, however, be axially symmetrically arranged.

Fig. 21 illustrates an ALP construction 133 with a pressure-generating element 6E corresponding to Fig. 7. The pyrotechnic part 6E can hereby encompass a central penetrator or also every other medium, for example, though a reaction capable component or a combustible fluid (ref. also to the remarks with regard to Fig. 16A).

Fig. 22 illustrates an ALP assembly 134 with segmental pressure generators 43 (explosive material segments; ref. to Fig. 38).

Fig. 23 illustrates an ALP assembly 46 with two concentrically superimposed casing shells 47 and 48. Hereby, this can relate, for instance, to a combination of a ductile and brittle material or materials as well with different properties. That type of configuration also represents as an example for casing-supported penetrators ("jacketed penetrators"). Such types of casings can then be required for a few constructions when, for example, they should be ensured a specified dynamic strength, such as upon firing, or when axially arranged modules should be bound together by means of such a guidance or support casing at least during firing, and along the trajectory to the extent that such functions are not assumed by correspondingly to designed propulsion mechanism.

Fig. 24 illustrates an ALP assembly 49 with a central explosive material cylinder 6C in the pressure-transmitting medium 4 and an internal jacket 2A/2B in connection with a relatively thick outer jacket 50. Alternatively, it is also possible to employ as a central pressure-generating unit, a hollow cylindrical explosive material in accordance with 6E from Fig. 21. Then there is also obtained the combination possibility pursuant to Fig. 21. The internal jacket 2A/2B can be constituted in this instance of heavy-metals such as WS, a tempered metal, a pressed powder or also of steel; the outer jacket 50 similarly of heavy-metal, steel or cast steel, light metal such as magnesium duraluminium, titanium or also from a ceramic or non metallic material. Lighter materials which increase the bending resistance (e.g. for avoidance of projectile fluctuations in the barrel or during flight), due to their utilization in the outer casing are technologically of special interest. They can form an optimum transition to propulsion mechanisms, and for a limited projectile total masses increase the design ranges (surface weight balance). In that also pre-manufactured

further active components can also be introduced, can be ascertained from the explanations in connection with the present invention.

Fig. 25 illustrates a cross-section 51 through the example of an ALP assembly with a external contour which is not circular during the flight. It is understandable that this manner of functioning which is based on the invention is not bound to specific cross-sectional shapes. Special configuration can frequently assist in that the range of configurations is still further broadened. Thus, it is contemplatable that, for example, the cross-section illustrated in Fig. 25 can preferably be used to produce four large sub-projectiles. This is then of particular advantage when, subsequent to the disintegration of the penetrator, there should still be achieved a high penetrating power by the individual penetrators.

Fig. 26 illustrates an ALP assembly 52 with a hexagonally-shaped central part with a pressure-generating element 60, a pressure-transmitting medium 54, a fragment ring of preformed sub-projectiles (or fragments) with non-circularly shaped cross-section 53, in which, for example, there can again be arranged massive or solid penetrators 59 or PELE penetrators 60, or satellite-ALPs 45. However, it is also contemplatable to provide connections / lines / explosive cords 61 between the central pressure-generating element 60 and the peripheral satellite ALPs 45.

Fig. 27 illustrates an ALP assembly in accordance with Fig. 26 with additional jacket or casing 56. For this element 56, there are also applicable the embodiments as described with regard to Figs. 23 and 24. The partial segments between the hexagonally-shape sub-projectile 53 and the jacket 56 can contain, for instance, a filler mass 57 in order to achieve diverse side effects.

Fig. 28 illustrates the example of an ALP projectile 58 with four (here, for example, circularly-shape) penetrators (e.g. in a massive or solid 59 or PELE constructional mode 60) and a central accelerating unit 16 in combination with a pressure-transmitting medium 4. Between the inner components 59 or 60 and the outer casing 62 there can be arranged a filler medium 63 which again, in turn, can be designed as an active medium or which can also contain such parts or elements.

Fig. 29 represents a variant / combination of the previously already represented exemplary embodiments (ref., e.g., to Figs. 16B, 18, 19 and 28). The cross-section of the penetrator 64, in this instance, consists of three massive or solid homogeneous sub-projectiles 59, three pressure-generating arrangements, for example, corresponding to element 60, a pressure-transmitting medium 4 and the fragment / sub-projectile generating or emitting casing 300. Basically this example stands for multipart central penetrators.

In Fig. 30a there is also represented for demonstration of the almost any suitable configuration range in conjunction with the present invention, a penetrator variant 66 with a central penetrator 67 having a triangular cross-section. The pressure-generating installations here consist expediently of three explosive material cylinders 68. These can be initiated either commonly or separately.

In the cross-section 69 illustrated in Fig. 30B, the triangular central penetrator 70 which fills out the entire inner cylinder, divides the interior surface into three regions, which are each equipped with a pressure-generating element 68 and a pressure-transmitting medium 4. As in the example of Fig. 30A, they can also be commonly or separately activated or initiated. It is also contemplable, that by means of a separate triggering of the element 68 there can be achieved a controlled lateral effect.

In the cross-section 285 illustrated in Fig. 30C there is arranged in the cylindrical inner space or respectively, in the pressure-transmitting medium 4, a triangular hollow element 286, whose internal space 287 can be additionally filled with a pressure-transmitting medium or other materials enhancing the effectiveness, such as reaction capable components or combustible fluids. For the triangular casing 65 of the element 286, there are the applicable the already above-described conditions. As in Fig. 30B, there are provided three pressure-generating elements 68. Upon the ignition of only one element 68, there is produced a clearly asymmetrical pressure distribution and a corresponding asymmetrical sub-projectile or respectively, fragment covering of the encompassing space (the attached surface).

In order to complete the explanation with regard to Figs. 30B and 30C, Fig. 30D illustrates an ALP cross-section 288, in which in the cylindrical inner space of the surrounding casing 290 is formed into four chambers by means of a cruciform part 289, in each of which there is provided a pressure-generating element 68 in the pressure-transmitting medium 4. Also herein, upon the ignition of only one element 68, there results an asymmetrical sub-projectile or respectively fragment distribution.

In the ALP cross-section 71 illustrated in Fig. 31, in conjunction with Fig. 30B the central penetrator (or the central module) 71 has a triangular cross-section and is in itself an ALP. Between this central penetrator 72 and the casing 301 there can be found, e.g., air, a fluid, liquid or solid material, a powder or a mixture or composition 73 (ref. to commentary with regard to Fig. 28), and in addition thereto further pressure-generating bodies 68 in correspondence with Fig. 30B. The central pressure-generating element 6E and the peripheral pressure-generating elements 68 can also here be interconnected so as to achieve a specified effect. Naturally, they can also be separately activated. Thereby, for example, it is possible upon approach to a target to activate the lateral components, and the central ALP at a later point-in-time.

The numerical simulation has verified that at a suitable selection of the pressure-transmitting medium (e.g. liquid, plastic such as PE fibreglass-reinforced materials, polymer materials, plexiglass and similar materials) also at an eccentric positioning of the pressure-generating components, quite rapidly there takes place a pressure compensation or balancing which, in a first approximation supports a uniform disintegration of the casing or, respectively, a correspondingly uniform distribution of sub-projectiles (ref., e.g., to Fig. 46B). Thereby, it can also be quite comprehensible in particular for not rapidly pressure-compensating materials through a suitable configuration of the pressure-generating components, to cause certain effects or desired disintegrations. Thus, for instance, Fig. 32 illustrates as an example a penetrator cross-section 75 with a pressure-generating unit 76 with a non-circular cross-sectional shape.

By means of such types of configurations it is possible to achieve additional, partly at least especially outstanding effects. Thus, for example, it is contemplatable that through the cross-sectional shape of 76 there can be attained four cutting charge-like effects at about the circumference. This is particularly advantageous when there should be achieved controlled, locally limited extensive lateral effects. For a metallic pressure-transmitting medium with a lower balancing capability relative to the dynamic pressure field, with that type of cross-sectional form 76 there can be achieved, for example, intended specified disintegrations of the casing 302.

The heretofore illustrated embodiments each relate, in accordance with the complexity of the construction to preferably medium or large-calibre sized penetrators. For warheads, rockets or large-calibre ammunition (e.g. for firing by means of howitzers or large-calibre naval guns) technologically more complex solutions are possible, especially with separate (e.g. through a radio signal) triggered or fixedly programmed activation in predetermined preferred directions.

Thus, Fig. 33 illustrates an example of an ALP projectile (warhead) 77 with a plurality (here three) units 79 (cross-sectional segments A, B and C, for instance with a separating wall 81) which are distributed over the cross-section, which also functions separately presently as ALPs (pressure-generating elements 82 in connection with a corresponding pressure-transmitting medium 80), and which can be separately actuatable, or actuated among each other by means of a conduit 140 or through a signal (interconnected). The three segments are either completely separated or possess a common casing 78. This casing 78, for example, can provide for the support of a desired disintegration with matches or slits 83, recesses or other mechanically or possibly laser-generated or material-specifically-required changes along the surface.

It is understandable that such engagements into the surface of the fragment-generating or sub-projectile forming or emitting casing 78 are basically possible for all illustrative embodiments in accordance with the present invention.

In a modification of the embodiment of Fig. 13, the ALP cross-section can, however, also be provided with an eccentrically positioned pressure-generating

element such as an explosive material cylinder 6C, as well as an internal and external pressure-transmitting medium and a fragment / sub-projectile generating or emitting casing. The inner components should preferably consist of a good pressure-distributing medium, such as a liquid or PE (ref. to explanation with regard to Fig. 31). For the remainder, with regard to the two components, there is applicable the situation which has already been described with regard to Fig. 13. At a suitable design of the internal medium, it can also be interesting to achieve controlled asymmetrical effects. This can, for instance, be achieved in that the mass rich side of the inner pressure-transmitting medium acts as a damming for the pressure-generating element 32, and thereby there is accordingly achieved a directional orientation (ref. to herewith also to the commentary concerning Figs. 30B and 33).

In that in the heretofore embodiments, explanations and descriptions with regard to the present invention there has been indicated an almost universally great spectrum of possibilities of variations on the basis of a multiplicity of examples, hereinbelow there is described in the following the designed-oriented view points. Thereby, besides the corresponding numerical simulations there also provided projectile concepts, which not only illustrate the power capability of the presented principle as an inert projectile, e.g. as PELE penetrator, but also especially explain the capabilities of modular constructions under the combinations of different power carriers in an effective technologically ideally explanatory manner.

The damming assumes with pyrotechnic installations basically a great significance, inasmuch as it quite essentially influences the propagation of the shock waves and thereby also the achievable effects. The damming can be statically effected by means of constructive measures, or dynamically, i.e. on the basis, of mass internal effects of suitable pressure-transmitting media. This is, in principle, also possible with liquid media, however, only first at extremely high impact or deformation velocities. Presently determined is the dynamic damming through the propagation speed of the sound waves, which determine the loading of the pressure-transmitting medium. Since, at the utilization of active laterally effective penetrators (projectiles in an especially measure for airborne bodies) there must be calculated also with relatively low impact speeds, the damming must be preferably carried out through

technical installations (for example, closure of the tail end, separating walls). A mixed damming, meaning mechanical arrangements coupled with dynamic damming through rigid pressure-transmitting media, broadens the palette of its applications. A purely dynamic damming should have a prerequisite of extremely high impact velocities, e.g. in a TBM defense.

Fig. 34 illustrates examples for the damming of pressure-generating elements during introduction into a penetrator. Thus, for example, the tip can be conceived as a damming element 93. Furthermore, at the locations of a desired damming there can be advantageously inserted damming discs 90, or forward 89 and rearward closure disks 92. Such elements can also form the closure of hollow cylinders. As further of numerous forms which are conceivable for a partial or complete constructive damming of the pressure-generating elements, for instance, in the form 6B (ref. to Figs. 6A through 6E and Fig. 7), there is also represented in Fig. 34 a damming element in the form of a cylinder 91 which is open at one side.

The type of damming which is of particular interest regarding projectiles or sub-penetrators pursuant the present invention for the introduced pressure-generating elements, resides in the combination with a fragment module. Thus, Fig. 35 shows, as an example, an ALP projectile 84 with a fragment module 85 located behind the tip. This concurrently serves as a damming for the pressure-generating element 6B and for the initiation of the triggering in the pressure-generating element (explosives cord) 6C. As a further technical variant for such types of penetrators, there is illustrated in Fig. 35 a fragment or sub-projectile generating or emitting casing 86 with a conical internal space 222. It is also contemplatable that an external conically extending fragment casing (conical jacket) can be employed without any restriction in the described operative principle.

Fig. 36 illustrates a further example of a penetrator 87 with a damming module 91 (e.g. for an improved triggering initiation), whereby the module 91 encompasses the pressure-generating element 6B, which itself extends into a lengthy pressure-generating element of conical configuration. With such types of conical elements 88 there can be generated in an extremely simple manner different acceleration forces across the length of the projectile or penetrator. It is also contemplatable to be able

to combine a conical jacketing for example, corresponding to 86, with a conical pressure-generating element 88.

In the descriptions and explanations with regard to the present invention there have already been discussed liquid or quasi liquid pressure-transmitting media, in effect, materials such as PE, plexiglass or rubber as being especially interesting pressure-transmitting media. With regard to a desired pressure distribution or shock wave propagation however, one is not in any manner required bound to these types of material, since by means of multiplicity of other materials there can be obtained throughout obtained comparable effects (ref. to the already mentioned materials). However, inasmuch as particular fluids afford a wide scope for additional effects in the target, they represent an important element in the palette of possible active carriers. This is particularly applicable of the manner of effectiveness of an ALP in an inert type of utilization, which has already been described in detail in patent document DE 197 00 349 C1.

Concerning the introduction of fluid or quasi-fluid media into an ALP, many constructive possibilities are available. These can, for example, be introduced in available and correspondingly sealed hollow spaces. Such types of hollow spaces can also be filled, for instance, with a grid like or foam like fabric, which can be saturated or filled in with the introduced fluid. A particularly interesting constructive solution consists of in that liquid media be introduced by means of correspondingly pre-finished, and as a rule prior to assembly, filled container. However, it can also be interesting from the standpoint of technological utility, that such containers are only filled in case of utilization.

Fig. 37 illustrates an ALP example 94 with modular internal construction (e.g. as a container for fluids). In this example, the internal module 95 having the outer diameter 97 and the internal cylinder, respectively, the inner wall 96, are introduced into the projectile casing 2B (slid in, inserted turned in, vulcanised in, glued in). Through a manner of construction of that type, it is not only possible to be able to exchange individual modules or to insert them later on, but also the pressure-generating element 6C can be introduced only upon need. This type of construction is especially advantageously applicable for active arrangement in accordance with

the present invention, inasmuch as the pressure generating element 6C (herein shown in a through extending form) need extend only through a relatively small radial part of the penetrator, inasmuch as the disintegration is ensured by means of the pressure-transmitting medium 98, for example, a fluid. Thereby, the ALP need only be equipped at the point-in-time of its expected utilization with the pyrotechnic module 6C and, if required, the pressure-transmitting fluid medium 98 first filled upon utilization into the internal module, which is a particular advantage of this invention.

Basically, this example is stands for the possibility that projectiles can be modularly conceptuated pursuant to the present invention. Hereby, it is always possible to replace active laterally-effective modules, for example, with inert PELE-modules, or conversely. The individual inert or active module can thereby fixedly (positive or non-positive fit) connected or through suitable connecting systems releasably arranged. This will in a special manner facilitate an exchangeability of the individual module and thereby facilitate a multiplicity of combinations. Accordingly, such projectiles or airborne bodies can also at later points-in-time be easily correlated to changes in utilization scenarios, for example, at increasing combat measures, can always be newly optimised.

The same is applicable for the exchange of homogeneous components or tips. There must only expediently be considered hereby that an exchange of individual components will not cause the overall behaviour of the projectile to change with respect to its internal and external ballistics.

Fig. 38 illustrates an ALP example with preformed casing structure fragments / casing segments in a longitudinal direction of the casing 102 and a central pressure-generating unit 100. Separation 74 between the individual segments 101 can be effected by means of the pressure-transmitting medium 4 or as a chamber filled with a special material (e.g. for shock damping and/or for connection of the elements) (for example, prefabricated jacket as its own, exchangeable module) - ref. to the detail drawing. The interspaces 74 can also be hollow. Obtained thereby, for example, is a dynamic loading of the casing 102 which is extensively variable over the circumference. Through the changing in the width of the stage by the separation

74 and the thickness of the casing 102, in effect, through a suitable material selection, this effect can be varied. An interesting application variant is hereby obtained through the utilization of industrially widely available manufactured ball or roller bearing cages. Such types of modules can actually be arranged in multiple stages, in order to achieve a greater number of sub-projectiles.

The consequent further development of the manner of producing a specified fragment / sub-projectile covering of the combat area as is illustrated in Fig. 38 leads to solutions as illustrated for example in Fig. 39. Hereby this relates to an ALP projectile 170 with a jacket of pre-finished fragments or sub-projectiles 131 which are encompassed by an outer jacket (ring/sleeve) 17. On the inside, the bodies 171 retained either by an inner shell / casing 133 or a sufficiently rigid pressure-transmitting medium 4.

The component 171, especially for large-calibre ammunition, or for warheads, or for rocket-propellant projectiles, allows for an usually great latitude with respect to the active bodies which are to be employed. Thus, for example, in the simplest case these can be constructed as slender cylinders from different materials. Furthermore, they can by themselves again be designed as ALP 176 (partially drawing A), somewhat in connection with the centre pressure-generating element 6A/6B/6C, and/or in connections with each other, or in assembly or a combination of modular groups for the generation of a directed fragment / sub-projectile emission. Moreover, the sub-projectiles 171 can be constructed as PELE penetrators 179 (partial drawing B). Just as well these elements 171 can represent tubes 174 which are filled with cylinders of different lengths or, respectively different materials, with balls among other prefabricated bodies or fluids (partial drawing C).

The modular conception of a projectile or penetrator in conformance with the present invention facilitates that the active zones and the required auxiliary arrangements can be optimally positioned or expediently subdivided. Figs. 40A to 40D hereby provide explanations for the example of a three-part projectile with a front, middle and rear zone.

Thus, in Fig. 40A the active laterally-effective component 6B is located in the tip or, respectively in the tip region of the projectile (tip-ALP) 103, with the auxiliary arrangements 155 in the rear zone. The connection 15 can be carried out by means of signal lines, radio or also by means of pyrotechnic installations (explosives cord).

In the example of Fig. 40B, the active part 6E with integrated auxiliary arrangements 155 in the tip region, is located in the middle zone of the projectile (middle segment-ALP) 104.

In the example in Fig. 40C, the active part 6B is in the tail end region of the projectile (tail end - ALP) 105, the auxiliary arrangements 155 are distributed among the tip and tail end, and connected with the active part 6B through signal lines 152.

Fig. 40D illustrates an example of an ALP projectile 106 with an active tandem arrangement (Tandem - ALP). The auxiliary arrangement 155 which is provided for the two active parts is hereby arranged in the middle region. Naturally the two active modules 6B of the tandem arrangement can also be activated separately or initiated. It is also possible to provide a logic junction, for example, by means of a delay element 139. The auxiliary arrangements 155 can also be arranged so as to be decentralized or remote from the centre axis.

A further technically interesting variant in a modularly assembled projectile or penetrator is either a technically specified or dynamically effected projectile division / separating of the module. The dynamic division / separating can hereby be effected during flight, prior to impact, at the point in time of impact, or during penetrating through the target. The rear module can also be first activated within the interior of the target.

Fig. 41 illustrates an example for a projectile separation or respectively a dynamic division into individual functional modules. Hereby by means of a rear separating charge 251, the tail end can be expelled away. The charge 251 also serves for the pressure build-up in an active inert module 251 which is inertly conceived as a PELE penetrator. Concurrently, by means of the separating charge 251, there can be effected a tail end expulsion with further lateral effects which are produced by the

tail end. As a result there is obtained an optimum utilization of the projectile mass in this part, inasmuch as the tail end is ordinarily considered to be as a "dead weight".

The second element for a dynamic separation is the front separating charge 254. Besides the separation, this can also serve for pressure generation. The tip can be concurrently sprung off and disintegrated. In this projectile, the two active parts are separated by means of an inert buffer zone or, respectively, a massive element, such as a projectile core or, respectively, a fragment part 252. Alternatively, the buffer element 252 can be equipped with a separating disc 255 with regard to the front active part (or rear part), or by itself by means of a ring-shaped pressure-generating element 6D so as to achieve a lateral effect. Furthermore, there can also be provided an auxiliary tip 250 at the rear projectile part, which projects into the buffer element 252.

In Figs. 42A to 42F there are illustrated examples for the configuration of a projectile tip (auxiliary tip).

Thus, Fig. 42A illustrates a tip 256 with integrated PELE module, consisting of the end ballistically - effective casing material 257 in combination with an expansion medium 258. In this embodiment the tip is further provided with a small hollow space 259, which at expediently on the function of the PELE module, especially at an inclined or sloping impact.

Fig. 42B illustrates an active tip module 260 consisting of the fragment jacket 261 in connection with the pyrotechnic element 263 pursuant to Fig. 6E and a pressure-transmitting medium 262. Here, it can also be expedient to melt the tip casing 264 with the fragment jacket 261. A still simpler construction is obtained by eliminating the pressure-transmitting medium 262. At an activation, the splinter form a down in the direction of the illustrated arrows, which not only achieves a corresponding lateral effect, but also for more increased inclined or sloping targets for an allows expectation of an improved impact behaviour.

Fig. 42C illustrates a tip configuration 295 in which a pressure-generating element pursuant to 6B projects partly in to the massive tip and into the projectile body, and

is retained and/or dammed through the casing 296. In this manner, the tip 295 forms its own module which, for example, need be inserted only when need.

A similar arrangement is illustrated in Fig. 42D, in which the tip 297 is constructed either hollow or is filled with an effective medium 298 which achieves additional effect. The element 291 corresponds with the element 296 in Fig. 42C.

Fig. 42E illustrates a tip arrangement 148 in which a hollow space 150 is provided between the hollow tip 149 and the internal space of the projectile body or, essentially the pressure-transmitting medium 4. Into this hollow space 150, upon impact there can flow in target material, and thereby enable the achieving of a better lateral effect.

In Fig. 42F, for a complete understanding there is shown a tip arrangement 152 in which the pressure-transmitting medium 56 projects into the hollow space 259 of the tip casing 149. Also this arrangement it can achieve a similar effect as does the arrangement pursuant to Fig. 42B, and effect a rapid initiation of the lateral acceleration sequence.

In the complex interrelationships which take place in connection with projectiles or penetrators pursuant to the present invention, the three-dimensional numerical simulation by means of suitable codes such as, for example, OTI-Hull with 10^6 grid points, is an ideal auxiliary aid not only for representation of the applicable deformations or disintegrations, but also for the proof of the additive functions of multi-part projectiles. Simulations which are illustrated in which the framework of this application are implemented by the German-French Research Institute Saint Louis (ISL). This auxiliary aid off the numerical simulation has been already implemented through investigations in conjunction with laterally acting penetrators (PELE penetrators) (ref. to DE 197 00 349 C1) and in the interim verified through a multiplicity of further experiments.

With the simulation, the dimension basically does not play any role. This is merely in the number of the necessary grid points and in advance sets a corresponding computer capacity. The examples were simulated with a projectile or respectively a

penetrator external diameter of 30 to 80 mm. The degree of slenderness (length / diameter ratio L/D) mostly is 6. Also this magnitude is of subordinate significance, since for the computations there should not be obtained quantitative but primarily qualitative results. As wall thicknesses there were selected 5 mm (thin wall thickness) and 10 mm (thick wall thickness). This wall thickness is, in a first instance, determinative for the projectile mass, and for cannon-fired ammunition is determined primarily from the power of the weapon, in essence, the attainable muzzle velocity for a specified projectile mass. For airborne bodies or rocket accelerated penetrators, the design spectrum is also significantly higher in this regard.

Inasmuch as the examples, for the largest part, pertain to basic functional principle, which can be advantageously employed especially for large-calibre ammunition or for suitably dimensioned warheads or rockets, there is also afforded a corresponding dimensioning. Understandably, however, all illustrative examples and all positions are not bound to a specific scale. It is merely the question of a sensible miniaturization of complex structures, also in conjunction with an eventual question as to costs which must be considered during implementation of the invention.

As the material for the casing producing the fragment / sub-projectiles, there was assumed tungsten / heavy metal (WS) of an average strength (600 N/mm^2 up to 1000 N/mm^2 tensile strength) and corresponding elongation or stretching (3 to 10%). Inasmuch as the deformation criteria which underlie this invention are always fulfilled, in order to ensure a desired disintegration, and one is not dependent upon a specified embrittling behaviour, not only can one reach back to an extremely large material palette, but the spectrum within a family of materials is similarly quite extensive and is principally determined only through the stresses encountered during firing or other requisites on the part of the projectile construction.

Basically, for active arrangements in the context of the present invention, for the non-activated instance of utilization there are valid the same considerations and selection and/or design criteria as with PELE penetrators (as in DE 197 00 349 C1). In addition thereto, as a decisive expanse relative to the PELE principle for an active laterally-acting penetrator, practically no restrictive criteria for the determination of material combinations need to be considered. Thus, for example, the pressure-

generation and the pressure- propagation for a ALP is constantly afforded and can be set, in form, height and expansion. The function of the ALP is also independent of its velocity. This determines merely the penetrating power of the individual components in the direction of flight and for the laterally accelerated parts in combination with the lateral velocity, the effective impact angle.

Pursuant to the above embodiments it is completely possible to expand an internal cylinder possessing a high density (up to, for instance homogeneous heavy or hardened metal, or pressed heavy-metal powder) by means of a pressure-transmitting medium and thereby as a pressure-transmitting medium to disintegrate and to radially to accelerate an outer jacket of lower density (e.g. pre-fabricated structures hardened steel, or also a light-weight metal).

Furthermore, due to the previously specifiable pressure generation and the necessary pressure level, respectively extent of expansion, almost every suitable jacket construction, inclusive prefabricated sub-projectiles, can be dependably radially accelerated. Thereby one is not subjected to the restrictions of a spontaneous disintegration with the restricted possibilities concerning desired fragment / sub-projectile velocity, but there can be realized extremely low lateral velocity in the magnitude of a few 10 m/s, up to high fragment speeds (above 1000 m/s) without necessitating, any special technical demand. Computations and experiments have shown that the necessary pyrotechnic mass is basically extremely small, so that the utilization in, a first instance, is determined by additive elements and desired effects. Therefore it is possible to proceed in that for penetrator masses in the range of 10 - 20 kg, minimum explosive material masses in the magnitude of 10 g are adequate. For smaller penetrator masses, this minimal explosive material mass is correspondingly reduced further to values of 1 to 10 g.

Thereafter, in Figs. 43A to 45D there are shown three-dimensional numerical simulations for relatively simple assemblies, in order to physically, and mathematically cover the above-represented technical explanations and implemented examples in their basic points. In order to render more clearly the deformation of individual parts, especially that of the casing, the representations of the deformed parts are frequently rendered visible through the detonation of the produced gas and the

pressure-transmitting medium when these do not cover the deformation process which is to be observed.

Thus, in Fig. 43A, there is illustrated a simple ALP active assembly 107, constructed on the front side by means of a WS cover 110A closed-off hollow cylinder (60 mm outer diameter, wall thickness 5 mm, WS with high ductility) with the casing 2B (ref. to Fig. 1B), and a compact acceleration / pressure generation unit 6B with an explosive material mass of only 5 g. As the pressure-transmitting medium there was employed liquid medium 124 (here water; construction pursuant to Fig. 4A).

Fig. 43B illustrates the dynamic disintegration at 150 microseconds (μs) subsequent to the ignition of the explosive charge 6B. For the present configuration, there are formed six large casing fragments 111 and a series of smaller fragments. Similarly, easily recognizable is the deformed cover 110B which is accelerated in an axial direction. Exiting at the rear side of the cylinder is the accelerated liquid pressure-transmitting medium 124 (exit length 113). In the forward region the pressure-transmitting medium 158 contacts against the inside of the casing fragments, a portion 159 has exited. Furthermore, at this point in time the beginning fissures 112 and the already produced longitudinal fissures 114 indicate that already for an this extremely low explosive material mass the ductile selected casing wall completely disintegrate. Concurrently, this deformation image documents that the perfect functioning of a construction of this type in accordance with the invention.

Fig. 44A illustrates a similar penetrator as is shown in Fig. 43A. The dimensions of the ALP 108 remain unchanged, merely the pressure-generating element was modified. It relates to a thin explosive material cylinder 6C (an explosives cord) according to Fig. 4F.

Fig. 44B illustrates the dynamic deformation of the ALP 108 at already 100 μs after to the ignition of the charge 6C. The corresponding pressure propagation and pressure distribution was already explained with regard to Fig. 10.

Furthermore, the influence of diverse materials as pressure-transmitting media was investigated. The selected assembly 109 pursuant to Fig. 45A corresponds to that of the 2D simulation in Fig. 11, consisting of a WS-casing 2B (with a 60 mm outer diameter) with a front damming 110A at one side thereof in the region of the thicker explosive material cylinder 6B. The pressure-transmitting medium surrounds the pressure-generating elements 6B/6C.

Fig. 45B illustrates the dynamic casing expansion with a liquid (water) 124 as the pressure-transmitting medium 150 μ s after the ignition of the pressure-generating charge 6B. The accelerated casing segment 115, the ripping open casing segment 116 and the reaction gases 146 can be readily recognized. The liquid medium 123 is only slight, accelerated, meaning, with the discharge length 113. The beginning fissure formation 123 has already propagated up to one-half of the entire casing length.

In Fig. 45C, with plexiglass was calculated as being the pressure-transmitting medium 121. The dynamic expansion 125 of the casing 2B and the beginning fissure formation 126 at 150 μ s after ignition is somewhat lower than in the example pursuant to Fig. 45B. The discharge of the medium 125 rearwardly is extremely slight.

For the numerical simulation pursuant to Fig. 45D, aluminium was employed as the pressure-transmitting medium 122. The deformation of the casing 2B at 150 μ s after ignition is very defined in the region of the pressure-generating element 6B. The casing fragments 127 are locally already intensely expanded. A fissure formation in the longitudinal direction of the casing 2B in contrast therewith (Figs. 45B and 45C) has not yet occurred, and the discharge of the medium 122 rearwardly is negligibly slight.

In Fig. 46A there is presented an ALP 128 with an eccentrically positioned pressure-generating element 35 in the form of a slender explosive material cylinder. In this arrangement there was effected an opposite positioning of liquid (water) 124 and aluminium 122 as the pressure-transmitting medium.

Thus, in Fig. 46B, there is shown the dynamic disintegration of this arrangement pursuant to Fig. 46A with the liquid 124 as the transmission medium at $150\ \mu\text{s}$ after ignition. There is not obtained any significantly different distribution of the casing fragments 129, and also no decisively different fragment velocities at the circumference.

Fig. 46C illustrates the dynamic disintegration of the arrangement according to Fig. 46A with aluminium 122 as transmitting medium at $15\ \mu\text{s}$ after ignition. Here the original geometry also shows itself in the disintegration picture. Thus, the case fragment 130 is intensely accelerated at the contacting side by the pressure-generating element 35, and the casing is intensely fragmented at this side, whereas the lower side which faces away from the charge 34 still forms a shell 131. At this point in time in the computation there can be recognized the inside merely beginning constructions (fissures) 132.

Fig. 47A illustrates an ALP 135 with a central penetrator 134 consisting of WS, of the for the WS casing mentioned quality, and with an eccentrically positioned pressure-generating element 35. As the simulated deformation image at $150\ \mu\text{s}$ after ignition illustrates in Fig. 47B, notwithstanding the selected liquid 124 as the pressure-transmitting medium, there is obtained a clear distinction with respect to the fragment or sub-projectile distribution over the circumference. Thus, the casing fragments 136 are more intensely accelerated on the side towards of the pressure-generating element 35. Towards the front, there is partially recognizable the accelerated liquid medium 159.

The comparison which Fig. 46B renders evident, in that the difference in the deformation image is due to the central penetrator 34. It acts, as already mentioned, apparently as a reflector for the pressure waves which emanate from the explosive material charge 35. Thereby by means of the simulation there is provided the proof that with such type of arrangement there can be achieved controlled directionally-dependent lateral effects across geometric designs. It is also significant that the central penetrator is not destroyed, but is merely displaced downwardly, in effect, deviating from its original trajectory.

From Fig. 47B there can also be derived that, in an above all technologically undisputable variant, it is basically possible that through a controlled activation of one or more charges 34 which are eccentrically distributed about the circumference, the central penetrator still can be imparted in proximity to the target a corrective directional impulse.

The previously illustrated simulation examples interlink the already described individual components as already described with regard to Figs. 2A, 2B, 4B, 4C, 4H, 6E, 12, and 40A to 40C relates to a spin or aerodynamically-stabilized ammunition concept, which especially in conjunction with the present invention always address and basic ammunition module concurrently evidence: tip, active laterally effective module, PELE components (to the extent as not combined with the active component), and massive or, respectively, homogenous components. Such constructions are illustrated expediently by the following Figs. 48A to 48C.

Fig. 48A relates to a three-part modular spin stabilized penetrator 277, constituted of tip module 278, a passive (PELE) or massive module 279 and an active module 280. The auxiliary arrangements can be located, for example, in the part 282 encompassing the active module, in the tip module 278, or in the tail end region, or as already described can be divided. The active module 280 is preferably closed off at its tail end with a damming plate or disc 147.

In Fig. 48B there is, for example, illustrated a four-part, modular, aerodynamically stabilized projectile 283. It consists of a tip module 278, an active module 280 with a damming disc 147 against the, for example, hollow or inadequately dammed tip, a PELE module 281, and a tail end portion 284 which is homogeneous and is connected thereto. Thereby are thus listed the essential projectile penetrator or warhead components, which can occur in complex built-up active bodies. However, it is understood in itself that one intends, pursuant the range of utilization, to conceptualise a simplest possible variant. Hereby, it is of surely great advantage that a plurality of module assumed dual or multiple functions.

In Fig. 48C there is illustrated a projectile 276, in which cylindrical 247 or piston like part 249 is located in the active part behind the disc-shaped pressure-generating

charge 6F. The cylinder 247 can also be provided with one or more bores 248 for pressure balancing or, respectively, for pressure-transmitting (see detail drawing Fig. 48D).

The piston-like part 249, for instance can possess a spherical or a conical shape 185 on the side facing the pressure-transmitting medium 4 (see detail drawing Fig. 48D), so as to during the pressure introduction, the medium 4 in the region of this cone is laterally accelerated more intensively. That type of piston for densification or for subjection of a medium to pressure is described for example in patent document EP 0 146 745 A1 (Fig. 1). In the contrast with the therein provided mechanical acceleration through the impacted ballistic hood and, possible (upon an inclined sloping impact) intermediately connected auxiliary means and they thereby raised question of a perfect axial movement initiation, at a pressure subjection by means of a pyrotechnic module, the piston 249 is always axially accelerated. Moreover, it can also be encompassed by the medium 4 (in effect not the entire cylinder will not be filled out). As a result, the produced pressure can expand in the medium 4 through the forward annular gap 184 between the outer casing 2B and the piston 249.

For a verification of the invention there is in the interim carried out in the ISL were also experiments on a scale of 1:2 in completion of the numerical simulations for a basic proof of the operativeness of an arrangement in accordance with the present invention.

As an example, Fig. 49A illustrates the original penetrator casing 180 (WS, diameter 25 mm, wall thickness 5 mm, length 125 mm) and a part of the found fragment 181.

Fig. 49B illustrates a dually illuminated x-ray flash image, approximately 500 μ s subsequent to the initiation of a triggering impulse, with the fragments 182 shown uniformly accelerated over the circumference.

Water was employed the pressure-transmitting medium. For pressure generation there was used a explosives cord-like (diameter of 5 mm) detonator simply inserted into the liquid, possessing a 4 g explosive material mass. The mass of the WS

casing consisted of 692 g (WS with a density of 17.6 g/cm^3), the mass of the liquid pressure-transmitting medium (water having a density of $\rho = 1 \text{ g/cm}^3$) consisted of 19.6 g. The ratio of explosive material mass (4 g) to the mass of the inert pressure-transmitting medium (19.6 g) thus was 0.204; and the ratio of the explosive material mass (4 g) to the inert projectile mass (casing + water = 711.6 g) thus was 0.0056, corresponding to a component of 0.56% of the inert total mass. The values for these ratios are still reducing for larger projectile configurations, or are increasing for smaller projectiles.

The implemented experiment proved that an inert penetrator with a ratio relative to the overall mass by extremely low pyrotechnic mass of the pressure-generating arrangement was about 0.5 to 0.6% of the inert total mass of the penetrator at a corresponding dimensioning of the projectile casing, and the inner space filled with a suitable inert pressure transfer medium allows itself to be laterally disintegrated by means of a pressure pulse initiated by a triggering signal of a detonator.

The implemented experiment is only one example for a possible embodiment of an ALP projectile. From the basic principle of the invention, however, there are no restrictions to the configuration or to the end ballistically effective casing and its thickness or respectively its length. Thus, the laterally effected disintegration principle functions for thick-walled casings (for example, a WS wall thickness for a penetrator diameter of 30 mm), as well as for extremely thin casings (for example, 1 mm titanium wall thickness for a penetrator diameter of 30 mm).

With respect to the length, it is applicable that the ALP principle similarly functions as well for all conceivable and ballistically sensible values. For example, the length/diameter ratio (L/D) can lie within the range of between 0.5 (disc-shape) and 50 (extremely slender penetrator).

For the ratio of the chemical mass of the pressure generating-unit relative to the inert mass of the pressure-transmitting medium, there is basically only the restriction to the extent in that the produced pressure energy be assumed in a sufficient measure and suitable timed succession from the pressure-transmitting medium and

then further transmitted to the encompassing casing. As a practical upper limit for a small projectile configuration is a value of 0.5.

For the ratio of (chemical) mass of the pressure generating unit to the inert total mass of the penetrator / projectile / airborne body, due to the implemented 3D simulations there were determined extremely small values within the range of 0.0005 up to 0.001, during the experiment a value of 0.0056. From this there can be prognosticated that even for extremely small projectile configurations, in which the active laterally effective principle can still be sensibly introduced, a value of 0.01 is not exceeded.

In the invention there is obtained a multiple configuration of an active laterally effective penetrator ALP (projectile or airborne body) with an integrated disintegration arrangement, the last finally signifies that for all conceivable scenarios of utilization there is necessary only one projectile principle of the inventive configuration (universal projectile).

In Figs. 50A to 53 there are illustrated a series of examples for projectiles with one or more active bodies according to appended claim 30. These examples thus relate to aerodynamically stabilized projectiles, however, in considerations can also be applied to spin-stabilized projectiles. Hereby, naturally there may be expected, due to the stabilization and the thereby connected limited constructive lengths, various constructional limitations.

Fig. 51A is an aerodynamically stabilized projectile 302 in a most general form, which in its entirety should be designed as an active effective body.

Fig. 51B illustrates a corresponding example for an aerodynamically stabilized projectile 303 with an independently effective, centrally positioned active effective body 304 pursuant to the invention. For the configuration of this body 304, in Figs. 15 to 29 there already provided a series of examples.

In Fig. 51C there is again represented a aerodynamically stabilized projectile example 305 with a plurality of active effective bodies or respectively projectile stages with

the corresponding cross-sections. In detail this hereby relates to one stage 306 with a bundle of active effective bodies 307. In this connection there are pointed out the embodiments in Figs. 26 and 27. Pursuant to an intermediate stage 311 there follows a stage 308 with a crown or respectively a ring bundle 309 of active effective bodies 307. In this example the stage 308 possesses a central unit 310. This, in turn can be either constructed again as an active effective member pursuant to the already described examples, or can also represent a central positionally inert penetrating body. A further possibility consists of in that this central body 310 can have associated therewith specified, e.g. pyrophoric or pyrotechnic active mechanisms. Pursuant to the intermediate stage 313, which for example can contain control or respectively triggering elements, there follows a further example for an active stage 312. This is formed from a bundle of 4 active segments 314 (ref. to Fig. 30B). This stage contains here a central unit 366 for which there can be applicable the considerations mentioned with regard to the central body 310. This stage can also serve for the lateral acceleration of the active segments 314. Naturally, such stage can also be eliminated. A further example for a segmented stage was also illustrated already in Fig. 33.

Figs. 52A and 52B illustrate two examples for the lateral acceleration of active effective bodies. Thus, Fig. 52A illustrates the fan-shaped opening of a stage 306 which is constituted of a bundle of active effective bodies 307A. For this purpose, the central body is replaced by a unit 315 with an accelerating module 316 in the forward region. Through this arrangement of the pyrotechnic unit 316 the ring constituted of active effective bodies will open in a fan shape. Fig. 52B illustrates a corresponding arrangement in which the central accelerating module 318 causes a symmetrical lateral acceleration of the active effective body 307B.

Fig. 53 illustrates a projectile 320 with a plurality of active, axially sequentially connected sub-projectiles 321. Arranged between the active sub-projectiles are intermediate or separating stages 322. The external ballistic hood 319 can be formed either by the tip of the first projectile 321, or can be connected ahead thereof as a separate element. The control or, respectively, triggering can be effected centrally or separately for each individual sub-projectile 321. It is also

possible that the individual projectiles can be separated prior to reaching of the target.

Fig. 54 illustrates an end phase guided, aerodynamically stabilized projectile 323 with an active effective body 324. As examples for an end phase guidance there are shown pyrotechnical elements 325 and a nozzle arrangement 327 which is supplied by a pressure container 328.

In Fig. 55A, a practice projectile 329 is illustrated as an active, disintegratable body 330. Fig. 55B illustrates an example for a practice projectile 331 with a plurality of modules 332, similarly designed as an active disintegratable low effective body.

Figs. 56 and 57 illustrate warheads with one or more active effective bodies. Thus, in Fig. 56 there is represented a warhead 333 with a central active effective body 334. Fig. 57 illustrates as an example a warhead 335 with a plurality of active effective stages 336, here constructed as an active body bundle, approximately as in Fig. 51.

Figs. 58 and 59 illustrate a guided rocket-accelerated airborne bodies with one or more active effective bodies pursuant to the invention. Thus, in Fig. 58 is represented a rocket-accelerated guided airborne body 338 with an active effective body 334. Fig. 59 illustrates an example for a rocket-accelerated airborne body 339 with a plurality of active effective body stages 336.

Figs. 60 to 65 illustrate guided or unguided underwater bodies (torpedoes) with one or more active effective bodies. Hereby, in Figs. 60 to 63 there are schematically illustrated classic torpedoes with and without guidance, in Figs. 64 and 65 high speed torpedoes which due to the high cruising velocity will travel practically within a cavitation bubble.

Fig. 60 illustrates a unguided underwater body 340 with an active effective body 341, Fig. 61 a guided torpedo 342. It possesses, in this example, a head 344 which, for example, can be filled with a pyrophoric material so that the subsequent stage 343 of active effective bodies can be introduced into the interior of a target

with a corresponding spreading effect. It is also contemplatable that the head 344 is constructed of an inert armour-rupturing material in order to achieve an extremely high penetrating power as needed.

Fig. 62 illustrates the schematic representation of an again unguided torpedo 345 with a plurality of successively connected active stages 346, for example, as described in the preceding examples. In Fig. 63 there is represented a further example for a underwater body 347 with a plurality of successively connected active effective stages 336 and 346. Located between these active stages with active body bundles is a central unit 348 which is constructed as either an active effective element or which can contain further active mechanisms of the already described type.

In Fig. 64 there is represented a high speed-underwater body 349 with an active effective component 350. Fig. 65 illustrates, again in an intensely simplified schematic representation, an example for a high speed-underwater body 351 with an active effective body bundle 352.

Figs. 66 to 70 illustrates aircraft supported or autonomously flying airborne bodies or ejection containers (dispensers) with one or more active effective bodies in accordance with the invention. Thus, in Fig. 66 there is illustrated an aircraft supported (356) airborne bodies 353 which is designed as an active effective unit 364. Fig. 67 illustrates an example for an autonomously flying airborne body with a search head 365 and with an integrated active effective body 354, and Fig. 68 an example for an airborne body with a plurality of active effective stages 336 or respectively 346. Fig. 69 illustrates an example for dispensing 360 with an active effective body bundle 336 and an axially ejection arrangement 361. Hereby, for example, the hood 359 was previously expelled or removed otherwise such as mechanically or aeroballistically. Fig. 70 illustrates an example for a dispenser 362 with a plurality of active effective body stages 336 in which the active effective bodies are radially accelerated by means of a centrally positioned ejection unites 363.

Special advantages of the invention naturally reside also in the utilization as end phase guided ammunition (intelligent ammunition) in conjunction with an increase in the range of the artillery, which also should be connected with an increase in hitting probability.

Furthermore, it is conceivable, that for the generation of a fragment / sub-projectile field at predetermined or specified distances in front of the weapon muzzle, for example, after completion of the burning of a light tracer, there is initiated the active projectile disintegration in conformance with the principle provided by this invention. In this manner, especially with weapons with a high cadence or firing rate, there can be achieved closely covered fragment / sub-projectile fields. Furthermore, it is possible that the projectile casings be assembled from preformed sub-projectiles which by means of a resistance stabilization will fly stabilized further along due to the aerodynamic forces, and thereby maintain such effective fields over a greater distance.

Collective details which are illustrated in the figures and explained in the specification are important to the invention. Hereby, it is a feature of the invention that all described details in a practical manner can be singly or multiply combined and resultingly thereby provide an active laterally effective penetrator which is individually correlated with all instances of use.

REFERENCE LIST

- 1A spin-stabilized ALP
- 1B aerodynamically stabilized ALP
- 2A fragments / sub-projectiles generating casing of spin-stabilized ALP
- 2B fragments / sub-projectiles generating casing of aerodynamically stabilized ALP
- 2C tail end side fragments / sub-projectiles generating casing of Fig. 12
- 2D central fragments / sub-projectiles generating casing of Fig. 12
- 2E tip side conical fragments / sub-projectiles generating casing of Fig. 12
- 3A sleeve inner space of 2A
- 3B sleeve inner space of 2B
- 4 pressure-transmitting medium
- 4A pressure-transmitting medium in zone A of Fig. 12
- 4B pressure-transmitting medium in zone B of Fig. 12
- 4C pressure-transmitting medium in zone C of Fig. 12
- 4D inner pressure-transmitting medium of Fig. 13
- 4E outer pressure-transmitting medium of Fig. 13
- 4F inner pressure-transmitting medium of Fig. 15
- 4G outer pressure-transmitting medium of Fig. 15
- 4H inner pressure-transmitting medium of Fig. 34
- 4I outer pressure-transmitting medium of Fig. 34
- 5 active pyrotechnic unit or, respectively, pressure-generating means
- 6 pressure-generating element / detonator / explosive
- 6A cylindrical pressure-generating element ($L/D \approx 1$)
- 6B cylindrical pressure-generating element ($L/D > 1$)
- 6C fuse cord - similar detonator
- 6D ring-shaped pressure-generating element
- 6E tube-shaped pressure-generating element
- 6F disc-shaped pressure-generating element
- 6G conical pressure-generating element
- 6H pressure-generating element having a cone tip

- 6I conical transition from 6A to 6C
- 6K round pressure-generating element
- 6L tube-shaped one-side closed pressure-generating element
- 6M conical acute (slender) pressure-generating element
- 6N combination of 6M and 6G
- 6O disc-shaped pressure-generating element having a tip
- 6P combination of 6F and 6C
- 6Q 6A comprising a rounding
- 7 activatable initiating device (programmed part, safety and initiating part)
- 8 transfer line
- 9 additional effective elements
- 10 outer ballistic hood or tip
- 11A receiving and/or initiating and safety unit in tip area
- 11B receiving and/or initiating and safety unit in forward part of projectile
- 11C receiving and/or initiating and safety unit in rearward part of projectile
- 11D receiving and/or initiating and safety unit in tail end area
- 11E receiving and/or initiating and safety unit in rearward part of an effective module
- 11F receiving and/or initiating and safety unit in forward part of an effective module
- 11G receiving and/or initiating and safety unit in middle part between two modules
- 11H receiving and/or initiating and safety unit in encompassing part of a spin projectile
- 12 guidance mechanism of an aerodynamically stabilized penetrator
- 13A wing guidance mechanism
- 13B conical guidance mechanism
- 13C mixture guidance mechanism of 13A and 13B
- 13D star-shaped guidance mechanism
- 14 bulkhead target comprising three relative thin sheets
- 15 solid target sheet
- 15A pre-armouring of target sheet 15
- 16 homogenous target
- 17A ALP comprising three active units

- 17B remaining penetrator subsequent to releasing of one ring of sub-projectiles or fragments
- 17C remaining penetrator subsequent to releasing of two rings of sub-projectiles or fragments
- 18A forward disintegration part of penetrator 17A
- 18B ring of fragments or sub-projectiles of 18A
- 18C ring of fragments or sub-projectiles of 18A at further approach to target
- 18D ring of fragments or sub-projectiles of 18A at target
- 19A central disintegration part of penetrator 17A
- 19B ring of fragments or sub-projectiles of 19A
- 19C ring of fragments or sub-projectiles of 19A just before target
- 20A rearward disintegration part of penetrator 17A
- 20B ring of fragments or sub-projectiles of 20A
- 21A hole, formed by part 19A of the remaining penetrator 17B
- 21B hole, formed by part 20A of the remaining penetrator 17B
- 22A hole, formed by part 18A of the penetrator 17A
- 22B hole, formed by part 20A of the penetrator 17A
- 23 penetrator having axially different pressure-transmitting media 4A and 4B
- 25A pressure-generating elements distributed over cross-section in Fig. 8A
- 25B pressure-generating elements distributed over cross-section in Fig. 8B
- 26 central pressure-generating element in Fig. 8B
- 27 connection between 26 and pressure-generating elements 25B
- 28 connection between pressure-generating elements 25A
- 29 ALP example comprising a central penetrator 34 and four pressure-generating elements 35
- 30 arrangement comprising decentralized explosive cylinder 32 and two radially different pressure-transmitting media 4F and 4G
- 31 ALP cross-section comprising central pressure-generating unit and additional eccentrically located pressure-generating units
- 32 eccentrically located pressure-generating element in Fig. 34
- 33 ALP cross-section comprising central hollow-shaped penetrator 137
- 34 solid central penetrator
- 35 pressure-generating element (e.g. of the type of 6C)

- 36 ALP example comprising central penetrator having star-shaped cross-section
37 and relatively thin casing 2A, 2B
- 37 central penetrator having star-shaped cross-section
- 38 ALP example comprising central penetrator having square (rectangular) cross-section 39
- 39 central penetrator having square (rectangular) cross-section 39
- 40 ALP example comprising effective segments 41 and 42 being peripheral symmetric
- 41 effective segment
- 42 effective segment
- 43 explosive segment
- 44 connection line
- 45 satellite ALP
- 46 ALP comprising two different casing materials 47, 48
- 47 outer thin casing material of 46 (fragment ring, jacket)
- 48 inner thick casing material of 46
- 49 ALP comprising additional thick outer casing
- 50 additional thick casing of 49
- 51 ALP example having square (rectangular) cross-section
- 52 ALP example comprising a casing constituted of hexagonal elements 53
- 53 hexagonal solid casing element
- 54 pressure-transmitting medium in 52
- 55 ALP structure corresponding to 52 and comprising an additional casing 56
- 56 additional casing for ALP example 52
- 57 filler mass between 52 and 56
- 58 ALP example comprising four sub-penetrators
- 59 solid sub-penetrator
- 60 example for sub-penetrator of PELE construction
- 61 connection to satellite ALP 45
- 62 outer casing of 58
- 63 filler medium between outer casing 62 and sub-penetrators 59 or 60, respectively
- 64 ALP example comprising three sub-penetrators
- 65 triangular casing of inner body 286

- 66 ALP example comprising a small solid sub-penetrator 67 having a triangular cross-sectional area
- 67 small solid sub-penetrator having triangular cross-sectional area
- 68 pressure-generating element in 66/69/285/288
- 69 ALP example comprising a big solid sub-penetrator 70 having a triangular cross-sectional area
- 70 big solid sub-penetrator having triangular cross-sectional area
- 71 laterally effective penetrator having internally ALP 72
- 72 solid sub-penetrator corresponding to 70 as internally ALP
- 73 medium between casing of 71 and 72
- 74 separation between shell elements 101
- 75 ALP example comprising special formed pressure-generating element 76
- 76 special formed pressure-generating element
- 77 penetrator comprising three cross-section segments as ALP
- 78 casing of 77
- 79 cross-section segment as ALP
- 80 pressure-transmitting medium in cross-section segment 79
- 81 wall between segments 79
- 82 pressure-generating element associated to cross-section segment 79
- 83 notch in casing 78
- 84 eccentrically located pressure-generating element in Fig. 14
- 85 fragment forming element / element for dammed initiating
- 86 conical formed fragments or sub-projectiles generating / releasing casing
- 87 ALP example comprising dammed triggering initiation 91 and explosive cone 88
- 88 conical pressure load in 87
- 89 forward closure disc as damming element
- 90 inner damming element
- 91 damming element in form of a one-side open cylinder
- 92 rearward closure disc as damming element
- 93 tip as damming element
- 94 ALP projectile example comprising active internal module 95 to be inserted separately
- 95 internal module

- 96 internal cylinder of 95
- 97 outer diameter of 95
- 98 internal volume of 95 (filling)
- 99 projectile comprising central pressure-generating unit 100 and pre-fabricated casing structure fragments 100
- 100 central pressure-generating unit of 99
- 101 pre-fabricated casing fragments (shell elements)
- 102 laterally effective casing of 99
- 103 projectile having three zones and ALP part in the tip
- 104 projectile having three zones and ALP module in central part
- 105 projectile having three zones and ALP part in tail end
- 106 tandem projectile having three zones and two ALP parts (tip and tail end area)
- 107 ALP simulation example with small explosive cylinder in forward area
- 108 ALP simulation example with slender pressure-generating element
- 109 ALP simulation example with a combination of the pressure generation of 107/108
- 110A cover-like damming
- 110B cover 110A after acceleration by means of the active arrangement (6B/4)
- 111 fragment or casing segment cone generated by 6B in Fig. 44B
- 112 beginning fissures in the remaining casing 2B in Fig. 44B
- 113 exit length of the liquid pressure-transmitting medium 124
- 114 dynamically generated longitudinal fissures in the casing 2B at Figs. 44B and 45B
- 115 accelerated casing segment in Fig. 46B
- 116 ripping open casing segment (Fig. 46B)
- 117 projectile example for separation
- 118 fuse cord-like detonator in tail end area of Fig. 12
- 119 fuse cord-like detonator in central area of Fig. 12
- 120 ALP standard cross-section
- 121 plexiglass as pressure-transmitting medium
- 122 aluminium as pressure-transmitting medium
- 123 beginning fissure formation with liquid as pressure-transmitting medium
- 124 water as pressure-transmitting medium

- 125 casing fragments with plexiglass as medium
- 126 beginning fissure formation with plexiglass
- 127 casing fragments with aluminium as medium
- 128 ALP comprising eccentrically located pressure-generating element 84 and liquid 124 (Fig. 47B) or aluminium 123 (Fig. 47C) as transmitting medium (ref. Fig. 14)
- 129 casing fragments with liquid as pressure-transmitting medium at the side of 84
- 130 casing fragments with aluminium as pressure-transmitting medium at the side of 84
- 131 partial casing with aluminium as pressure-transmitting medium on the opposite side of 84
- 132 beginning fissure formation in 131
- 133 ALP example comprising ring-shaped pressure-generating elements
- 134 ALP example comprising segmented pressure generators
- 135 ALP example comprising a central penetrator 34 and an eccentrically located pressure-generating element 35 and liquid as medium (ref. Fig. 16B)
- 136 casing fragments (Fig. 48B)
- 137 central hollow-shaped penetrator
- 138 hollow space in 137
- 139 junction at tandem ALP
- 140 junction (signal line) between pressure generators 82 in Fig. 33
- 142 ALP cross-section comprising pressure-generating elements 25A distributed over the cross-section
- 143 ALP cross-section comprising central pressure-generating element 26 and pressure-generating elements 25B distributed over the cross-section
- 144 axially symmetric arrangement with two radially different pressure-transmitting media 4D and 4E
- 145 ALP cross-section comprising an eccentrically located pressure-generating unit 84
- 146 reaction gases
- 147 damming disc in Fig. 49B
- 148 tip form with succeeding hollow space
- 149 tip casing at 148/256/153

- 150 hollow space between tip and pressure medium 4
- 151 partial casing in Fig. 48B
- 152 signal lines
- 153 tip form with pulled-up pressure-transmitting medium
- 155 auxiliary means
- 156 pressure-transmitting medium pulled-up into the tip
- 158 liquid medium adjacent to casing
- 159 leaked out liquid medium
- 170 ALP example comprising sub-projectile ring
- 171 sub-projectiles in 170
- 172 outer jacket
- 173 internal shell
- 174 tubes, cylindrical hollow bodies as sub-projectiles in 170
- 176 ALP as sub-projectile in 170
- 179 PELE as sub-projectile in 170
- 180 WS tube (ISL test)
- 181 fragments after lateral disintegration (ISL test)
- 182 lateral fragments in dually illuminated x-ray flash image (ISL test)
- 184 ring gap between 2B and 249
- 185 cone of 249
- 222 cone type acceleration medium
- 223 fragments / sub-projectiles generating casing of 30
- 247 cylindrical part in Fig. 49C/D
- 248 bore in cylinder 247
- 249 piston-like part in Fig. 49C/D
- 250 auxiliary tip (Fig. 42)
- 251 rearward separating charge (Fig. 42)
- 252 inert buffer zone / solid element / projectile core / fragment part (Fig. 42)
- 253 solid module / PELE module / explosive module (Fig. 42)
- 254 forward separating charge (Fig. 42)
- 255 blast off disc (Fig. 42)
- 256 PELE type tip
- 257 casing material for PELE expansion
- 258 expansion medium

- 259 hollow space in tip
- 260 tip with active disintegration module
- 261 fragment jacket
- 262 pressure-transmitting medium
- 263 pyrotechnic element corresponding to Fig. 6E
- 264 tip casing
- 265 detonation front of explosive cylinder 6C
- 266 pressure propagation front
- 267 pressure propagation front of short / thick cylinder
- 268 pressure propagation front of fuse cord
- 269 detonation front of explosive cylinder 6B
- 270 transition of pressure propagation fronts 267 and 268
- 271 advanced pressure compensation in liquid fear
- 272 wave reflected from wall 2B
- 273 pressure compensation wave / wave of internal reflections
- 274 flat embossment of casing 2B
- 275 embossment of 2B
- 276 three-part aerodynamically stabilized projectile
- 277 three-part spin-stabilized projectile
- 278 tip module
- 279 homogeneous projectile module
- 280 active projectile module
- 281 PELE projectile module
- 282 projectile casing of 277
- 283 three-part aerodynamically stabilized projectile
- 284 solid tail end part of 283
- 285 ALP example comprising a hollow internal body 286
- 286 hollow body having triangular cross-section
- 287 hollow space of 286 or, respectively, internal space of 286 filled with a medium
- 288 ALP example comprising star-shaped internal body 289 forming four chambers
- 289 cross-shaped internal body of 288
- 290 casing of 288

- 291 sleeve for pressure-generating element 6C (Fig. 43D)
- 293 outer casing of ALP according to Fig. 30A
- 294 outer casing of ALP according to Fig. 30B
- 295 solid active tip module
- 296 sleeve for pressure-generating element 6B (Fig. 43C)
- 297 tip module filled with effective medium 298
- 298 effective medium
- 299 outer casing of ALP cross-section according to Fig. 30C
- 300 outer casing of ALP cross-section of figure 29
- 301 outer casing of ALP cross-section according to Fig. 31
- 302 projectile constructed as active effective body
- 303 projectile with active effective body
- 304 active effective body
- 305 projectile comprising a plurality of active effective body bundles (e.g. 306 or 307)
- 306 stage with a bundle of active effective bodies
- 307 active effective bodies (commonly or separately controlled)
- 307A fan-shaped accelerated active effective body 307
- 307B symmetrically radially accelerated active effective body 307
- 308 stage with a ring of active effective bodies (commonly or separately controlled)
- 309 ring bundle / crown of active effective bodies
- 310 central unit of 312
- 311 intermediate stage between 306 and 308
- 312 active stage of four segments
- 313 intermediate stage between 308 and 312
- 314 active ring segment
- 315 central unit of 306 comprising asymmetric acceleration module 316
- 316 asymmetrically effective acceleration module
- 317 central unit of 312
- 318 symmetrically effective acceleration module
- 319 outer ballistic hood
- 320 projectile comprising a plurality of active sub-projectiles
- 321 active sub-projectile

- 322 intermediate or separating stage
- 323 end face guided projectile with active effective body
- 324 active effective body
- 325 pyrotechnical element for trajectory correction
- 326 aerodynamically correction of trajectory
- 327 control of trajectory by means of a nozzle
- 328 pressure container
- 329 practice projectile, formed of active disintegratable body
- 330 active disintegratable body
- 331 practice projectile, formed of a plurality of active disintegratable bodies
- 332 active disintegratable low effective bodies
- 333 warhead, formed as an active disintegrating body
- 334 active disintegrating body
- 335 warhead with a plurality of active effective stages
- 336 bundle of effective bodies
- 337 active effective body stage
- 338 rocket-accelerated effective body, formed as active disintegrating body
- 339 rocket-accelerated effective body with a plurality of active effective stages
- 340 torpedo with active effective body 341
- 341 active effective body
- 342 guided torpedo with active effective body bundle 343
- 343 active effective body bundle
- 344 torpedo head
- 345 guided torpedo with a plurality of active stages 346
- 346 active stages
- 347 torpedo with effective body bundle at tip and tail end
- 348 central unit
- 349 high speed torpedo with conical active effective body 350
- 350 active effective body
- 351 high speed torpedo with effective body bundle 352
- 352 effective body bundle
- 353 aircraft supported container with active effective unit 354
- 354 active effective unit
- 355 suspension

- 356 aircraft
- 357 autonomously flying container with active effective unit
- 358 aircraft supported or autonomously flying container with a plurality of active stages
- 359 hood of 358
- 360 aircraft supported or autonomously flying dispensing container with a plurality of active stages
- 361 dispensing unit
- 362 aircraft-supported or autonomously flying container with a radial effective body ejection
- 363 central ejection unit
- 364 active effective unit
- 365 search head

CLAIMS

1. An active effective body (1) with an internal inert pressure-transfer medium (4), an active body casing (2), a pressure-generating means (5) which adjoins the inert pressure-transmitting medium (4) or a selectively introduced into said pressure-transmitting medium(4), and an activatable initiating device (7), characterised in that
the pressure-generating means (5) includes one or a plurality of pressure-generating elements (6), wherein the mass of the pressure-generating means (5) is small in relation to the mass of the inert pressure-transmitting medium (4).
2. The active effective body according to claim 1, characterised in that
the ratio of the mass of the pressure-generating means (5) to the mass of the inert pressure-transmitting medium (4) is ≤ 0.5 .
3. The active effective body according to claim 1 or 2, characterised in that
the ratio of the mass of the pressure-generating means (5) relative to the total mass of the pressure-transmitting medium (4) and the effective body casing (2) is ≤ 0.01 .
4. The active effective body according to anyone of preceding claims, characterised in that
the pressure-transmitting medium (4) is entirely or at least partially constituted of a material which is selected from the group consisting of light metals or their alloys, plastically deformable metals or their alloys, duroplastic or thermoplastic synthetic materials, organic substances, elastomeric materials, glass-like or pulverous materials, pressed members of glass-like or pulverous materials, and mixtures or combinations thereof.

5. The active effective body according to anyone of preceding claims, characterised in that
the pressure-transmitting medium (4) is constituted partially of a pyrophorous or other energetically positive (combustible, explosive) materials.
6. The active effective body according to anyone of preceding claims, characterised in that
the pressure-transmitting medium (4) is pasty, gelatinous, gooey, a fluid or liquid.
7. The active effective body according to anyone of preceding claims, characterised in that
the pressure-transmitting medium (4) is arranged so as to be variably located, or possesses different damping properties along the length of the active body (1).
8. The active effective body according to anyone of preceding claims, characterised in that
the pressure-transmitting medium (4) is assembled from two or more radially inwardly arranged elements which possess different material or damping properties.
9. The active effective body according to anyone of preceding claims, characterised in that
the activatable initiating device (7) is initiatable by a time or approach signal during firing or during the flying phase, respectively.
10. The active effective body according to anyone of preceding claims, characterised in that
the activatable initiating device (7) is activatable upon impact against a target structure, during penetration or subsequent to penetration through the target structure.
11. The active effective body according to anyone of preceding claims, characterised in that

the pressure-generating elements (6) of the pressure-generating means (5) comprise explosives fuses, explosive capsules, detonators or gas generators.

12. The active effective body according to anyone of preceding claims, characterised in that there are provided a plurality of pressure-generating elements (6) which are initiated time-wise either separately or simultaneously.
13. The active effective body according to anyone of preceding claims, characterised in that there are provided auxiliary means for the triggering of the pressure-generating elements (6) which are formed as separate modules or which are embedded in the pressure-transmitting medium (4).
14. The active effective body according to anyone of preceding claims, characterised in that the pressure-transmitting medium (4) is either entirely or partially constituted of pre-fabricated structures.
15. The active effective body according to anyone of preceding claims, characterised in that embedded in the pressure-transmitting medium (4) are entirely or partially rod-shaped or successively connected end ballistic or the like effective similar or different bodies, whereby the bodies are arranged in the pressure-transmitting medium ordered or suitably distributed.
16. The active effective body according to claim 15, characterised in that the bodies which are embedded in the pressure-transmitting medium (4) possess pyrophoric or explosive properties.
17. The active effective body according to anyone of preceding claims, characterised in that the active body casing (2) is constituted of a material which is selected from a

group consisting of sintered, pure or brittle metals of high density, steel of high hardness, pressed powders, lightweight metals, plastics and fibre materials.

18. The active effective body according to Claim 17,
characterised in that
the active body casing (2) allows forming of statistically divided sub-projectiles or fragments.
19. The active effective body according to Claim 18,
characterised in that
the active body casing (2) is constituted of one or more rings of segments, elongated structures or sub-projectiles which are mechanically connected, glued or soldered to each other.
20. The active effective body according to anyone of preceding claims,
characterised in that
the active body casing (2, 48) is either entirely or partially encompassed by a second casing (50, 47).
21. The active effective body according to anyone of preceding claims,
characterised in that
the active body casing (2) possesses variable wall thicknesses (2C, 2D, 86) along the length thereof.
22. The active effective body according to anyone of preceding claims,
characterised in that
one or more penetrators, containers or the like active components are arranged in the pressure-transmitting medium (4).
23. The active effective body according to Claim 22,
characterised in that
the penetrators, containers or the like active components possess a suitable surface and are solid, or entirely or partially possess a hollow space.

24. The active effective body according to Claim 23,
characterised in that
the hollow spaces are filled entirely or partially with a pressure-transmitting
medium or with reaction capable components.
25. The active effective body according to Claim 22,
characterised in that
the active components are inert PELE penetrators or actively laterally effective
penetrators.
26. The active effective body according to anyone of preceding claims,
characterised in that
the effective body (1) is constituted of a plurality of individual modules (tip
module, one or more sectional modules, tail module), which are constructed as
solid or inert laterally effective (PELE) or actively laterally effective (ALP),
whereby the individual modules are selectively exchangeable.
27. The active effective body according to Claim 26,
characterised in that
there is arranged a plurality of such individual modules about the circumference
and/or length of the effective body (1).
28. The active effective body according to anyone of preceding claims,
characterised in that
the effective body (1) possesses a modular internal construction such that
auxiliary means, the pressure-generating elements (6) or the pressure-trans-
mitting medium (4) are exchangeable when required or insertable therein just at
the instance of utilization.
29. The active effective body according to anyone of preceding claims,
characterised in that
the effective body (1) is spin-stabilized or aerodynamically stabilized or is firable
with a compensating spin.

30. Rotationally stabilized or aerodynamically stabilized projectile with one or more active effective bodies according to anyone of claims 1 to 29.
31. End phase guided projectile with one or more active effective bodies according to anyone of claims 1 to 29.
32. Practice projectile with one or more active effective bodies according to anyone of claims 1 to 29.
33. Warhead with one or more active effective bodies according to anyone of claims 1 to 29.
34. Rocket-accelerated guided or unguided airborne body with one or more active effective bodies according to anyone of claims 1 to 29.
35. Guided or unguided underwater body (torpedo) with one or more active effective bodies according to anyone of claims 1 to 29.
36. Aircraft supported or autonomously flying dispensing or ejection container (dispenser) with one or more effective bodies according to anyone of claims 1 to 29.
37. Tube arm ammunition comprising a projectile according to claim 30, 31 or 32.