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DESCRIPTION

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Apparatus and method for programming a projectile

The invention relates to an apparatus for measurement of electromagnetic fields on and/or within a programming device which, for example, is included on the muzzle of a tube weapon, in particular having a measurement apparatus on a programming device for an air burst munition (ABM), that is to say having a field test appliance on a measurement and programming basis.

15 The measurement apparatus can measure fields and/or signals from the programming coil, thus making it possible to check the correct operation of the programming coil, the programming signal and the time correlation with the projectile, as well as the programming of a projectile itself. In special cases, these values can then be taken into account for the programming of the projectile.

For the purposes of the present description, the term a tube weapon means both guns and rocket launch tubes. The term projectile is intended to mean all airborne vehicles which can be launched or fired from a weapon barrel, that is to say ballistic projectiles and projectiles which at least partially propel themselves.

30 The term ballistic projectiles means normal conventional projectiles which detonate on impact, such as projectiles which can be fuzed and/or programmed, and, for example, detonate in flight. The projectiles may be spin-stabilized and/or fin-stabilized and may, for example, be in the form of discarding sabot projectiles, primary projectiles which carry a plurality of secondary projectiles in them, or exercise projectiles with a core and casing.

In general gunnery, the muzzle velocity of a projectile is normally referred to as V_0 , and is also referred as the V_0 velocity. This is therefore the velocity at which a projectile launched or fired from a tube weapon moves
5 on its trajectory relative to the weapon barrel when it emerges from the weapon barrel. The flight duration, the firing distance and the hit-point position are dependent, inter alia, on the V_0 velocity. However, precise knowledge of the muzzle velocity V_0 is
10 particularly important in the context of programmable projectiles, since the time at which a programming code is transmitted to a projectile in order to achieve the desired weapon effect depends on the muzzle velocity, V_0 . The muzzle velocity V_0 also depends on the weight
15 and the temperature of the propellant charge.

A theoretical muzzle velocity $V_0(\text{theor.})$ can be determined by calculation if all the relevant data relating to the weapon, the weapon barrel and the
20 projectile to be fired or launched is known. However, the muzzle velocity V_0 differs from the theoretically calculated muzzle velocity $V_0(\text{theor.})$. In addition, the V_0 velocity is reduced as a consequence of weapon barrel wear. Therefore, the actual muzzle velocity is
25 preferably in each case measured on firing, in order to correct the azimuth and elevation of the weapon barrel as necessary for the target to be attacked, and/or in order to appropriately program the projectile, or at least the subsequent projectiles.

30 An airburst munition (ABM) is a munition type which breaks up during the flight phase without any need to strike a target object or to be in the vicinity of a target object. For this purpose, a suitable mechanism
35 is used to fire a break-up charge within this munition and to cause it to explode. If the muzzle velocity of the ABM is known sufficiently accurately, the desired range can be determined via an indication of a time

after which the break-up charge is intended to be fired after leaving the muzzle. Because of the natural scatter in the muzzle velocities of ABM, it is particularly important, for this type of munition, to
5 determine the initial velocity at the muzzle (V_0) with sufficient accuracy.

Various apparatuses and methods are known for measurement of the actual V_0 velocity. Frequently, the
10 measurement of the V_0 velocity is based on a gate principle. A V_0 measurement such as this is known from EP 0 108 973 B1. In this case, two coils are used, which are arranged at a known distance from one another, to be precise after the exit cross section of
15 the weapon barrel, seen in the direction of flight of the projectile. These coils and the distance between them form a measurement base path. The coils are in general arranged at least approximately concentrically with respect to the longitudinal axis of the weapon
20 barrel, and their internal diameter is somewhat larger than the calibre of the weapon barrel. The coils are connected to current sources, thus resulting in a magnetic field in the area of each coil, and an induced voltage can be tapped off as the projectile passes
25 through. While a projectile is flying through the area of the coils, the magnetic field is disturbed, and the voltage which can be tapped off changes as a function of the relative position of the projectile with respect to the coil. CH 691 143 A5 deals with the same subject.

30 Therefore, if the V_0 of the individual projectile is determined at the muzzle of the gun, then, after the appropriate break-up time has been calculated, this value can be programmed into the projectile via a
35 programming unit, which is located downstream in the direction of the projectile flight path, as a result of which the projectile is broken up by the break-up charge at the desired point. One such system is known,

for example, from EP 0 802 390 A1, EP 0 802 392 A1 and EP 0 802 391 A1. In this case, the projectile passes through a measurement path in the area of the muzzle, which measurement path is formed by two coils arranged
5 one behind the other, and produces a time-dependent voltage signal in each of these coils. If the distance between the coils is known, the projectile velocity can be determined from these signals. The appropriate break-up time is calculated in a computation unit, and
10 is programmed in the projectile via a third coil.

In order to make it possible to set the time fuzes for breaking up the projectile with the desired accuracy, it is necessary, according to the teaching of
15 EP 0 467 055 A1, to transmit at least 12 bits from the transmission coil of the programming device to the receiving coil in the projectile. By way of example, in the case of a muzzle velocity of 1200 m/s, the receiving coil in the projectile passes by the
20 transmission coil, which is attached to the weapon barrel muzzle, in a relatively short time, as a result of which only a short time is available for transmission of the information from the transmission coil to the receiving coil. At the same time, the
25 transmission time window must be chosen such that the projectile is located within the transmission coil at that time.

The invention is based on the object of providing an
30 apparatus which can be used for accurate programming while a shot is being fired.

The object is achieved by the features of Patent Claim 1. Advantageous refinements are reflected in the
35 dependent claims. A method is specified by the features of Patent Claim 9.

The invention is based on the idea of checking the correct operation of the programming coil, the programming signal and the time correlation with the projectile as well as the programming of a projectile
5 itself. This can be done by detection of the fields and/or signals of the programming coil. This information can then be taken into account in the programming. The measurement apparatus according to the invention furthermore makes it possible to also detect
10 disturbance fields from further components of the tube weapon, as well as disturbance fields which act on the tube weapon from the outside. Furthermore, it is also possible to check for active incident radiation from, for example, Natel, radar, active jamming devices and
15 switching jammers. These are further influences which can now be taken into account during programming. Admittedly, test devices which can detect fields and signals of a programming coil are already known, for example by the term > base test appliance <,
20 but these are restricted to laboratory environments, that is to say they do not measure the situation of a real shot, and the possible correction associated therewith.

25 In order to implement the idea within the scope of an existing programming device, for example in the area of the muzzle of a tube weapon and preferably even on the programming coil for the munition itself, an additional measurement apparatus is provided, that is independent
30 of the programming coil, can detect the signals which are present in the area of the programming coil, and in particular the signals emitted by the programming coil, and can pass these to a measurement evaluation device. The system is designed as a purely passive system.

35 In the simplest case, this measurement apparatus may consist of a coil having one or more turns around the muzzle opening of the tube weapon. The coil is

functionally connected to a fundamentally known signal receiving and signal processing device, for example via a wire connection.

- 5 The coil is preferably positioned such that, on the one hand, it does not cover the unobstructed opening of the barrel muzzle, while nevertheless at the same time makes it possible to detect sufficiently well the fields which emerge/originate from the programming coil
10 with a low field strength. For this purpose, they must be positioned outside the metallic screening of the programming coil.

The number of coil turns may be one or more. Since the
15 number of turns influences the response time of the coil, the turns are chosen on the basis of the flank gradient of the signal to be detected. The fastest response behaviour is achieved with a single coil winding. Better signal sensitivities are achieved with
20 a plurality of windings - the best solution should in each case be chosen depending on the signal strength and the gradient. The windings may either be in the form of wire in a surrounding structure or, alternatively and particularly preferably, may be
25 implemented in the form of a printed circuit board ("print").

An electrically non-conductive material should be provided for the material surrounding the coil, for
30 example non-conductive plastics or epoxy materials. At the same time, it is advantageous for this material to have low density, which therefore means only a small additional mass in the area of the muzzle since, as is known, additional masses in the muzzle area influence
35 the dynamic and static behaviour of the tube weapon.

The measurement apparatus can be attached to the programming coil assembly via an adhesive joint, a push

joint or else as a printed embodiment on a surface. The positioning can be considered in many ways.

5 This results, inter alia, in the further advantages of
a good signal evaluation capability: bit patterns and
possible interruptions, signal strengths, attenuations
and single-bit tests, that is to say whether correct
bits have been set. Furthermore, the time window/time
10 instant of programming (within 20 μ s) can be tested,
and the programming basis can be tested during actual
firing. An independent functional and quality test of
the programming base can also be carried out. This is
used as a referee tool for failure (to break up in the
15 intended target region): >caused in the programming, or
in the munition?< and the documentation of the base
characteristics during acceptance firing.

A measurement apparatus is proposed which is included
on a measurement and programming basis for the
20 programming of a projectile (13), which can detect the
fields and/or signals which emerge/originate from a
programming coil. These "detected" values are evaluated
in an evaluation device, and can then also be made
available for programming the projectile. This
25 therefore makes it possible not only to make decisions
on the method of operation of the programming coil as
such, but also to implement corrections, when this is
electronically possible.

30 The invention will be explained in more detail with
reference to one exemplary embodiment and with a
drawing, in which:

Figure 1 shows a longitudinal section through a
35 measurement and programming device according
to the prior art,

Figure 2 shows a sectional illustration of a first embodiment of a measurement apparatus for measurement of the field and/or of the signals of at least the coil of the programming device,

Figure 3 shows a sectional illustration of a second embodiment,

Figure 4 shows a sectional illustration of a third embodiment, and

Figure 5 shows a sectional illustration of a further embodiment.

Figure 1 shows a supporting tube 20, which is attached according to the prior art to the muzzle of a gun barrel 13 and consists of three parts 21, 22, 23. Annular coils 24, 25 for the measurement of the projectile velocity are arranged between the first part 21 and the second and/or third parts 22, 23. A transmission coil 27, which is held in a coil former 26, is attached to the third part 23 - also referred to as the programming part. Lines 28, 29 are provided for feeding the annular coils. Soft-iron bars 30 are arranged on the circumference of the supporting tube 20, for screening against magnetic fields which interfere with the measurement. The projectile 18 has a receiving coil 31, which is connected to a time fuse 34 via a filter 32 and a counter 33. When the projectile 18 passes through the two annular coils 24, 25, a pulse is produced at short successive intervals in each annular coil. These pulses are fed to an evaluation circuit (not illustrated), in which the projectile velocity is calculated from the time interval between the pulses and the distance a between the annular coils 24, 25. The projectile velocity is used to calculate a break-up time, which is transmitted inductively to the

receiving coil 31 in a suitable form while the projectile 18 is passing through the transmission coil 27, in order to set the counter 32 etc.

5 Figure 2 describes a first embodiment of the apparatus 10 according to the invention. In this case, this section drawing represents the muzzle 11 of the tube weapon, which is formed by a component 1 which extends in a circular form around the barrel centre axis 2. At
10 least one winding 5 of the measurement apparatus 10 is incorporated within an electrically non-conductive attachment ring 4. The ring 4 is preferably adhesively bonded to the end surface of the tube-weapon muzzle, and in the process isolates the winding 5 from the
15 electrically conductive closure cap 3 on the tube weapon.

Figure 3 describes a second embodiment of the apparatus 10' according to the invention. In this case, this
20 section drawing represents the muzzle 11 of the tube weapon, which is formed by the component 1 which extends in a circular shape around the barrel centre axis 2. At least one winding 5 of the measurement apparatus 10 is incorporated within an electrically
25 non-conductive attachment ring 12. The ring 12 is equipped with an enlarged area, in order to improve the adhesive joint to the component 1 and the closure cap 3 on the tube weapon.

30 Figure 4 describes a third embodiment of the apparatus according to the invention. In this case, the attachment ring 14 is in the form of a cap which can be placed over the muzzle 10 of the tube weapon. This improves the mechanical retention of the measurement
35 apparatus 5 according to the invention on the tube weapon further in comparison to the previous embodiments.

Figure 5 describes a fourth, particularly preferred, embodiment of the apparatus according to the invention. In this case, a conductor track 5' in the form of a circular coil winding is provided as a printed circuit within the attachment ring 15, with electrical connecting means 6 being passed out of the attachment ring 15, and being operatively connected to an evaluation device 16.

- 10 The additional measurement apparatus 10, which is preferably included in the area of the programming coil 27, is used to detect the emitted signals from the transmission or programming coil 27, and to pass them to the evaluation device 16. The result or results can
- 15 then also be included in the programming of the projectile 13 (correction). In any case, information relating to the method of operation of the programming coil 27 can be derived.
- 20 It is self-evident that this principle may also be used for testing the measurement coils 24, 25, although the design complexity is undoubtedly greater here than that for testing the programming coil 27.

PATENT CLAIMS

1. Apparatus for programming a programmable projectile (13) having at least one programming
5 coil (27), characterized in that a measurement apparatus (10, 10') is included, which detects the fields and/or signals which emerge/originate from the programming coil (27) and is electrically connected to an evaluation device (11) which
10 evaluates these detected values.
2. Apparatus according to Claim 1, characterized in that the detected values can also be made
15 available as correction values for the programming of the projectile (13).
3. Apparatus according to Claim 1 or 2, characterized in that the measurement apparatus (10) consists of
20 a coil (5) with one or more turns around the muzzle opening (11) of the tube weapon.
4. Apparatus according to Claim 1 or 2, characterized in that, as a conductor track (5') in the form of
25 a circuit coil winding, the measurement apparatus (10') is in the form of a printed circuit.
5. Apparatus according to one of Claims 1 to 4,
30 characterized in that the measurement apparatus (10, 10') is preferably located such that, on the one hand, it does not cover the unobstructed opening of the barrel muzzle.
6. Apparatus according to one of Claims 1 to 5,
35 characterized in that the measurement apparatus (10) is included in an attachment ring (4, 12, 14, 15) which can preferably be adhesively bonded to the end surface of the tube-weapon muzzle.

7. Apparatus according to Claim 6, characterized in that the attachment ring (12) is equipped with an enlarged area.
- 5 8. Apparatus according to Claim 6, characterized in that the attachment ring (14, 15) is in the form of a cap.
- 10 9. Method for programming a programmable projectile (13) having at least one programming coil (27), characterized in that a measurement apparatus (10, 10') detects fields and/or signals which emerge/originate from the programming coil (27) and then evaluates them in an evaluation device
15 (11).
- 10 10. Apparatus according to Claim 9, characterized in that the values can also be made available as correction values for the programming of the
20 projectile (13).