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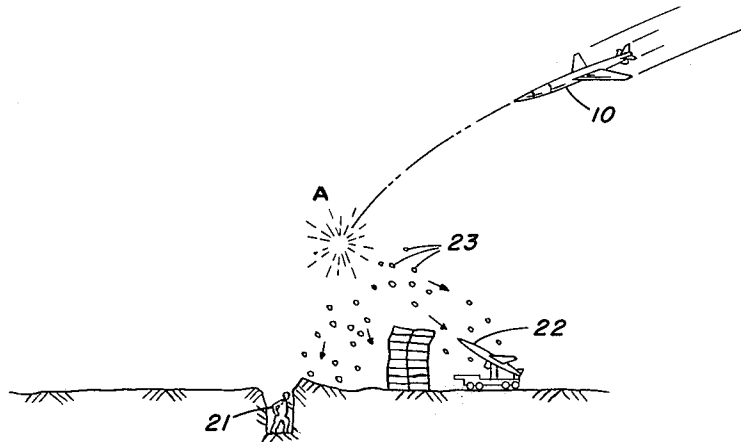
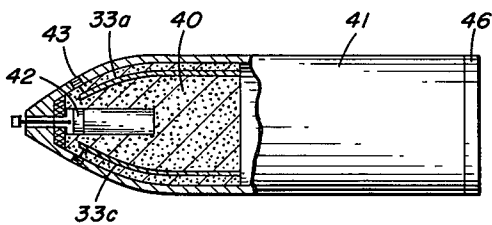
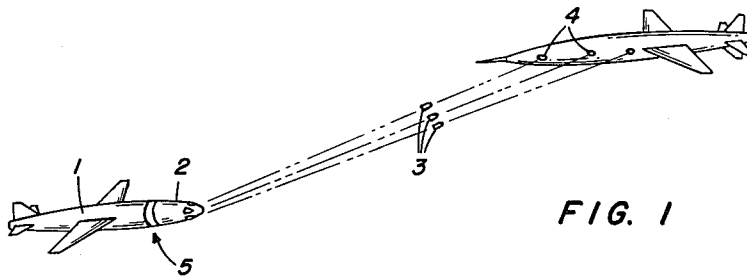
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3,136,251

ELECTRICALLY CONTROLLED DIRECTIONAL WARHEAD

Filed Jan. 18, 1963

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

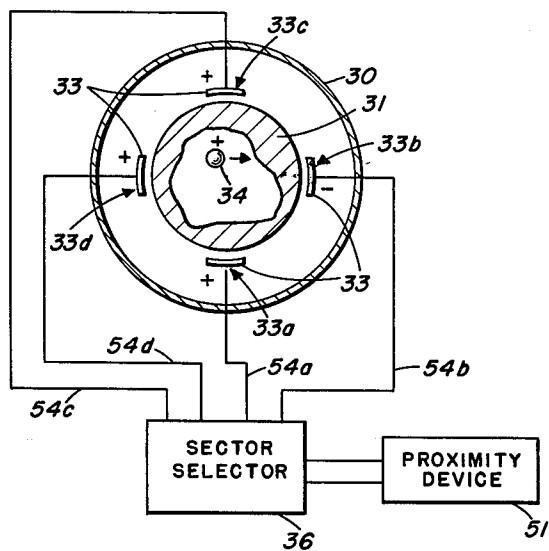


FIG. 3

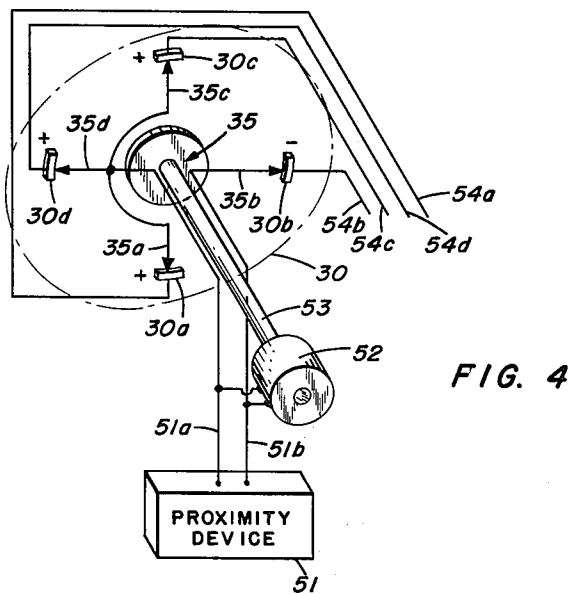


FIG. 4

1

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ELECTRICALLY CONTROLLED DIRECTIONAL WARHEAD

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11 Claims. (Cl. 102-67)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This application is a continuation in part of application Serial Number 72,808, filed November 30, 1960.

This invention relates to a warhead fragmentation system and more particularly to a means for making the explosive charge in a warhead highly directional and of greater mass velocity and range than has been heretofore possible.

Near misses in guided missile systems have long been a problem in the antiaircraft application of such missiles. While the instant invention has much broader application than this particular environment it did arise as a method for preventing near misses by giving the missile greater destructive range and power. It is not uncommon for an antiaircraft missile not to make direct contact with the target aircraft. In such a case it is desirable, and quite often possible, that such a "near miss" need not result in failure, and thus success in destroying the target aircraft can be realized if the missile can be called upon to explode while it is near the target aircraft and propel fragments or charges against the aircraft in a destructive manner. To accomplish such a result, a sensing or proximity system may be provided, on the missile preferably, which will indicate to the missile when it is within range of target aircraft and at that moment command the missile to explode, and thereby cause shrapnel or shell fragments to hit the target. At this point the problem of range of fragmentation arises. This problem has been solved by the instant invention by increasing the amount of mass propelled against the target as well as increasing the mass fragment velocity in that direction.

Accordingly is an object of this invention to increase the destructive range of an explosive charge.

It is also an object of this invention to increase the velocity of the fragmentation resulting from an explosive charge.

It is another object of this invention to provide an explosive projectile with a warhead which is directionally explosive.

Yet another object of this invention is to provide a warhead of increased destructive effect in the direction of the target.

Still another object of the present invention is to provide a fragmentation type warhead the fragmentation of which is both directional and of increased range.

Another object of the present invention is to provide a directed warhead which has increased range as the result of its directional concentration of energy.

A further object of this invention is to provide a guided missile with a warhead whose fragmentation will be of the localized-velocity localized-mass type in the direction of the target resulting in greater destructive effect.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a diagrammatic view of the instant invention in an operative environment;

2

FIG. 2 is a diagrammatic view of the instant invention in an alternative operative environment;

FIG. 3 is a diagrammatic view of one embodiment of the instant invention including a transverse sectional view taken through the warhead;

FIG. 4 is a detailed view of one means of applying a charge to the field electrodes; and

FIG. 5 is a longitudinal sectional view of the warhead.

Briefly the present invention relates to a field-directed warhead which adds energy to the fragments of the shell in the direction of the target. The present invention also adds range to the fragments exploded in the direction of the target by increasing the velocity of the fragments thereby decreasing the chance of near misses. This invention also increases the mass of fragmentation exploded in the direction of the target and thereby decreases near miss errors.

Heretofore, the only means for making a charge explode directionally have been mechanical. These comprised methods of weakening the casing of the warhead in the direction of the target thus making it easier for the exploding matter to burst out in that direction. Expedients such as scoring the side of the warhead or exploding a detonator on the target side of the warhead have been used. All of these merely relate to the weakening of the container on the target side so as to make the bursting effect occur in that direction. The present invention is not a mechanical mechanism but a basic plasma or charged particle mechanism whereby such particles are predirected from the moment that they have volatilized as a result of the heat from the developing explosion. The prescribed field, electromagnetic or electrostatic, acts upon this plasma of charged particles in a gaseous state and is oriented so as to attract most of the particles of an appropriate charge in a preferred direction. This field attraction results in a preferential migration of exploding matter in the direction of the oppositely charged field-producing means at the instant of final rupture of the warhead.

Basically, the mechanism of explosion involves a chemical reaction which is exothermic. The tremendous heat produced as well as the speed of combustion are the determinative factors. In fact high speed studies of explosions have discovered that the explosive process goes through two distinct phases or stages: deflagration and detonation. Deflagration is the burning or flame phase where the extremely high temperatures generated will cause the production of large numbers of free electrons and positive ions. The time period for this phase is short when compared with conventional time standards but long with relation to the detonation period. During this burning phase the strong electrical field set up by electrical plates will cause a mass migration of the negatively charged free electrons away from the negative plates and toward the positive plates. This migration tends to set up a shock absorbing layer or cushion around the inner surface of the explosive container which is identified with the positive plates. At the same time there is a mass migration of the positive ions toward the negative plate.

During the deflagration phase there is an increasing buildup of pressure within the closed container; then with astonishing suddenness, the transition to the explosive phase takes place. During the explosion, the burning rate increases to 1000 times or more of the burning rate during the deflagration phase and a violent shock wave is produced which exerts tremendous and almost instantaneous pressures on any object which offers resistance. The section of the container which has the cushion of gases will tend to absorb the shock wave for one short instant of time—but this short instant is enough. The uncushioned segment of the container, or in other words where the negative plate is located, receives the shattering, ham-

mer-like shock a fraction of a second sooner and with the additional severity sufficient to fragmentize the material. In this manner the direction of explosion is controlled. The gist of this invention is to make this particle migration a directed one under the action of an electrical field. Thus, the mass migration will be in a specific direction rather than random. As a result, the charged particles of plasma in a gaseous medium, instead of having a random velocity and migrating omnidirectionally, will have a preferred velocity in the direction of the target and, under the action of extreme heat and pressures as a result of this instantaneous combustion, will burst the warhead casing throwing fragments at high velocity and particle density in the direction of the target. In this respect it must be remembered that the bursting or fragmentation of the exploding matter is an effect which is not analogous to a balloon bursting but, in effect, is a nearly instantaneous boiling reaction. The exploding particles will be impelled in the direction of the velocities they assume in the kinetic vaporized state before the final combustive effect of the explosion occurs. If these velocities are directed, rather than random, the particles will be directed along the velocity vector. This direction may be predetermined in the direction of the target. These particles are placed inside a pressurized warhead and, upon explosion, will burst out in the direction of the target.

In essence, the result is that these ionized particles are a part of the explosive matter which, having become ionized in the heat of the explosion and having their velocity directed in a particular direction by the field at the moment of burst of the explosive matter, are predominantly directed towards the target and have abnormally high velocity in the target direction as well as abnormally high particle density. Furthermore, the range of the fragmentation is hereby increased, both because the velocity is higher and will carry the particles farther and because there are more particles in the mass directed toward the target. Hence, the invention can result in a target kill in a "near-miss" situation which would be ineffective due to inadequate particle range or density.

In the embodiment illustrated in FIG. 1, there is shown a missile approaching an aerial target in a "near-miss" fashion. That is, it is not directed so as to contact the target, but only to come close to it. As the missile approaches the target guided by the sensor 5 which may be of the infrared magnetic, photoelectric or acoustic type, the warhead is told by the sensor the direction in which the target lies. Therefore, the sensor can direct the charging of the field plates so that there will be an attracting field in the direction of the target. This field will induce the ionized exploding particles to be propelled out through the shell carrying fragments thereof with them in the direction of the target with a high velocity particle density and range. It is particularly important to note that this fragmentation system is apt for missiles of the "near-miss" type. This is because there is a special problem in aiming a missile at a fast approaching flying object, as for instance, an unmanned aggressor aircraft or missile, for this is a target whose position coordinates are changing very rapidly. As a result, it is not uncommon for a missile such as missile 1 to be on a collision course with the target until almost the final moment of impact. Missiles such as the one shown are often constructed so they need not strike the target because their destructive force is often more wide-spread, as in the case of shrapnel, if they are exploded near, but not on, the target itself. Therefore, it becomes important to solve the problems of range of fragmentation, direction of fragmentation and velocity of the particles fragmented. These are the problems which the present invention solves.

FIG. 2 is an embodiment wherein there is shown, in a typical environment, the use of the invention in a missile system to attack a surface target area with a fragmentation type warhead. Here, the attacking missile 10 is guided

toward targets 21 and 22 which may be entrenched enemy personnel and a missile installation, respectively. At some point near these targets the missile is detonated and fragments are thrown as shown against either or both targets. This is exactly the situation that the invention is designed to optimize. Here, there could be a problem, as there often is in fragmentation, of a waste of particles and energy in an omnidirectional type burst. The present invention will prevent a waste of particles and energy in an omnidirection type burst by directing most, if not all, of the energy of the burst, as well as the particles of the burst, toward the target or targets. Here, when the sensing means indicates the orientation of the target (to the warhead) the field will be directed towards the target, the ionized particles and the fragments they carry with them will follow in that preferred direction and carry most of the energy of the burst, the particles of the burst and the destructive effect of the burst in the direction of the target. Hence, the present invention will prevent a waste of particles and energy in an omnidirection type burst by directing most, if not all, of the energy of the burst, as well as the particles of the burst, toward the target or targets. Here, when the sensing means indicates the orientation of the target (to the warhead) the field will be directed towards the target, the ionized particles and the fragments they carry with them will follow in that preferred direction and carry most of the energy of the burst, the particles of the burst and the destructive effect of the burst in the direction of the target. Hence, the present invention accomplishes a saving in explosive energy needed for a particular system and an increase in the range and destructiveness of a particular charge. There is the further advantage of a minimization of the danger of shrapnel damage to the carrying vehicle or friendly nearby personnel located not too far or away from the warhead when it explodes. This is true because the fragmentation is directed not omnidirectionally but only at the target.

In FIG. 3 there is shown one embodiment of the present invention, including a sectional view taken through the warhead of the missile so as to disclose the location of field plates therein. In order to determine the location of the target which the missile is intended to intercept there is provided a proximity device, or sensor, 51 which may be any of the well known types, such as one sensitive to infrared emanations, for example. As can be more clearly seen in FIG. 5, the sensitive infrared receivers 43 are spaced 90° apart, around the nose of the missile, and in this way it is possible to determine in which quadrant the target is located relative to the missile.

Connected to the proximity device 51 is a sector selector 36, to be described in more detail later. Extending from the sector selector are four leads which terminate in four charge plates 33a, 33b, 33c, and 33d, spaced 90° apart and imbedded in the explosive of the missile head. It will be noted in FIG. 3 that the selector so operates as to place a positive charge on three of the charge plates and a negative charge on the fourth plate.

In FIG. 4 there is shown in more detail that portion of the sector selector which is used to apply the proper charge to plates 33a, 33b, 33c, and 33d. Extending from proximity device 51 are two leads 51a and 51b which connect with a motor 52 having an elongated shaft 53 forming part of its rotor. At one end of the shaft 53 there is rigidly attached a disc switch 30 having a hub 35 and four wiper arms 35a, 35b, 35c, and 35d which cooperate to make contact with corresponding wiper plates 30a, 30b, 30c, and 30d. All four of the wiper arms are integrally attached to hub 35 so that they all move in unison and their position relative to each other is unchanging. It should further be noted that the leads 51a and 51b not only connect to motor 52, but they continue on to make electrical contact with the wiper arms. Three of the wiper arms are electrically tied together and consequently carry the same or positive potential while the fourth arm has the opposite or negative polarity. In the position illustrated in FIG. 4, for example,

arms 35a, 35c, and 35d carry a positive potential while arm 35b carries the opposite or negative polarity. Extending from the wiper plates 30a, 30b, 30c, and 30d are leads 54a, 54b, 54c, and 54d which connect directly to charge plates 33a, 33b, 33c, and 33d for applying a charge to these plates as will be described hereinafter.

FIG. 5 illustrates in sectional view the container in which the sensing means 43, field charging electrodes 33a and 33c, explosive charge 40, and detonating charge 42 are arranged inside a shell 46. It will be seen that the sensing means 43 can be arranged in sections lying in different sectors or quadrants of the warhead so that when a particular sector is energized by an impulse received from the target it, in turn, will transfer the signal by means of the sector selector to the field charging plate 33a, for example, which is also in that sector of the warhead.

In operation the device functions so that as the missile approaches a target its proximity device 51 performs to detect the presence of the target. As the range between target and missile closes the sensitive receiver 43 which is in the quadrant nearest the target is energized. This in turn energizes the sector selector 36 so that motor 52 will rotate switch 30 until the single, or negatively charged wiper arm (as 35b) is oriented in the same quadrant as the energized receiver 43. This, in turn, applies a negative charge through wiper contact 30b, and lead 54b, to charge plate 33b, and it will be appreciated at this time that the charge plate nearest the target is now charged negative while the remaining three are charged positive. This condition remains until the missile warhead is detonated, at which time the large quantities of free electrons and positive ions are released, the negative electrons moving toward the three positive plates. At the same time the mass migration of the positive ions, such as particle 34, FIG. 3, toward the negative plate causes the missile casing 30 to shatter, spraying fragments at high velocity and particle density in the direction of the target. As pointed out previously, above, through the operation of the sector selector the charge plate in the quadrant nearest the target is always charged negative in order to have the fragments discharged through this quadrant toward the target.

It will be understood that several other applications of this invention are possible. In, for instance, a depth charge system, instead of wasting the energy of explosion by sending concussion waves in all directions, such waves could be directed by a sensing system solely in the direction of the target submarine.

Thus, the efficiency and destructive capabilities of depth charges can be greatly increased by applying the principles of the instant invention thereto.

Similarly, the invention has application in armor-piercing projectiles. Such projectiles have been made directional by mechanical means. For example, thick rigid walls and an open face have been constructed in such a manner that the projectile will, on impact, penetrate, slightly at least, into the armor and, on detonation of the secondary piercing explosive, the top of the container will be blown off and the stronger side walls remain rigid so as to direct the blast almost entirely in against the armor and pierce it. Similarly, directionality has been imparted to projectiles of this type by scoring the shell casing so as to weaken it in one particular direction. However, the difficulty here is that one cannot predict with most subtle projectile and missile systems the direction in which the target will lie when the flight of the projectile or missile has been completed. Therefore, it is not known which part of the shell casing should be weakened for producing the maximum destructive effect on the target. Similarly, shell cases are pierced directionally by providing outer detonators at the portion of the warhead to be ruptured.

In addition, the directionality of a projectile need not be unidirectional. Such a missile or projectile as, for instance, in FIG. 2, which might be characterized as anti-personnel, could operate under the influence of a sensing

system which would pick up, by IR signals, both the personnel in the ditch at 21 and personnel on the launching system at 22 and, charge those two plates which lie on opposite sides of the missile. Thus, the warhead would tend to direct its destructive capability in more than one narrow sector and against targets 21 and 22 thereby concentrating the fragments on two targets, and providing dispersibility as well as directionality of explosion.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In an explosive device, the combination therein of a container, detonation means arranged therein so as to be actuated by a predetermined stimulus, explosive material arranged in the container so as to be actuated by said detonation means, field plates arrayed about said explosive material so as to divide said container into a plurality of sectors, a source of electrical energy having oppositely charged outputs, switch means connected to different oppositely charged outputs of said source and including selectors and connectors connecting each of said selectors to one of said plates whereby, upon detonation, the resultant heating will ionize at least part of said explosive material which will then be attracted to at least one sector of said container and result in directional fragmentation of the latter.

2. An explosive device according to claim 1 wherein said field plates comprise plates disposed about said explosive material in at least each of four quadrants and chargeable electrostatically to provide an electrostatic field of opposite charge to the ionizing charge on the particles so as to attract the latter in a preferred direction and orient particle velocity predominantly in that direction.

3. A directional explosive warhead comprising, in combination, a container, an explosive material disposed within said container, a plurality of chargeable plates spaced around said explosive material to produce a field for attracting particles ionized from said explosive material, means for electively charging some of said plates oppositely to the charge of the ions and in the direction of a target, means for sensing the presence of the target in a given quadrant of the warhead, and means for communicating the response from said sensor to a switch, said switch being arranged so as to charge the plate with a charge opposite to that of the ions and attract the latter in the direction of the target whereby the explosion of said device will have a directional effect with maximum velocity and fragmentation density in the direction of the target.

4. A directional warhead firing system comprising in combination a missile shell, an explosive device of highly ionizable material, a plurality of plates sectorially spaced about said explosive device, signal generating target detection and direction determining means carried within said missile shell, a switch having contacts oriented as the detection and direction determining means are oriented and arranged so as to transmit a target detection and direction signal to the chargeable plate in the sector nearest the target, and a potential source for charging the plates.

5. A directional warhead firing system according to claim 4 wherein said plates include electromagnetic field creating means and said potential source is arranged so as to create an attracting field in the target sector field for attracting ionized particles from the explosive device.

6. A directional-explosive system comprising a container, explosive material of a highly ionizable type contained therein, field generating means arrayed about said explosive material, a potential source, switch means connected to said potential source and communicating

through contacts and conductors with each of said field generating means whereby selected field generating means may be energized to attract the ionizable matter of said explosive material, sectorially constructed target sensing signal producing means connected to said switch means so that when a given sector of said sensing means is energized the signal therefrom may be communicated through an appropriate switch contact to the field generating means in the same sector, and connectors between contacts and their respective field generating means which are arranged so that by attracting the ionizable matter in a highly heated and gaseous state the velocity and particle density of such matter may be oriented so as to discharge and explode predominantly in the target direction and thereby create an explosion of more particles of higher velocity and greater range in the target direction.

7. A directional-explosive system according to claim 6 wherein said field generating means comprises electrostatically charged plates.

8. A directional-explosive system including: a cylindrical container, an ionizable explosive defined by said container, an electrical field producing means defining segments of said container, means for controlling the direction of the electrical field, explosive ignition means, target sensing means controlling said field direction control means and said ignition means, said ionizable-explosive forming negatively ionized gases and particles which are attracted to said field producing means of an opposite charged potential, said negative particles creating a shock absorbing cushion segment and unprotected segments, said unprotected segments being fractured by the explosive

force allowing the escape of explosive energy in a predetermined direction.

9. A directional-explosive system including a cylindrical container, an explosive charge defined by said container, means for selectively forming a shock absorbing layer around one segment of said container, means for detonating said explosive charge, the resultant explosion being completed in the direction of the unprotected segment of said container.

10. A directional-explosive system in a missile including: a cylindrical container, an ionizable explosive defined by said container, a proximity device for sensing the direction of a target from said missile, a motor driven switch connected to said proximity device, a plurality of contacts on said switch electrically connected to carry one potential, another contact on said switch to carry another potential, a plurality of charge plates located within the explosive to define sectors, and means connecting the contacts of said switch with the charge plates in the explosive whereby a charge of said other potential is applied to the charge plate nearest the target and a charge of said one potential is applied to the remaining plates.

11. The directional-explosive system as defined in claim 10 wherein said plurality of contacts and said other contact on the motor driven switch are in a fixed position relative to each other and all rotate together.

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