

Entangling Projectiles and Systems for their Use

PRIORITY CLAIM

Priority is claimed of and to U.S. Patent Application Serial No. 15/081,440, filed March 25, 2016, and U.S. Patent Application Serial No. 15/399,537, filed January 5, 2017, each of which is hereby incorporated herein by reference in its entirety.

5 **BACKGROUND OF THE INVENTION**

Field of the Invention

The present invention relates generally to non-lethal, ranged weapons systems to aid in impeding or subduing hostile or fleeing persons of interest.

Related Art

10 It has been recognized for some time that police and military personnel can benefit from the use of weapons and devices other than firearms to deal with some hostile situations. While firearms are necessary tools in law enforcement, they provide a level of force that is sometimes unwarranted. In many cases, law enforcement personnel may wish to deal with a situation without resorting to use of a firearm. It is generally accepted,
15 however, that engaging in hand-to-hand combat is not a desirable choice.

For at least these reasons, ranged engagement devices such as the Taser™ have been developed to provide an alternative. While such electrical muscular disruption (“EMD”) weapons have been used with some success, debates continue as to whether such devices are as safe as claimed or are an appropriate level of force for many
20 situations. Other ranged engagement solutions, such as mace or pepper spray, are very limited in range and are often criticized for the pain caused to subjects and the potential for such solutions to affect police or bystanders.

As such, designers continue to seek non-lethal solutions that can be effectively used by police or law enforcement especially to impede or subdue fleeing subjects.

25 **SUMMARY OF THE INVENTION**

In accordance with one aspect of the invention, a projectile deployment system is provided, including an entangling projectile, including a pair of pellets and a tether connecting the pellets. A projectile casing can include a pair of sockets, each socket sized to carry one of the pair of pellets, and a selectively activatable pressure source, carried by the projectile casing. The pressure source can be capable of expelling the entangling projectile from the projectile casing toward a subject. A launcher can carry an activator operable to activate the pressure source to expel the entangling projectile from the projectile casing toward the subject. The projectile casing can be removably engageable

with the launcher to allow removal of the projectile casing from the launcher after expulsion of the entangling projectile from the projectile casing.

In accordance with another aspect, a projectile deployment system is provided, including an entangling projectile having a pair of pellets and a tether connecting the pellets. A projectile casing can include a pair of sockets, each socket sized to carry one of the pellets. The pair of sockets can be angled relative to one another such that the pellets

5 travel apart from one another as they are expelled from the projectile casing, with at least a portion of one of the sockets overlapping a portion of another of the sockets. A launcher can carry the projectile casing, and a selectively activatable pressure source can be carried by one of the launcher or the projectile casing. The pressure source can be capable of expelling the entangling projectile from the projectile casing toward a subject.

10 The projectile casing can be removably engageable with the launcher to allow removal of the projectile casing from the launcher after expulsion of the entangling projectile from the projectile casing.

In accordance with another aspect of the invention, an entangling projectile for use in a projectile deployment system is provided, the entangling projectile including a pair of

15 pellets and a flexible tether connecting the pellets. An engagement hook can be coupled to one or both of the pellets, or to the tether, the engagement hook being operable to engage clothing worn by a subject engaged by the entangling projectile to aid in retaining the entangling projectile about the subject.

In accordance with another aspect of the invention, a projectile deployment system

20 is provided, including a launcher and an entangling projectile, the entangling projectile including a pair of pellets and a tether connecting the pellets. a projectile casing can be coupled to the launcher, the projectile casing including a pair of sockets, each socket carrying one of the pellets. A selectively activatable pressure source can be carried by one of the launcher and the projectile casing such that activating the pressure source

25 results in expelling the entangling projectile from the projectile casing. The sockets can be oriented within the projectile casing such that the pellets travel toward differing vertical trajectories as they are expelled from the projectile casing.

In accordance with another aspect of the invention, an entangling projectile for use in a projectile deployment system is provided, the entangling projectile including a pair of

30 pellets and a flexible tether connecting the pellets. At least one engagement hook can be coupled to one or both of one of the pair of pellets or the flexible tether, the engagement

hook being operable to engage clothing worn by a subject engaged by the entangling projectile to aid in retaining the entangling projectile about the subject.

Additional features and advantages of the invention will be apparent from the detailed description which follows, taken in conjunction with the accompanying drawings, which together illustrate, by way of example, features of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The following drawings illustrate exemplary embodiments for carrying out the invention. Like reference numerals refer to like parts in different views or embodiments of the present invention in the drawings.

FIG. 1 is a top, bottom, front or rear view of an entangling projectile extended substantially to its full length in accordance with an embodiment of the invention;

FIG. 2A is a side view of a pellet and a portion of a tether of the projectile of FIG. 1;

FIG. 2B is an end view of the pellet of FIG. 2A;

FIG. 3A is a top view of a subject toward which an entangling projectile was launched, shown immediately prior to the entangling projectile engaging the subject;

FIG. 3B is a top view of the subject and projectile of FIG. 3A, shown shortly after the entangling projectile engaged the subject;

FIG. 4 is a front view of a portion of a subject in accordance with an embodiment of the invention, shown immediately prior to an entangling projectile engaging the subject's legs;

FIG. 5 is a front view of an entangling projectile in accordance with another embodiment of the invention, shown with the pellets pulling the tether into a taught condition;

FIG. 6 is a side view of a portion of an entangling projectile in accordance with another embodiment of the invention;

FIG. 7 is a top perspective view of a projectile deployment system of the present invention, shown in an exploded condition with a projectile casing being removed from or installed in a launcher;

FIG. 8 is a front view of the projectile casing of FIG. 7;

FIG. 9 is a rear view of the projective casing of FIG. 7;

FIG. 10 is a top, partially sectioned view of the projectile casing of FIG. 7;

FIG. 11 is a side, partially sectioned view of the projectile casing of FIG. 7;

FIG. 12 is another side, partially sectioned view of the projectile casing of FIG. 7;

FIG. 13 is a side, partially sectioned view of the launcher of FIG. 7, shown with various components removed to reveal inner components of the launcher;

FIG. 14 is a side view of a section of an entangling projectile in accordance with an embodiment of the invention;

5 FIG. 15 is a side, sectioned view of a hook portion of a pellet in accordance with an embodiment of the invention;

FIG. 16 is a side, sectioned view of a hook portion of a pellet in accordance with an embodiment of the invention;

10 FIG. 17 is an end view of a pellet in accordance with an embodiment of the invention;

FIG. 18 is an end view of another pellet in accordance with an embodiment of the invention;

FIG. 19 is a side view of a portion of an entangling projectile in accordance with another embodiment of the invention

15 FIG. 20 is a side view of a portion of an entangling projectile in accordance with another embodiment of the invention;

FIG. 21 is a side view of a portion of an entangling projectile in accordance with another embodiment of the invention.

20 FIG. 22 is a side, partially sectioned view of a portion of an entangling projectile in accordance with another embodiment of the invention;

FIG. 23 is a side view of a portion of an entangling projectile in accordance with another embodiment of the invention;

FIG. 24 is an end view of an exemplary projectile casing in accordance with an embodiment of the invention; and

25 FIG. 25 is a side view of the exemplary projectile casing of FIG. 24.

DETAILED DESCRIPTION

Reference will now be made to the exemplary embodiments illustrated in the drawings, and specific language will be used herein to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby
30 intended. Alterations and further modifications of the inventive features illustrated herein, and additional applications of the principles of the inventions as illustrated herein, which would occur to one skilled in the relevant art and having possession of this disclosure, are to be considered within the scope of the invention.

Definitions

As used herein, the singular forms “a” and “the” can include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “a pellet” can include one or more of such pellets, if the context dictates.

5 As used herein, the terms “firearm blank” or “blank cartridge” refer to the well-known blank cartridge that can be used with firearms. Such blank cartridges contain gunpowder but not a bullet or shot: as such, they can be discharged to produce only a high velocity pressure wave, without an accompanying shot or slug.

As used herein, the term “substantially” refers to the complete or nearly
10 complete extent or degree of an action, characteristic, property, state, structure, item, or result. As an arbitrary example, an object that is “substantially” enclosed is an article that is either completely enclosed or nearly completely enclosed. The exact allowable degree of deviation from absolute completeness may in some cases depend upon the specific context. However, generally speaking the nearness of completion will be so as to have
15 the same overall result as if absolute and total completion were obtained. The use of “substantially” is equally applicable when used in a negative connotation to refer to the complete or near complete lack of an action, characteristic, property, state, structure, item, or result. As another arbitrary example, a composition that is “substantially free of” an ingredient or element may still actually contain such item so long as there is no
20 measurable effect as a result thereof.

As used herein, the term “about” is used to provide flexibility to a numerical range endpoint by providing that a given value may be “a little above” or “a little below” the endpoint.

Relative directional terms can sometimes used herein to describe and claim various
25 components of the present invention. Such terms include, without limitation, “upward,” “downward,” “horizontal,” “vertical,” etc. These terms are generally not intended to be limiting, but are used to most clearly describe and claim the various features of the invention. Where such terms must carry some limitation, they are intended to be limited to usage commonly known and understood by those of ordinary skill in the art in the context
30 of this disclosure.

As used herein, a plurality of items, structural elements, compositional elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. Thus, no individual member of such list should be

construed as a *de facto* equivalent of any other member of the same list solely based on their presentation in a common group without indications to the contrary.

Numerical data may be expressed or presented herein in a range format. It is to be understood that such a range format is used merely for convenience and brevity and thus should be interpreted flexibly to include not only the numerical values explicitly recited as the limits of the range, but also to include all the individual numerical values or sub-ranges encompassed within that range as if each numerical value and sub-range is explicitly recited. As an illustration, a numerical range of "about 1 to about 5" should be interpreted to include not only the explicitly recited values of about 1 to about 5, but also include individual values and sub-ranges within the indicated range. Thus, included in this numerical range are individual values such as 2, 3, and 4 and sub-ranges such as from 1-3, from 2-4, and from 3-5, etc., as well as 1, 2, 3, 4, and 5, individually.

This same principle applies to ranges reciting only one numerical value as a minimum or a maximum. Furthermore, such an interpretation should apply regardless of the breadth of the range or the characteristics being described.

Invention

The present technology relates generally to non-lethal weapons systems, sometimes referred to as ensnarement or entanglement systems, that can be effectively used as an aid in impeding the progress of or detaining aggressive or fleeing subjects.

Devices in accordance with the present technology can be advantageously used to temporarily impede a subject's ability to walk, run, or use his or her arms in cases where law enforcement, security personnel or military personnel wish to detain a subject, but do not wish to use lethal or harmful force or to engage in close proximity hand-to-hand combat. The technology provides a manner by which the arms or legs of a subject can be temporarily tethered or bound, to the extent that the subject finds it difficult to continue moving in a normal fashion.

While the present technology can be directed at any portion of a subject's body, the following discussion will focus primarily on use of the technology to temporarily tether or bind a subject's legs. It is to be understood, however, that the present technology is not limited to this application. In some cases, multiple portions of the subject's body can be targeted, such as both the arms and the legs.

As shown generally in FIGs. 1-5, the present technology provides an entangling projectile 12 that can be deployed toward a subject's legs to cause the projectile to wrap about the subject's legs. The projectile includes at least one flexible tether 16 and at least

two pellets 14, coupled together by the tether. By engaging a subject with the entangling projectile, the subject is temporarily rendered partially or fully incapacitated and thereby restricted in his or her ability to flee or attack. The entangling projectiles of the present technology are launched toward a subject (100 in FIGs. 3A-4) by a launcher. In addition to the launchers discussed herein, numerous examples of suitable launchers are provided, as examples, in the above-referenced parent case, U.S. Patent Application Serial No. 15/081,440, filed March 25, 2016, which is hereby incorporated herein by reference in its entirety. Such launchers can include energy sources such as compressed gas, explosives/combustibles, mechanical springs, etc.

Generally speaking, a launcher for use with the present entangling projectiles will launch the projectile toward a subject 100 at a relatively high rate of speed. Typically, the projectile can be deployed toward a subject from a distance of between about 6 feet and about 30 feet (1.8 to 9.1 meters), and engages the subject within a matter of about 0.0075 to 0.0375 seconds (traveling at about 800 ft/sec (243.8 m/s)). After being deployed from the launcher, the entangling projectile will wrap about the subject's legs two or three or more times, causing the subject to be temporarily unable to effectively move. As the entangling projectile can be launched from some distance, law enforcement personnel can maintain a safe distance from a subject, yet still be able to effectively and safely temporarily restrain, disable or impede the subject.

Operation of the entangling projectile is shown generally in FIG. 4: after being released by a launcher, the projectile 12 travels toward a subject 100. As the projectile travels toward the subject, pellets 14 travel away from one another, resulting in the tether 16 being pulled substantially taught between the two. Once the projectile engages the subject (in the example shown in FIG. 4 the subject's legs are engaged), the pellets and tether wrap about the subject and thereby temporarily entangle and/or disable the subject.

A variety of differing pellet and tether combinations can be utilized in the present technology. In the examples shown in FIGs. 1-4, the projectile 12 is shown with two generic pellets 14 connected by a single tether 16. While more than two pellets can be utilized, the examples shown herein include only two. In some embodiments, the invention is limited to two, and only two, pellets connected by a single tether. In one aspect, the invention consists of two pellets and a single tether. In one aspect, the invention consists essentially of two pellets and a single tether. It has been found that limiting the number of pellets to two results in a more effective deployment system: the risk of tangling of the tether 16 is diminished and the pellets spread apart from one another

much more cleanly and quickly after being deployed from the launcher. This results in a more consistent trajectory after deployment. This arrangement can also allow, with the proper launcher configuration, the projectiles to be more accurately directed toward a subject.

5 FIG.5 illustrates further features of the entangling projectile 12. As referenced above, the projectile includes two pellets 14 coupled on opposing ends of a tether 16. In this embodiment, two and only two pellets are provided, coupled by only a single tether 16. The use of only two pellets has been found to be advantageous in that a much cleaner and accurate projectile can be directed toward a subject, and the projectile can
10 more effectively engage the subject. The pellets 14 can apply equal and opposite forces, shown by example with directional indicators 102 and 104, upon tether 16. In this manner, the tether is pulled into a taught, linear configuration by the force of the pellets traveling away from one another.

The tether 16 can include no additional structure coupled thereto, with no additional
15 structure extending therefrom. In this manner, the pellets 14 can pull the tether into the straight, uninterrupted, linear configuration shown. The tether and pellets can occupy substantially a common plane 106 in the configuration immediately prior to contacting a subject. As shown, this plane 106 is typically angularly offset from "true" horizontal 108, as the pellets are positioned at differing elevations prior to contact with the subject (as
20 detailed further below). By omitting additional pellets or tethers, or other extraneous structure, the present technology can deliver an entangling projectile that engages subjects with a much higher rate of successful engagement.

FIG. 1 illustrates the projectile 12 extended to its full length " L_O ." In one embodiment, the overall length of the tether is much longer than the size of pellets (L_P).
25 The overall length can be on the order of seven feet (2.14 meters) or greater. The pellets can have a length " L_P " on the order of an inch (2.54 cm), and a diameter " D_P " on the order of 3/8 of an inch (0.95 cm). While differing embodiments of the technology can vary, it is generally desirable to maintain the pellets at a relatively small size to thereby limit the overall size requirements of the projectile casing that houses the pellets prior to
30 deployment and to reduce the impact should a pellet hit the subject. In this manner, the technology can be provided in a lightweight, hand-held device.

The relationship of the pellet diameter, weight and length in relation to the tether length/weight can significantly affect the performance of the entangling projectile. It has been found that a pellet diameter of about 0.330 inches (0.84 cm) with a length of about 1

to 1.5 inches (2.54 - 3.81 cm) with a weight of about 5-6 grams combined with a tether of about 7 feet (2.13 m) weighing about 1 gram provides an effective entangling projectile. The present casing discussed below has been designed to effectively deliver such entangling projectiles with a high degree of precision and reliability.

5 The tether 16 can be formed from a variety of materials. In one aspect, the tether is formed from conventional nylon material. Waxed cord can also be used, as the wax can aid in packing and/or coiling the tether to properly fit within, and stay within, the tether compartments. In one embodiment, the tether can be formed from an elastic material.

10 In one example, the tether is formed from KevlarTM cord, with a thickness of about 0.1 mm. A Kevlar tether has been found to perform well for a number of reasons. The Kevlar tether is very strong, and not as prone to breakage as other cords. In addition, the Kevlar material does not tend to "wick" adhesives as do other materials – thus minimizing drying/curing times of adhesive and reducing the tendency of the cord to become stiff with cured adhesive that have wicked along stretches of cord.

15 FIG. 6 illustrates a portion of one exemplary entangling projectile 12c in accordance with an embodiment of the invention. In this example, pellet 14c is provided that includes various features that aid in more accurately and effectively engaging a subject. A portion of tether 16 is shown extending from access hole 166b, which is generally formed in or through a shank of the pellet 14c. The tether can be secured to the shank by the use of
20 adhesive applied through access hole 166b. A hook assembly 180 can be attached atop the shank of the pellet, and can be secured to the shank via application of adhesive through access hole 166a. Access holes 166a and 166b, which function much like rosettes, can be used to allow the hook structure or pellet to be coupled to the tether, or to one another. In the embodiment of FIG. 6, the hook assembly 180 can be positioned
25 where desired, and a small amount of adhesive or other attachment material can be applied through access hole 166a to mount the hook assembly in position. Access hole 166b can be easily used in the same manner to mount the pellet 14c to the tether 16.

30 While the present projectiles can be used with variety of launchers, FIGs. 7 through 13 illustrate one exemplary system that can be utilized to effectively direct the entangling projectile toward a subject. As shown in exploded view in FIG. 7, the projectile deployment system 40 generally includes an entangling projectile that includes a pair of pellets 14a, 14b, and a tether 16 connecting the pellets (note that the tether is omitted from many of these views to enable a more clear description of other components). A projectile casing 44 is provided that can include a pair of sockets 30a, 30b (see FIGs. 8,

10 and 11, for example). Each socket can be sized and shaped to carry one of the pair of pellets: in the examples shown, socket 30a carries pellet 14a and socket 30b carries pellet 14b.

The projectile casing 44 can include a selectively activatable pressure source 50 (FIGs. 9 - 12). The pressure source can be carried by the projectile casing, independently of the launcher or other components of the system. The pressure source can be capable of expelling the entangling projectile from the projectile casing toward a subject 100. The system can also include a launcher 42 that can carry an activator operable to activate the pressure source to expel the entangling projectile from the projectile casing toward the subject. One example of activator 54 is discussed in more detail below in relation to FIG. 13.

5 The projectile casing 44 can be removably engageable with the launcher 42 to allow removal of the projectile casing from the launcher after expulsion of the entangling projectile 12 from the projectile casing. In this manner, the present technology provides a deployment system that includes two separate and distinct components: the launcher 42 and the projectile casing 44. In one embodiment, the pellets 14a, 14b and tether 16 are carried by the projectile casing, as is the pressure source 50. The activator (54 in FIG. 13,
10 for example) is carried by the launcher. Generally, all components necessary to power the activator are carried by the launcher, and all components necessary to launch the projectile are carried by the projectile casing. In this manner, the unit as a whole is not operable until the casing 44 and the launcher 42 are functionally engaged with one another. Once the two are engaged with one another, operation of the launcher 42 (and
15 the activator 54) results in expulsion of the entangling projectile from the casing 44.

In the example shown, launcher 42 includes a trigger panel 46, discussed in more detail below in connection with FIG. 13. Generally, activation of the trigger panel causes the launcher 42 to activate the pressure source 50, which results in expulsion of the entangling projectile from the casing 44. Once the projectile has been deployed from a
20 particular projectile casing, that casing can be removed and a fresh projectile casing with a preinstalled entangling projectile 12 and pressure source can be installed within the launcher. Activation of a first casing and replacement with a fresh casing can be achieved in a matter of seconds. Thus, law enforcement, security, military, etc., personnel can very rapidly exchange a spent projectile casing with a fresh projectile casing that is loaded and
25 ready to activate by the launcher.

As the casing 44 can include all the disposable components of the system, the launcher 42 can have an extended useful life and rarely, if ever, need be replaced or maintained. The entangling projectile 12 and pressure source 50 can be installed within the projectile casing in a controlled environment, thereby ensuring that a clean, effective deployment can be consistently achieved. Projectile casings can be provided to law enforcement personnel loaded and ready to use, requiring only that the personnel insert the projectile casing into the launcher. While it is contemplated that end users of the device could reload the projectile casing with a pressure source and entangling projectile, they are not required to do so and is felt likely that quality can be much better controlled by preloading the projectile casing with both the entangling projectile and the pressure source.

The casing 44 can be held within the launcher 42 in a variety of manners. In one embodiment, the casing can "snap" into the launcher and be firmly held in position by one or more mechanical locks (not shown in detail). The locks can be easily disengaged by an end user when it is desired to remove the casing from the launcher.

FIG. 8 illustrates a front view of the casing 44. In this view, pellets 14a, 14b can be seen stored, ready for use, in sockets 30a, 30b, respectively. Tether storage compartments 32 can be provided and can consist of shaped depressions formed in the projectile casing to allow the tether (not shown in this view) to be stored adjacent the pellets prior to use. The projectile casing can include a front shroud 56 that can serve to create a protective pocket 58 around the tether and the pellets. As shown in FIG. 7, a cover 57 can be applied over the pocket 58 and can be attached to the shroud 56 to protect the pocket from exposure to contaminants and/or to contain the entangling projectile within the projectile casing.

In the examples shown in FIGs. 9-12, the pressure source 50 comprises a cartridge blank. This type of pressure source is well known to contain gunpowder that is typically activated by striking a primer formed in the cartridge. The blank cartridge contains no slug; deployment of the cartridge results only in a high-pressure wave being directed from the projectile casing. This high-pressure wave is utilized by the present technology to propel the entangling projectile from the system at high velocity. In one embodiment of the invention, the cartridge blank can be irremovably attached to the cartridge such that the cartridge is a single actuation cartridge. In this manner, installation of the cartridge can be done in a controlled manufacturing environment, to ensure the proper cartridge is

use, that the cartridge is properly installed, and that the casing 44 is otherwise ready for use. The cartridge can be secured to the casing by adhesive, mechanical crimp, etc.

By irremovably attaching the cartridge blank 50 to the casing 44, there is little to no risk that an actual bullet or "real" cartridge can be accidentally inserted into the casing. In addition, a length and configuration of the central bore 60 can be configured to prevent the insertion of anything other than a properly designed blank cartridge 50.

In contrast, the entangling projectile 12 is *removably* installed within the projectile casing. All components of the entangling projectile (i.e., the pellets 14a, 14b and tether 16) are installed within the casing such that they can be readily and completely ejected from the casing when the pressure source 50 is deployed. The geometry of the sockets 30a, 30b within the casing 44, along with the geometry of the pellets, has been carefully designed to ensure that a consistent, effective deployment of the entangling projectile is achieved each time the launcher is activated. FIGs. 10-12 illustrate this geometry in more detail.

As shown in top view in FIG. 10, the sockets 30a and 30b are angled relative to one another such that the pellets 14a, 14b travel apart from one another as they are expelled from the projectile casing 44. In the example shown, at least a portion of one of the sockets extends beneath a portion of another of the sockets within the cartridge (in this example, "bottom" socket 30b extends beneath "upper" socket 30a). Depending upon the particular arrangement, one of the pellets can overlap, or extend beneath or above, another of the pellets when the pellets are installed within the sockets. In the example shown, pellet 30b extends beneath (when viewed perpendicularly from a horizontal plane on which the casing sits) pellet 30a when the pellets are stored and ready for activation. As shown in side view in FIG. 11, in one example, the sockets can also be, or can alternatively be, vertically offset relative to one another and can extend on planes parallel to one another.

The casing 44 can also include a central bore 60, shown in FIGs. 10-12, located immediately adjacent the discharge end of pressure source or blank cartridge 50. In this embodiment, upon activation, the blank cartridge 50 discharges into the central bore a high-pressure wave. This high-pressure wave then travels into both sockets 30a and 30b, generally distributed equally among the two. Thus, each of socket 30a and socket 30b terminate into, or are at least in fluid communication with, central bore 60.

As discussed, each of socket 30a, 30b can hold one pellet, 14a, 14b, respectively, prior to deployment of the pellets from the projectile casing. As a high-pressure wave is

generated by the cartridge, it is directed through the central bore and is applied to the pellets held in sockets 30a, 30b. The pellets are then forcibly expelled from the inner block toward the subject.

As best appreciated from FIG. 10, the sockets 30a, 30b can be oriented at an angle
5 “ α ” relative to one another. While the angle can vary, it is generally an acute angle, typically ranging from about 10 degrees to about 60 degrees. In another embodiment, the angle can range between about 25 degrees to about 45 degrees. In another embodiment, the angle is about 30 degrees. By angling the sockets relative to one another, the pellets 14a, 14b are directed away from one another as they are expelled from the sockets. In
10 this manner, the pellets separate relative to one another very quickly, pulling the tether 16 taut between them so that the tether can fully extend prior to engaging the subject. The forward energy applied to the pellets is both split between the two pellets and angled by the nature of the sockets: as such, in the event that a pellet inadvertently directly contacts a subject, the force is less than that otherwise applied by a full charge, minimizing the risk
15 of injury to the subject.

The resulting launch is shown in FIGs. 3A and 3B. In FIG. 3A, the entangling projectile 12 has been launched toward a subject 100 (shown from above) and has traveled to engage the subject. Prior to contacting the subject, the tether 16 has been pulled taut, such that the pellets 14 are travelling in a linear direction toward the subject.
20 Immediately after the tether 16 contacts the subject, the momentum of the pellets, prevented by the tether from continuing along their present trajectory, causes them to begin moving toward one another (shown in FIG. 3B), which momentum will cause the pellets to orbit about the subject.

As the pellets orbit about the subject's legs, the tether wraps itself tightly about the
25 subject's legs. Note that, as the tether wraps about the subject's legs, the rotational velocity of the pellets will increase, causing them to wrap more quickly as the effective length of the tether is decreased. In an average deployment, the pellets will wrap themselves about the subject's legs 2-3 times, resulting in the tether being wrapped about the subject's legs 4-6 times. As will be appreciated, a subject will at least temporarily have
30 great difficulty moving after the tether is thus wrapped about his or her legs.

Referring again to FIG. 10, in this example the axes 31a, 31b of the sockets 30a, 30b, respectively, can intersect one another at a location within the casing 44. That is, a portion or section of one of the sockets can intersect with a portion or section of the other

socket within the confines of the casing. In the example shown, sockets 30a and 30b intersect or overlap where each socket is fluidly coupled to central bore 60. The sockets can also be stacked horizontally relative to one another, to provide an overlapping configuration of one atop the other. In this manner, the sockets can be spaced relatively close to one another while also maintaining a desired angle between the two. The location at which the sockets intersect can be adjusted nearer to or further from the central bore.

This stacking/overlap configuration allows the use of a relatively narrow projectile casing 44 regardless of the angle at which it is desired to orient the sockets. If the sockets were merely oriented in a side-by-side relationship, without overlapping axes, the width or diameter of the projectile casing would have to be increased as the angle " α " between the socket axes 31 was increased. By overlapping the axes, however, this limitation in arranging the sockets is eliminated. This can allow the projectile casing to be much more narrow than otherwise possible. This results in a launcher system that can be easily carried by law enforcement personnel, similar to conventional firearms or Taser. While not so limited, in one aspect of the invention, the projectile casing 44 can be formed having a diameter or maximum width of less than about two inches (5.1 cm), and as little as 1 ½ inches (3.8 cm) or less. The projectile casing can be formed with a length of less than about 2 ½ inches (6.4 cm), or as little as two inches (5.1 cm) or less. Overlapping or stacking of the sockets also allows a vertical displacement of the pellets to differ as the pellets contact the subject. This vertical offset of the pellets is discussed in more detail in the parent applications referenced above.

FIG. 13 illustrates one example of the launcher 42, and some of the components within the launcher. Note that several operable components of the launcher have been omitted from this view in the interest of more clearly illustrating operable principals of the launcher. In this example, the activator comprises a sliding firing bolt 54. The firing bolt can include an internal spring 66 that can be biased into a compressed condition to ready the bolt for firing. This can be accomplished by a sliding "cocking" mechanism (not shown in detail) that can be used to compress the internal spring. Trigger panel 46 (which is generally accessible from atop the launcher) can be depressed when it is desired to activate the launch of the entangling projectile. Depressing panel 46 causes lever 46a to depress lever 68, which in turn causes tang 70 to release the firing bolt. The tension in spring 66 then propels bolt 54 along a predetermined trajectory. The blank cartridge 50,

when the casing was installed within the launcher, is positioned at the end of the bolt's trajectory. The bolt impacts the cartridge, causing the primer to ignite and generate a high-pressure wave.

While FIG. 13 illustrates general operation of the exemplary triggering bolt 54 shown, it is to be understood that many components contributing to operation of the launcher have been omitted from this view. These include, without limitation, structure used to "cock" the firing bolt 54 into ready position; safety mechanisms that can prevent inadvertent activation of the launcher, latching mechanisms that latch the casing 44 to or within the launcher 42, etc. One of ordinary skill in the art, having possession of this disclosure, could readily appreciate the operation of such components.

In addition to utilizing a blank cartridge as the pressure source 50, the pressure source can be provided in a number of other forms. In one example, the pressure source includes a compressed gas cylinder that can be activated in much the same way as discussed in relation to the blank cartridge. In other embodiments, an electronic triggering system can be utilized. In this example, an electronic switch (shown schematically for exemplary purposes at 80b in FIG. 13) can be provided within the launcher. Contact pad 80a can be provided on the casing (shown schematically for exemplary purposes at 80b in FIG. 9) on the launcher. A complementary pad (not shown) can be associated with the launcher. Activation of the triggering panel 46 can activate the electronic switch, which can then generate an electronic signal that can be transferred to the projectile casing through pad 80a to thereby cause activation of the pressure source. Pad 80a can ensure that the electronic signal cannot be provided to the casing unless the casing is properly installed within the launcher.

By packaging the pressure source 50 and the entangling projectile 12 in the removable projectile casing 44, all of the components that generate force (and react to force) are contained in a single unit. There are no unnecessary gaps or connections between the power source and the entangling projectile. This aspect also eliminates any need to reload two parts, the entangling projectile and the pressure source, as these are contained within one removable part, the projectile casing, which can be easily and quickly loaded into or unloaded from the launcher 42.

FIGs. 24 and 25 illustrate an alternate embodiment of the invention in which four sockets, 30c, 30d, 30e and 30f are formed in inner exemplary projectile casing 44a. As shown in FIG. 25, the upper sockets 30c, 30d can carry pellets from one entangling projectile (not illustrated here) that are directed forwardly of the block upon activation.

Lower sockets 30e, 30f can carry the pellets from a different entangling projectile (not illustrated here) and, upon discharge, these pellets will be propelled at a non-parallel angle relative to the upper sockets by angle " ϵ ." Each pair of sockets can also be oriented (or vertically staggered) as illustrated in Figs. 8 and 11. In this embodiment, aiming the launcher that contains casing 44a toward a target can result in directing one projectile toward a subject's torso, while a second projectile is directed toward the subject's legs. This can provide more opportunities to temporarily incapacitate the subject. This arrangement can also allow law enforcement personnel to direct the launcher toward a subject's body mass. As many law enforcement personnel are trained to direct fire at a subject's torso rather than the subject's legs, this may ensure that the projectile launcher is properly utilized by law enforcement. The angle " ϵ " can vary, but the present inventors have found that as little as 6 degrees is sufficient to cause two projectiles to contact a subject's body in different areas.

In the embodiment shown in FIGs. 24 and 25, activation of the energy source (not shown in these figures) results in both projectiles (four pellets in all) being expelled from the casing 44a. It is to be understood, however, that the system can be configured to provide a pressure wave to the upper sockets independently of the lower sockets, to allow, for example, law enforcement personnel to select which projectile to deploy. Likewise a block could contain more than two pairs of sockets that can fire simultaneously, or they can be configured to fire separately by one or more triggering mechanisms.

While much of the discussion above focused on the projectile casing and launcher used in the present technology, the ballistic features of the entangling projectiles must be carefully matched with the operable features of the casing and launcher. Generally, the entangling projectiles of the present technology are provided as electrically inert. That is, they are not attached to an electrical charge source, nor do they require an electrical charge to subdue or entangle a subject. As used herein, the term "electrically inert" is understood to refer to a condition in which the projectiles, and pellets and tether, do not carry an electrical charge other than that carried by inert objects within the environment in which the projectiles are deployed. Thus, while some static charge may be carried by most objects in such an environment, the projectiles (pellets and tether) do not carry any additional charge. In most embodiments, the tether and pellets similarly need not carry any other structure capable of delivering an electrical charge to a subject.

Further examples of suitable pellets and tethers are illustrated in FIGs. 14-23. In the example shown in FIG. 14, at least one engagement hook 144 can be coupled to at least one of the pellets 12. The engagement hook can be operable to engage clothing worn by subject 100 engaged by the entangling projectile to aid in retaining the entangling projectile about the subject. The engagement hook can also engage, during or after completion of the wrap, another engagement hook. The present inventors have found that, while wrapping the present projectiles about a subject has proven effective, the use of engagement hooks on the pellets can aid in retaining the projectile about the subject after the projectile has wrapped, increasing the likelihood of a successful entangling engagement or wrap. The present engagement hooks are designed to engage clothing worn by the subject (or to engage other hooks of the projectile), not necessarily the subject's skin or body. In some embodiments, engaging the subject's skin or body is undesirable, while in other embodiments, such a consideration may not be as critical (when very small hooks are used, for example).

While the various engagement hooks illustrated in the figures include a conventional "hook" shape, it is to be understood that the hooks can include linear segments that extend from the pellet in a variety of directions. For example, a hook can include a straight segment that extends perpendicularly from the pellet in one direction, and then turn at an angle in another direction. In other words, the hooks need not contain curved portions – they can include one or more linear segments formed at angles relative to one another. The hooks can also extend directly from the pellet in a unitary direction, and need not include segments that extend in different directions.

The present arrangement attains this by the unique manner in which the engagement hooks are arranged relative to the pellets. As shown for example in FIG. 14, the hook 144 can include a point 146 that extends in a direction opposite a direction in which the tether extends from the pellet. In this manner, the point 146 can engage the subject's clothing while the pellet is completing its wrap about the subject. Note that the distal end 170 of the pellet 14d of FIG. 14 will be traveling toward (and radially about) the subject's clothing as the projectile wraps. The point of the hook will engage the subject's clothing just prior to completing its wrap. This orientation allows the hook to immediately engage the subject's clothes: otherwise, it would be required that the hook be pulled backwardly to engage the clothing.

Conversely, in the embodiment shown in FIG. 21, hooks 148 are provided that are oriented to extend from the pellet 14h in the same direction as does the tether 16. In

accordance with varying embodiments, hooks can be provided in a forward orientation, a rearward orientation, and both orientations. In this example, hooks 144 are also provided that extend in the opposite direction. Pellets in accordance with the present technology can be provided that include hooks oriented in one or both directions. In the examples shown in FIG. 14, the hooks 144 include a barb 159 that projects from the hook in a direction generally opposite to that of the point 146. The barbs can aid in retaining the hooks in engagement with the subject's clothing. In other embodiments, however, such as that shown in FIG. 16, no barb is provided. In this case, hooks 152 include only unidirectional point 154, which can be oriented in, or pointed toward various angles or trajectories.

As also shown in FIG. 16, the hooks can be configured to extend from the pellet in a specific orientation. Angle " β " shown is the angle between the longitudinal axis (142 in FIG. 14) of the pellet and the general direction of extension of the point portion of the hook from the pellet. In some embodiments, this angle can be between about 15 degrees and about 35 degrees. In one embodiment, this angle is about 23 degrees.

As shown in FIG. 14, in one aspect of the invention, the pellet can include a neck portion 160 that can include a diameter having a diameter less than the outer diameter of the pellet. Thus, the neck provides, in some embodiments, a recessed shank that extends away from the larger portion of the pellet containing the pockets 132.

The engagement hooks 144 can extend over the neck portion 160 of the pellet. In one embodiment, the engagement hook extends outwardly in a radial direction from the longitudinal axis of the pellet to a circumferential span. This circumferential span of the engagement hook can be less than a circumferential span of an outer surface of the pellet. As can be appreciated from FIG. 14, the hooks 144 extend outwardly only so far as the diameter "D" of the lower portion of the pellet. This allows use of the hooks with the pellet, while also allowing the pellets to be inserted into a socket or barrel from which the pellets will be discharged. Thus, hooks can be provided without requiring specialized configuration of the sockets. The pellets, with the hooks coupled thereto, can fit within the same size diameter bore as is used for pellets with no hooks.

The recessed neck portion 160 provides an additional advantage in that the distal end 170 of the pellet is generally much larger than the neck portion, and thus has a larger mass. As the pellets are expelled from the launcher (which applies a pressure wave to end 170 of the pellet of FIG. 14), the neck portion is expelled from the barrel or socket of the launcher first. However, as the tether is pulled taut, end 170 becomes the leading end

and the increased mass of this end aids in providing forward momentum to the pellet to obtain a good wrap about the subject 100.

FIGs. 15-18 illustrate exemplary embodiments in which a hook assembly can be provided as part of the pellet, or can serve as the pellet itself. In these embodiments, the hook structure includes a hollow shank 162 (FIG. 15) that can accommodate the tether 16. In this manner, the hook structure can be easily coupled to the tether without creating a weight offset on one side of the tether or another. The use of the hollow shank can also allow one or more hook structures to be coupled to the tether along various longitudinal positions on the tether. For example, as shown in FIG. 20, pellet 14g includes no hook structure. However, hook assembly 164 includes two hooks 144, and includes the hollow shank 162 (not shown in detail). The hollow shank allows the hook assembly to be moved to any desired location along the tether 16 and be easily mounted in place without damaging or twisting or kinking the tether. The tether can include multiple hook assemblies 164 oriented in various directions including opposing hooks 180 (FIG. 22) on such hook assembly. Hook assemblies on the tether can also be employed along with hook assemblies on the pellets.

Access hole 166, which functions much like a rosette, can be used in this embodiment (and many of the others) to allow the hook structure or pellet to be easily coupled to the tether. In the embodiment of FIG. 20, the hook assembly 164 can be positioned where desired, and a small amount of adhesive or other attachment material can be applied through access hole 166 to mount the hook assembly in position. In the example shown in FIG. 14, access hole 166 can be easily used to mount both the pellet to the tether 16, and to mount hooks 144 within the pellet, if such an arrangement is desirable.

The examples shown in FIGs. 14, 15, 16, 19, and 20 each include two hooks 144 coupled to or carried by the pellet. In addition to the use of two hooks, a single hook can also be used. Alternately, it has been found that utilizing multiple hooks, spaced equally around the pellet, can ensure proper engagement of a subject. In FIG. 17, three hooks 149 are used. In one embodiment, a number 12 treble hook has been found suitable. In FIG. 18, four hooks 151 are used. In each of these cases, the hooks are spaced evenly around the longitudinal axis of the pellet and the hollow shank 162. In some embodiments, more than four hooks are used.

The tether 16 can also include structure that can aid in limiting a subject's ability to quickly disengage from the tether. As shown for example in FIG. 19, engagement

features 168 can be added to the tether at intervals along the tether. Representative spacing intervals are shown, by example, at "S." The engagement features 168 can take a variety of forms. In one example, small knots can be formed in the tether at regular intervals. These knots can engage clothing worn by the subject to limit the subject's ability to quickly disengage from the projectile. They can also aid in causing the tether to engage itself as it wraps about a subject. In another example, beads, spheres or other structures can be attached to, or formed integrally with, the tether. Small "blobs" or dots of adhesive or similar material can be added to the tether to create the engagement features. In another example, the engagement feature can include the hook assembly, shown at 164 in FIG. 20, which can be spaced at regular intervals as desired. Thus, a series of hook assemblies can be attached to the tether at spaced intervals.

The tether 16 can be formed from a variety of materials. In one aspect, the tether is formed from conventional nylon material. Waxed cord can also be used, as the wax can aid in packing and/or coiling the tether to properly fit within, and stay within, the tether compartments. In one embodiment, the tether can be formed from an elastic material. The elastic material can allow the tether to extend from a nominal configuration (e.g., "Lo" in FIG. 1), to a longer, extended configuration.

In one example, the tether can extend as much as 20% to 300% of its original length. By providing elasticity to the tether, the tether can be extended by the momentum of the pellets as the entangling projectile is propelled toward a subject. Thus, at the moment shown in FIG. 3A immediately prior to contact with the subject 100, the tether 16 can be in an extended configuration. Once the tether contacts the subject, the elastic properties of the tether can aid in pulling the pellets around the subject. In this manner, in addition to the momentum of the pellets causing them to wrap about the subject once the tether contacts the subject, the elasticity in the tether can also aid in pulling the pellets around the subject.

As shown in FIG. 22, in one embodiment, a hook assembly 180 can be provided that can include a plurality of hooks 144, 148, etc. The hook assembly can be installed within, for example, a hollow neck portion 160 of a pellet (not completely shown in this figure). The hook assembly can include a leading shank 182 and a trailing shank 184. In this example, the trailing shank 184 is installed within the neck portion of the pellet aside the tether 16. The tether is then routed around the hooks of the hook assembly as it extends from the pellet. In this manner, a longitudinal axis of the tether (shown for example at 192 in FIG. 23) is offset from a longitudinal axis of the hook assembly. The

present inventors have found that offsetting the longitudinal axis of the tether in this manner can result in the pellet and/or hook assembly "cocking" relative to the tether as it travels toward a subject. This can aid in successfully engaging the subject with the hooks upon contacting the subject's clothing (or upon contacting hooks from another pellet or hook assembly).

A similar relationship is shown in more detail in the additional embodiment shown in FIG. 23. In this example, pellet 14j can include a longitudinal axis 190. In this example, the tether is routed out of the pellet through opening 166 rather than an end of the pellet. In this manner, the longitudinal axis 192 of the tether is offset from the longitudinal axis 190 of the pellet by offset O_W . In addition, as the tether is coupled to the pellet at the opening 166, it is effectively coupled to the pellet at offset O_L , relative to an overall length L_P of the pellet. Note that, in this example, if the tether extended from an upper end of the pellet, as shown in previous embodiments, the offset O_L would be zero. In one example, the offset O_L is about half the overall length L_P . In one aspect, the overall length L_P is about 1.5 inches (3.81 cm) and the offset O_L is about 0.75 inches (1.91 cm). In this embodiment, a length of the neck portion is about 0.9 inches (2.29 cm). Thus, the opening 166 is formed in or through the neck portion just above the wider portion. While not shown in FIG. 23, in addition to the opening 166 of FIG. 23 through which the cord can enter the pellet, an additional opening can be provided (typically higher up the neck portion, as shown in FIG. 14) to allow access to the hook assembly.

By establishing one or both of these offsets greater than zero, the pellet (and any accompanying hooks) are partially rotated or "cocked" relative to the tether, particularly as they travel through the air. This has been found to increase the likelihood of successfully engaging a desired structure with said one or more of the hooks attached to or carried by a pellet.

The hook assembly 180 illustrated in FIG. 22 can be installed within a shank formed in the pellet, as shown, or it can be coupled to an end of the pellet. In addition to the hook assembly being formed as an integral unit, the multitude of hooks can also be installed within, or coupled to, the pellet as individual units.

Various additional features of the present technology are illustrated throughout the accompanying figures. In one aspect of the invention, one or more pellets can include a portion extending inwardly from an outer diameter, the recessed portion having an inner diameter smaller than the outer diameter of the pellet such that a pocket is formed in the pellet, the pocket providing an area for accumulation of debris and gasses carried by a

pressure wave created by the projectile deployment system. In one example, the recessed portion can fully circumscribe the pellet.

The pellet can further include at least two recessed portions, the at least two recessed portions being spaced longitudinally along the pellet to create two pockets
5 separated by an unmodified portion of the pellet. The recessed portion can include a conically tapering portion extending into a planar portion substantially perpendicular to an elongate axis of the pellet. The at least one recessed portion can be formed on an end of the pellet opposite an end of the pellet to which the tether is coupled to the pellet. At least one engagement hook can be coupled to at least one of the pellets, the engagement hook
10 being operable to engage clothing worn by a subject engaged by the entangling projectile to aid in retaining the entangling projectile about the subject.

The pellet can include a neck portion having a diameter less than the outer diameter of the pellet, and the at least one engagement hook can extend over the neck portion of the pellet. The hook can include a point that extends in a direction opposite a
15 direction in which the tether extends from the pellet. Note, as shown in FIG. 6, however, that pellet 12c can include only a single "head" 194, without accompanying recessed portions.

In accordance with another aspect of the invention, a method for entangling a subject is provided, including: targeting a subject with a projectile launcher, the projectile
20 launcher carrying an entangling projectile having a pair of pellets connected by a tether, each of the pellets carried by one of a pair of sockets formed in the launcher; and activating the projectile launcher to cause the pellets to be expelled from the projectile launcher, the pellets traveling outwardly from the projectile launcher and laterally away from one another as they are being expelled from the projectile launcher, the pellets
25 having differing vertical elevations relative to one another when the tether contacts the subject.

The method can further include spacing the projectile launcher a distance from the subject such that the tether is at substantially maximum extension at the point the entangling projectile engages the subject. The tether can be elastic such that the tether
30 can expand as the pellets are expelled from the projectile casing. Activating the projectile launcher can include activated a compressed gas cylinder carried by the projectile launcher. Activating the projectile launcher can include activating a cartridge blank carried by the projectile launcher. Expelling the pellets can include expelling the pellets at an

angle of between about 10 degrees and about 60 degrees relative to one another. The angle can be between about 25 degrees and about 45 degrees.

The method can further include aligning the sockets within the projectile launcher in a specific orientation prior to activating the launcher. Aligning the sockets in a specific
5 orientation can include aligning the sockets to cause the pellets to travel at offset vertical trajectories as they are expelled from the projectile launcher.

It is to be understood that the above-referenced arrangements are illustrative of the application for the principles of the present invention. Numerous modifications and alternative arrangements can be devised without departing from the spirit and scope of the
10 present invention while the present invention has been shown in the drawings and described above in connection with the exemplary embodiments(s) of the invention. It will be apparent to those of ordinary skill in the art that numerous modifications can be made without departing from the principles and concepts of the invention as set forth in the examples.

CLAIMS

1. A projectile deployment system, comprising:
an entangling projectile, including a pair of pellets and a tether
connecting the pellets;
5 a projectile casing, including a pair of sockets, each socket sized to
carry one of the pellets;
the pair of sockets being angled relative to one another such that the
pellets travel apart from one another as they are expelled from the projectile
casing, at least a portion of one of the sockets overlapping a portion of
10 another of the sockets; and
a launcher, carrying the projectile casing;
a selectively activatable pressure source carried by one of the launcher
or the projectile casing, the pressure source capable of expelling the
entangling projectile from the projectile casing toward a subject.
15
2. The system of claim 1, wherein the pressure source is carried by
the casing and the activator is carried by the launcher.
3. The system of claim 1, wherein the pressure source comprises a
20 cartridge blank.
4. The system of claim 1, wherein the pressure source comprises a
compressed gas cannister.
- 25 5. The system of claim 1, wherein the sockets are vertically offset
relative to one another and extend on planes parallel to one another.
6. The system of claim 1, wherein the pellets overlap one another
when installed within the sockets.
30
7. The system of claim 1, wherein the pressure source is in fluid
communication with a single discharge bore, the single discharge bore being
in fluid communication with each of the sockets.

8. A projectile deployment system, comprising:
a launcher;
an entangling projectile, including a pair of pellets and a tether
connecting the pellets;
a projectile casing, coupled to the launcher, the projectile casing
5 including a pair of sockets, each socket carrying one of the pellets;
a selectively activatable pressure source, carried by one of the
launcher and the projectile casing such that activating the pressure source
results in expelling the entangling projectile from the projectile casing; wherein
the sockets are oriented within the projectile casing such that the
10 pellets travel toward differing vertical trajectories as they are expelled from the
projectile casing.
9. The system of claim 8, wherein the pressure source comprises a
blank cartridge.
- 15 10. The system of claim 8, wherein the pressure source comprises a
compressed gas cannister.
11. The system of claim 8, wherein the projectile casing is releasably
20 coupled to the launcher to enable interchangeability of multiple projectile
casings.
12. The system of claim 8, wherein the sockets are held within the
projectile casing at differing vertical elevations.
- 25 13. The system of claim 12, wherein the sockets are oriented on
parallel planes.
14. The projectile deployment system of any claims 1 through 13,
30 further comprising one or more engagement hooks coupled to at least one of
the pair of pellets, the engagement hooks being operable to engage clothing

worn by a subject of the deployment system to aid in retaining the entangling projectile about the subject.

15. A method of entangling a subject, comprising:
- 5 aiming the projectile deployment system of any of claims 1 through 13 toward a subject; and
- activating the selectively activatable pressure source to activate the pressure source to expel the entangling projectile from the projectile casing toward the subject.