US009175936B1

(12) **United States Patent**
Collier

(10) **Patent No.: US 9,175,936 B1**
(45) **Date of Patent: Nov. 3, 2015**

(54) **SWEPT CONICAL-LIKE PROFILE AXISYMMETRIC CIRCULAR LINEAR SHAPED CHARGE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 149 days.

(21) Appl. No.: **14/181,223**

(22) Filed: **Feb. 14, 2014**

Related U.S. Application Data

(60) Provisional application No. 61/765,656, filed on Feb. 15, 2013.

(51) **Int. Cl.**

F42B 1/00	(2006.01)
F42B 1/028	(2006.01)
F42B 1/032	(2006.01)
F42B 1/036	(2006.01)

(52) **U.S. Cl.**
CPC ***F42B 1/028*** (2013.01); ***F42B 1/032*** (2013.01); ***F42B 1/036*** (2013.01)

(58) **Field of Classification Search**
CPC F42B 1/028; F42B 1/032; F42B 1/036
USPC 102/307
See application file for complete search history.

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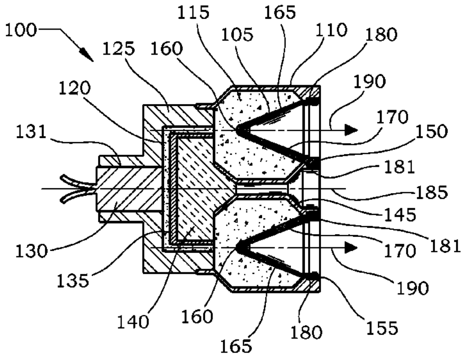
(57) **ABSTRACT**

A novel shaped charge device that produces a hollow cylindrical jet capable of creating a hole in a target larger than the overall diameter of the device. In the conical family of axisymmetric circular linear shaped charge liners (Conical, Tulip, and Trumpet), this novel swept conical-like profile shaped explosive device produces a large diameter stretching hollow cylindrical jet and corresponding slug. The hollow jet is formed by peripherally initiating a high explosive (HE) that collapses the circular linear liner into the hollow cylindrical jet. The precision of the circular simultaneous peripheral initiation of the HE billet is accomplished by the use of a novel Circular Precision Initiation Coupler (CPIC). This CPIC uses a single point initiation to create a simultaneous peripheral detonation of the HE billet that collapses and drives the swept liner into a high speed stretching hollow cylindrical projectile, or more commonly called a jet in the industry.

22 Claims, 3 Drawing Sheets



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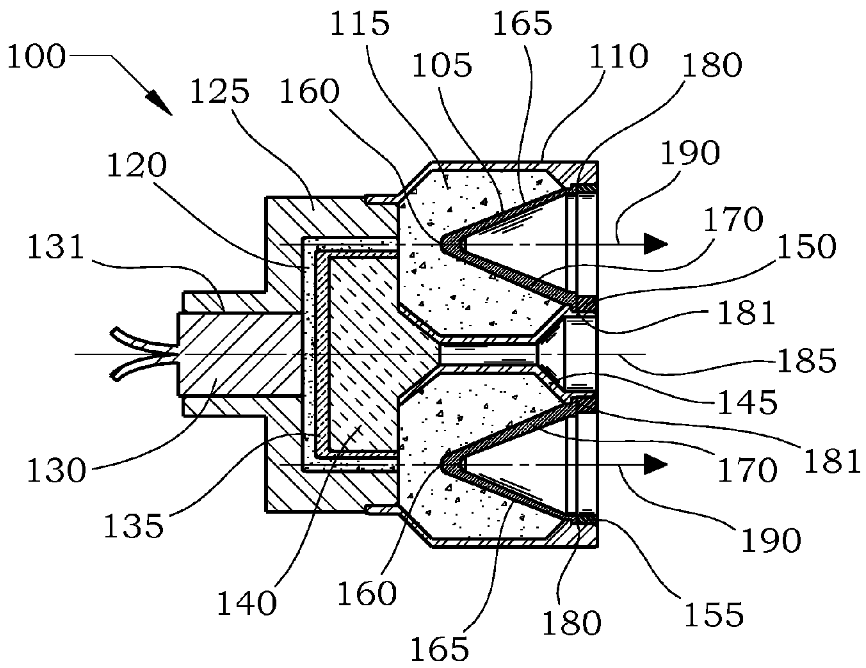

FIG. 1

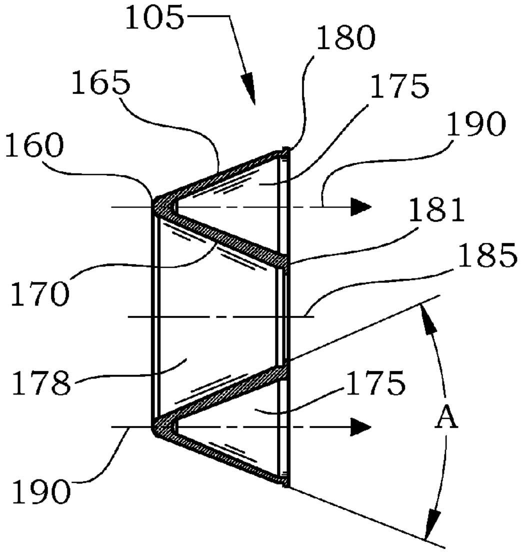

FIG. 1A

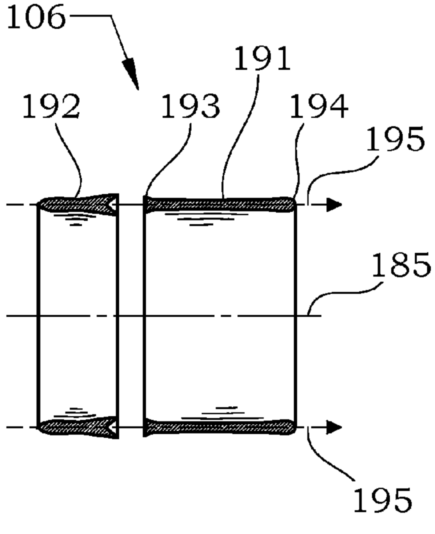

FIG. 1B

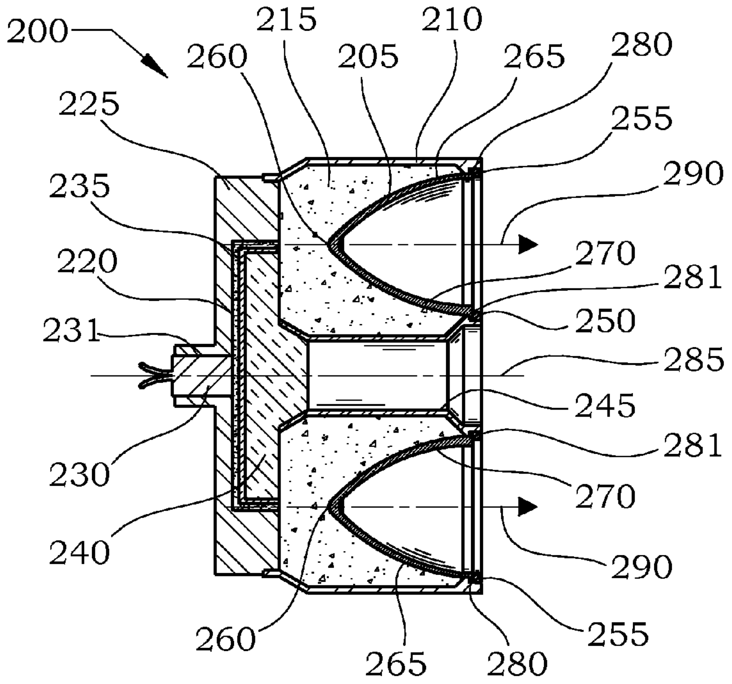

FIG. 2

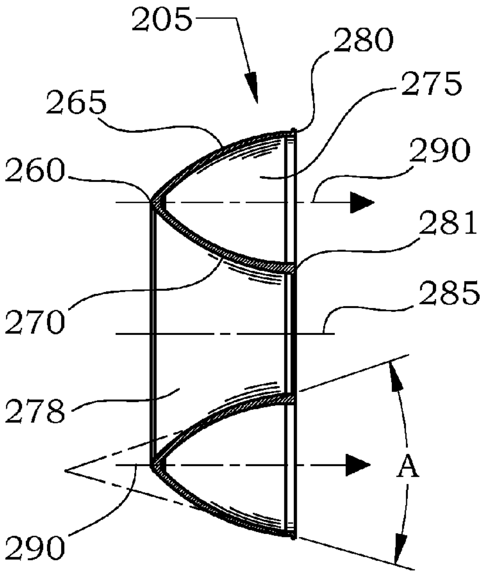

FIG. 2A

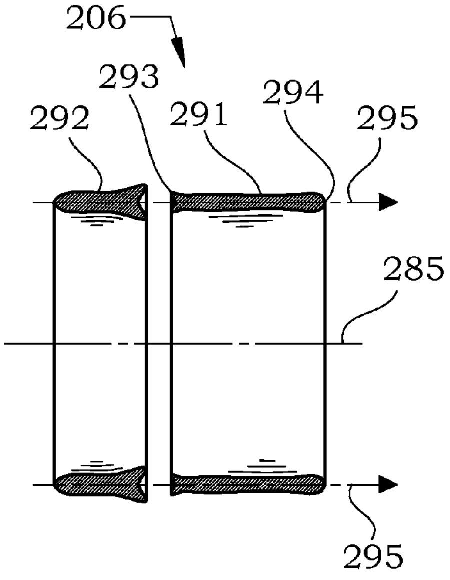

FIG. 2B

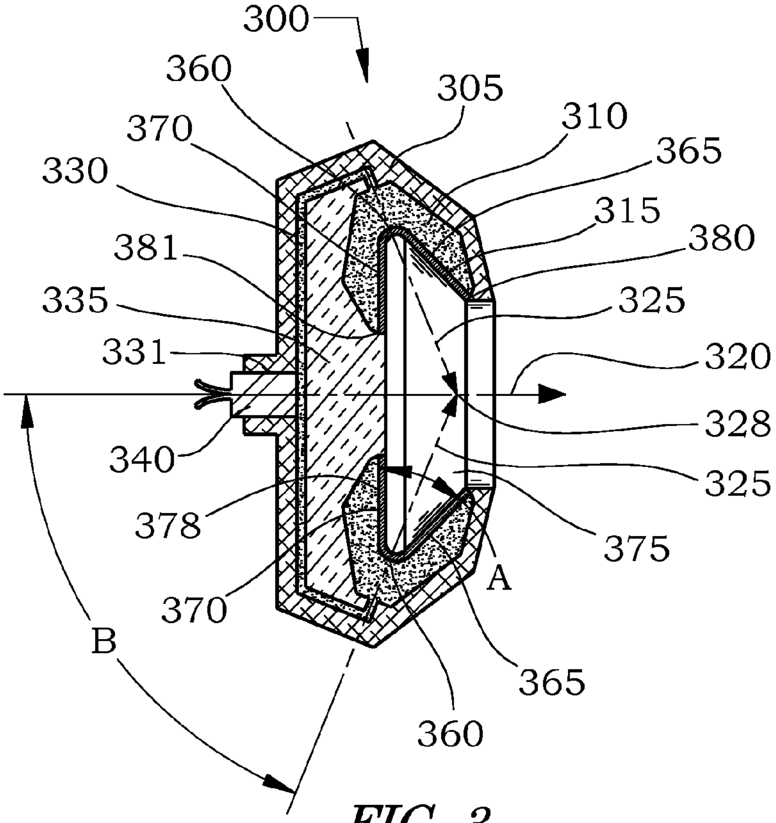
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FIG. 3

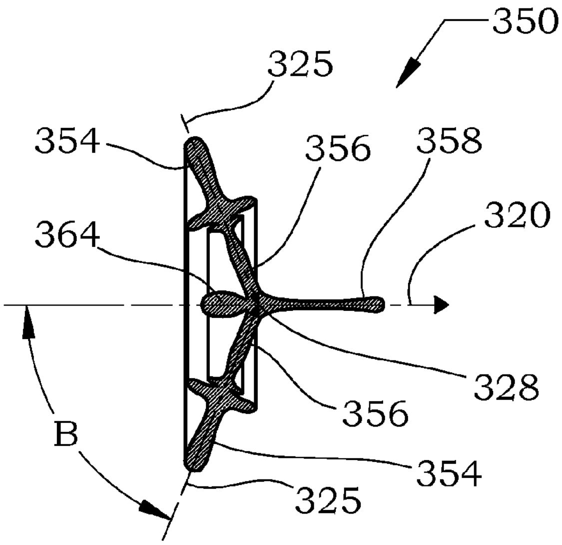
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FIG. 3A

SWEPT CONICAL-LIKE PROFILE AXISYMMETRIC CIRCULAR LINEAR SHAPED CHARGE

RELATED APPLICATION DATA

This application is a non-provisional application which claims the benefit of U.S. Provisional Application No. 61/765,656, filed Feb. 15, 2013.

TECHNICAL FIELD OF INVENTION

This invention relates to shaped charges and in particular to a swept conical-like profile shaped explosive device that produces a full caliber or greater hole, that is to say a hole as large as the explosive charge diameter (CD).

BACKGROUND OF THE INVENTION

Shaped charges come in many sizes and shapes and are used mainly for military weaponry and oil well perforating; to a lesser extent demolition and rescue are also users of this complex technology.

The concept of shaping an explosive charge, in order to focus its energy was known in 1792. ("The History of Shaped Charges" Donald R Kennedy)

In 1884 Max von Foerster conducted experiments in Germany showing that a hollow cavity explosive charge will focus the explosive energy and produce a collimated jet of high speed gasses along the longitudinal axis of the cavity, this jet also could penetrate steel.

In 1888, while conducting research for the U.S Navy, at Newport R.I., Charles Munroe discovered that not only could explosive energy be focused, but lining the hollow cavity in the explosive with metal increased the penetration dramatically, the effect is commonly called the Munroe effect.

These discoveries were further studied in 1910 by Egon Neumann of Germany who conducted similar experiment's, which showed that a cylinder of explosive with a metal lined conical hollow cavity could penetrate through steel plates. The military implications of this phenomenon were not realized until the lead up to world war two.

In the 1930's flash x-ray technology was developed which allowed the in depth study of the Shaped Charge jetting process. With this new and other diagnostics, it was possible to take XRay pictures of the collapse of the liner and the resulting jet. This led to a more scientific and complete understanding of the Munroe principle and emphasized the power of shaped charges.

Modern shaped charges as used in anti-tank weapons produce a long stretching rod like metal jet that penetrates about 5 to 8 charge diameters in steel, deeper in masonry or rock. The average diameter of a 5 CD through hole in steel from these charges is less than 15% of the explosive charge diameter (CD) of the device. The holes made by these jets do not provide sufficient diameter to allow follow on or follow through devices to pass into the perforation and add to the hole depth.

There have been some specialized efforts by Haliburton to produce other than conical type shaped charges for special purposes such as pipe cutting and anchor chain cutting. These types of charges are called linear shaped charges and use the two dimensional collapse to produce a thin sheet like jet with somewhat similar cutting power to the usual conical shaped charge. These linear shaped charges are flexible and can be formed by hand into desired shapes. The British Wall AXE circa 1960 is an example of a formable linear shape charge with a wide angle liner; the device is used against light structures such as wooden doors and thin walls and does not give very deep penetration.

Patent Application US2011/0232519 A1 by Erick J. Sagebiel discloses a diverging jet. The Sagebiel design is limited to a diverging jet trajectory of 1 to 45 degrees relative to the device axis of symmetry and produces a circular cookie cutter cut in a finite target leaving a center plug of material in the target.

The Sagebiel device contains a core plug that Sagebiel teaches could be used as a projectile to impact the annular ring cut pattern of a finite target.

The Sagebiel device is basically a symmetrical linear shaped charge device that has been formed into a circle around a symmetrical axis with planar, frusto-conical liner walls, which explains why it produces a round cookie cutter cut leaving behind a center core of the target material. Since Sagebiel's device is designed symmetrically like linear shaped charge it does not offer a solution for matching the momentums of the radially converging and diverging liner walls by balancing the liner wall masses and the amount of HE driving each wall. It does not teach the directional varying of the inner and outer wall thicknesses to compensate for the volume and mass differences, of the outside and inside liner walls, due to the vastly differing diameters in relation to the axis of symmetry.

Throughout the history of shaped charges the primary effort of research in this field was directed toward depth of penetration by the jet. Although hole size is worth considering, little research has been done on significantly increasing jet diameter and cross-sectional shape of the jet to produce a larger hole diameter. In oil field applications a larger hole is most desirable as the flow area of the hole increases rapidly with an increase in hole diameter. With the ability to produce a full caliber hole, a follow on or follow through device can be deployed into the hole to the correct standoff from the bottom of the hole. When detonated at the correct standoff this will increase the hole depth by that of the primary hole producing device, this can be repeated numerous times in the same hole.

SUMMARY OF INVENTION

The swept profile designs of the swept conical-like profile axisymmetric circular linear shaped charge (ACLSC) will efficiently remove more target material than a rod producing shaped charge. This increase in efficiency is achieved by making a much larger diameter jet. To produce a significantly larger jet one must consider focusing the energy of the jetting liner in a much larger pattern than that of a conventional shaped charge. This large diameter jet is achieved by detonating the high explosive (HE) billet, which is a mass of high explosive, thereby forming the swept liner profile into a stretching hollow cylindrical jet. This jet being close to the same diameter as the device forms a hole larger than the device diameter and removes the full device diameter of the target material.

In the conical family of ACLSC liners (Conical, Tulip, and Trumpet) this novel swept profile shaped explosive device produces a stretching hollow cylindrical jet and corresponding slug. The precision of the circular simultaneous initiation of the HE billet is accomplished by the use of a novel Circular Precision Initiation Coupler (CPIC). This CPIC uses a single point initiation to create a simultaneous peripheral detonation of the HE billet that collapses and drives the swept liner into a high speed stretching hollow cylindrical projectile, or more commonly called a jet in the industry.

BRIEF DESCRIPTION OF THE DRAWINGS

Because of the complexity of shapes involved, the inventor will use descriptive drawings and text to describe the device and how it functions.

FIG. **1** is a cross-sectional view of a swept conical shaped charge device (SCSC).

FIG. **1**A is a cross-sectional view of a swept conical profile (SCP) liner

FIG. **1**B is a cross-sectional view of a jet formed from an SCSC liner.

FIG. **2** is a cross-sectional view of a swept tulip shaped charge device (STUSC).

FIG. **2**A is a cross-sectional view of a swept tulip profile (STUP) Liner.

FIG. **2**B is a cross-sectional view of a jet formed from a STUSC.

FIG. **3** is a cross-sectional view of a swept converging conical shaped charge device (SCCSC).

FIG. **3**A is a cross-sectional view of a jet formed from an SCCSC.

DETAILED DESCRIPTION

This novel swept conical profile axisymmetric circular linear shaped charge (ACLSC) differs from a conventional lined shaped charge device, in that the ACLSC produces a large diameter hollow cylindrical jet as opposed to a rod like jet from a conventional lined shaped charge. This large diameter hollow jet will produce a full caliber or greater sized hole. This full caliber hole capability allows for a follow on or follow through devices of equivalent diameter to be placed at the correct standoff, in the hole produced by first said device. The ability to place secondary and tertiary devices in said hole allows the hole to be increased in depth with each device detonation in an infinite target. The uses and advantages of this innovation in shaped charge design are many in both military and commercial applications.

The swept profile designs of the swept conical-like profile axisymmetric circular linear shaped charge (ACLSC) will efficiently remove more target material than a rod producing shaped charge. This increase in efficiency is achieved by making a much larger diameter jet. To produce a significantly larger jet one must consider focusing the energy of the jetting liner in a much larger pattern than that of a conventional shaped charge. This large diameter jet is achieved by detonating the high explosive (HE) billet, which is a mass of high explosive, thereby forming the swept liner profile into a stretching hollow cylindrical jet. This jet being close to the same diameter as the device forms a hole larger than the device diameter and removes the full device diameter of the target material.

The ACLSC device produces a parallel, converging, or diverging jet relative to the axis of symmetry, and is capable of removing the full diameter of material without leaving a center plug of target material to an infinite depth by the repeated use of follow on devices.

The swept profile liner configurations included in this invention are the Conical, Tulip, and Trumpet profiles. These liner profile names represent the two dimensional (2D) geometrical profiles that would be seen if a hollow half toroid of said shape were cut sagittal along its longitudinal axis. This profile is swept about the central axis of the device creating the hollow half toroid shape or trough liner consisting of an inner and outer diameter providing a through hole in the center of the liner. The center through hole of the liner provides space for a central body, explosive shock wave attenuation materials, the escape of expanding gasses and the addition of a secondary projectile producing device. A hollow or solid central body will provide the inner HE billet containment surface, the inner liner wall mounting surface, a space for wave attenuation materials, the addition of a central secondary projectile producing device, and the escape path of inner expanding gases.

This invention should not be limited to these conical-like liner designs or profiles only; many other swept conical-like liner geometries can be incorporated, without changing the novelty of the device.

To simplify the description of the geometry, detonation and collapse of an ACLSC liner, we could look only at the 2D profile of the swept liner shape and other device components as if the charge was cut sagittal through the symmetrical axis. This cut will show the liner profile that makes the hollow toroid with an inner and outer wall joined by an apex at the collapse axis. The collapse axis that passes through the apex of the liner profile is visually an axis when viewed in 2D, but in reality it is not a true axis. If viewed in three dimensional (3D) space this collapse axis would be seen as a hollow cylinder with a diameter equal to the apex diameter of the liner extending through the device and coaxial to the device axis of symmetry. For easy of discussion the 2D term collapse axis will be used to describe the 3D hollow cylinder that the liner collapses on.

In the conical family of ACLSC liners (Conical, Tulip, and Trumpet), this novel swept profile shaped explosive device produces a stretching hollow cylindrical jet and corresponding slug. The aforementioned jet is formed by the extremely high pressures created by the detonation of an HE billet, which is a mass of high explosive. This HE billet is initiated in a circular pattern at the aft end of the HE billet and at the exact diameter of the apex of the swept liner profile. The precision of the circular simultaneous initiation of the HE billet is accomplished by the use of a novel Circular Precision Initiation Coupler (CPIC). This CPIC uses a single point initiation to create a simultaneous peripheral detonation of the HE billet that collapses and drives the swept liner into a high speed stretching hollow cylindrical projectile, or more commonly called a jet in the industry. The CPIC can be used with many swept liner geometries, and tailored to the desired size and shape required.

Although the ACLSC charge will not penetrate as deep as a conventional shaped charge, it will remove a full charge diameter of material, which allows the ACLSC to remove far more material volume than a much deeper penetrating conventional shaped charge device.

Since ACLSC devices produce, full caliber holes it is possible to send follow on charges into the penetration deepening the hole and sending the debris out of the hole at ½ the velocity of the penetrating jet. Follow on charges are not possible with traditional shaped charges since the penetration hole is very much smaller than the charge diameter which prevents the next charge from obtaining the correct standoff from the bottom of the hole. Oil and gas well completions and military users will benefit greatly from the use of ACLSC devices which is the goal of this shaped charge concept and development.

Liner thickness of shaped charges are dependent on the overall diameter of the device, the liner wall should increase in thickness as the device diameter increases and decrease in thickness as the device diameter decreases. Shaped charges scale very nicely and for the person skilled in this craft making this device in any size would be evident based on the information given. Shaped charges by their very nature have varying wall thicknesses and profiles depending on material, density, and desired effect on a target.

Preferably the liner uses a copper material, but liners may be made from most any metal, ceramic, powdered metals, tungsten, silver, copper or combination of many materials.

Initiation of a swept profile shaped charge detonation requires a two stage initiation process that accurately aligns the detonation wave with the chosen swept liner design. This accuracy is obtained by first coupling a single point detonation from a detonator that initiates the CPIC high explosive (HE) that is in the shape of a shallow circular cup which forms a non-broken simultaneous ring detonation. During the second stage of initiation the simultaneous detonation ring from the CPIC HE initiates detonation at the aft end of the main HE billet. The diameter of the ring initiation of the main HE billet is critical to obtain the desired direction of j et projection and must be tailored to each liner design.

As the ring detonation wave travels through the HE billet, the pressures created on the swept liner walls cause them to collapse and converge onto a collapse axis forming the hollow cylindrical jet wall. As this process continues, the jetting material forms a stretching hollow cylinder jet with its median diameter equal to the diameter of the apex of the swept profile liner cavity.

Detonation wave control is very important to form stable jetting from shaped charges. Reflected shock waves can negatively affect jet formation and the overall performance of the shape charge. The ACLSC design in this embodiment has various features incorporated into it to minimize and redirect reflected shock waves. One method of control is using a central column made from a low sound velocity material that serves as a shock wave dampener or attenuator. The design of the outer and inner HE billet containment bodies including shape, material type (i.e., powdered metal) and thickness, will both have specific designs to minimize reflected shock waves that would return and disturb jet formation. The ACLSC devices can use cast, pressed, extruded, or even hand packed HE from any high quality explosive that is capable of 4-10 km/s detonation rate.

In order to take advantage of the penetrating power of a swept profile shaped charge to produce a full caliber hole, it is necessary to concentrate the energy of the jetting material in a different pattern than that of a conventional shaped charge, such as spreading the energy into a large diameter circle, thus the need for a circular linear swept profile design. There are many difficulties with spreading the energy of a shaped charge in order to achieve a full caliber hole. Conventional cone lined shaped charges collapse and converge its liner material to a centrally located symmetrical axis, whereas the material of a swept profile lined shaped charge liner has to converge and diverge at the same time to a collapse axis of greater diameter than a central symmetrical axis. Timing and momentum balancing of the converging and diverging liner material is critical for jet creation and stability. If the swept liner wall thickness and the amount of explosive used are not correctly matched for the application it will result in an under driven or over driven liner, neither event will produce proper jetting. Adequate charge to mass ratios of explosive to liner as per Gurney equations should be adhered to as close as the application size restrictions will allow to prevent underdriving or overdriving the liner.

Herein disclosed is an axisymmetric circular linear shaped charge device. The shaped charge device has a liner configured in a partial toroid with a longitudinal axis intersecting an aperture located near the center of the partial toroid. The partial toroid being open-ended on a plane that intersects the longitudinal axis in a perpendicular manner toward a front end of the shaped charge device. The liner having a hollow conical cross-section extending toward a closed end of the partial toroid as defined by a longitudinal plane that is aligned on the longitudinal axis and an apex of the conical cross-section at a closed end of the partial toroid that extends toward a rear end of the shaped charge device. The liner having an outer surface and an inner surface with the inner surface exposed toward the open end of the front end of the shaped charge device and the liner producing an explosive hollow cylindrical jet stream directed toward the front of the shaped charge device upon detonation of the shaped charge device.

A billet of high explosive material having a front end and a rear end located behind and proximate to the outer surface of the liner and configured as a toroid with an internal aperture located proximate to the aperture of the liner. The billet producing a high explosive detonation effect applied to the liner to produce the hollow cylindrical jet stream. A coupler located in a rear portion of the shaped charge device and coupled to the rear end of the billet and the coupler producing a detonation wave initiating the high explosive detonation effect of the billet.

A body located around the outer surface of the billet and extending longitudinally the length of the billet. The body having a front end secured to the liner and a rear end secured to the coupler. An attenuator located proximate to the aperture in the billet that dampens a detonation wave. A center body located proximate to the aperture of the liner and rearward of the billet toward the rear portion of the shaped charge device.

Herein disclosed is a method of producing an axisymmetric cylindrical jet stream from a circular linear shaped charge device by providing a liner configured in a partial toroid with a longitudinal axis intersecting an aperture located near the center of the partial toroid. The partial toroid being open-ended on a plane that intersects the longitudinal axis in a perpendicular manner toward a front end of the shaped charge device. The liner having a hollow conical cross-section extending toward a closed end of the partial toroid as defined by a longitudinal plane that is aligned on the longitudinal axis and an apex of the conical cross-section at a closed end of the partial toroid that extends toward a rear end of the shaped charge device. The liner having an outer surface and an inner surface with the inner surface exposed toward the open end of the front end of the shaped charge device.

Positioning a billet of high explosive material behind and proximate to the outer surface of the liner and proximate to the aperture of the liner. The billet producing a high explosive detonation effect applied to the liner to produce the hollow cylindrical jet stream. Positioning a coupler at a rear portion of the shaped charge device in contact with the rear of the billet. The coupler producing a detonation wave and initiating the high explosive detonation effect of the billet.

Surrounding the shaped charge device with a body around the outer diameter of the billet and extending longitudinally the length of the billet. Producing an explosive hollow cylindrical jet stream with the liner that is directed toward the front of the shaped charge device upon detonation of the shaped charge device.

Additionally you can provide an attenuator proximate to the aperture in the billet that dampens a detonation wave. Positioning a center body proximate to the aperture of the liner and rearward of the billet toward the rear portion of the shaped charge device.

Three conical-like designs using the circular linear concept will be described here: the swept conical profile design, the swept tulip profile design, and the converging swept conical profile design, though many other shapes are possible within the conical family.

The swept conical shaped charge device (SCSC) **100**, having an aft area and a fore area, is shown in FIG. **1** and consists of a swept conical profile (SCP) liner **105**, a body **110**, a high explosive (HE) billet **115** which is a mass of high explosive, a Circular Precision Initiation Coupler (CPIC), an explosive shock attenuator (ESA) **140**, a center body **145**, an inner retaining ring **150**, and an outer retaining ring **155**. All components of device **100** share a common symmetrical axis **185**.

The SCP liner **105** is the working material of the shaped charge and is located about the fore area of the SCSC. Preferably the liner uses a copper material, but liners may be made from most any metal, ceramic, powdered metals, tungsten, silver, copper or combination of many materials.

The SCP liner **105**, as singularly shown in FIG. **1**A, has an inside wall **170**, an outside wall **165**, an apex **160** an outer base end **180**, an inner base end **181**, an outer surface **178**, an inner surface **175**, and an included angle A. For a 5 inch diameter liner of the SCSC, the inside wall **170** needs to be between 1-3 mm at the apex **160** and taper toward the inner base end **181** to between 2-5 mm. The outside wall **165** must taper the reverse direction from between 1.5-3 mm at the apex **160** and tapering down to between 1-2.5 mm at the outer base end **180**. These dimensions will be refined with numerical code and experiment to give the most tailored jet to address the specific target material. Included angles for attaining the Munroe effect from two colliding walls ranges from 36 to 120 degrees. The jet velocity achieved from a shaped charge is dependent on the included angle of the liner; the narrower the angle the faster the jet but the lower the jet mass. A zero included angle (i.e., cylinder liner) can be made to jet but the jet mass is so low, the efficiency is reduced. Jet velocities can vary from 4 to 10 km/s depending on the liner material, included angle, wall thickness and other geometries.

The HE billet **115**, located about the outer surface of the SCP liner **105**, provides the energy to collapse the SCP liner **105**, increases the ductility of the SCP liner **105**, and focuses the flowing material causing it to jet in the shape of a hollow cylinder at very high velocity. The SCSC body **110** provides an outer mounting surface for the SCP liner **105** which is held to body **110** by outer retaining ring **155** about the outer base end **180**. Body **110** also serves as a containment vessel for the delicate HE billet **115** and protects from damage or impact by supporting the outer diameter of HE billet **115**. Body **110** can provide tamping for the HE billet **115** depending on body **110** thickness and density. The outer diameter of the HE billet **115** can range from about 0-25% of liner outer diameter larger than the SCP liner **105** outer diameter and still produce a proper jet. The inner diameter of the HE billet **115** can range from about 0-25% of liner inner diameter smaller than the SCP liner **105** inner diameter and still produce a proper jet. If the swept liner wall thickness and the amount of HE used are not correctly matched for the application it will result in an under driven or over driven liner, neither event will produce proper jetting. Adequate charge to mass ratios of HE to liner as per Gurney equations should be adhered to as close as the application size restrictions will allow to prevent underdriving or overdriving the liner.

The CPIC, located in the aft area of the SCSC, consists of a CPIC HE **120**, charge cover **125**, detonator **130**, and CPIC HE cover **135**. Detonator **130**, located about the aft of the CPIC, provides the initial detonation impulse to the shallow cup shaped CPIC HE **120**. Charge cover **125** provides a mounting cavity **131** for detonator **130** and CPIC HE **120**, and provides the critical alignment of detonator **130** with CPIC HE **120** on the symmetrical axis **185**. Charge cover **125** also provides the critical alignment of CPIC HE **120** with HE billet **115**, which allows for a precise ring initiation of HE billet **115**. Charge cover **125** also serves to cover and protect the aft side of the HE billet **115** and maintains intimate contact of CPIC HE **120** with the HE billet **115**. The CPIC function is to transform a single point initiation from detonator **130** into a ring detonation of the CPIC HE **120** that will ring initiate the aft end of the HE billet **115** which is precisely aligned with the collapse axis **190** and apex of SCP liner **105**. The CPIC HE cover **135** provides a stable platform for the CPIC HE **120**, houses the ESA **140**, and provides a mounting structure to the aft end of the center body **145**.

The ESA **140** is made from a low sound velocity material and serves as a detonation wave dampener. Center body **145** supports the inner diameter of HE billet **115** and provides space for ESA **140**, a path for escaping detonation gases, and other devices (i.e., secondary projectile forming devices). Center body **145** provides an inner mounting surface for SCP liner **105** and aligns it with symmetrical axis **185**. SCP liner **105** is held to center body **145** by inner retaining ring **150** about the liner inner base end **181**. Device **100** is capable of producing a hollow cylindrical jet from the SCP liner **105**, said jet will produce a full device diameter hole or larger in the target.

The center body **145** is encompassed by the explosive charge or main high explosive (HE) billet and can be solid or hollow. The hollow center body **145** being an essential part of the swept profile design could contain shock attenuation materials used to dampen, reflect, and absorb shock waves that would have a detrimental effect on the formation of a stable jet. The hollow center body **145** space can also be used to contain a center projectile producing device or for adjusting HE billet quantity driving the inside wall of the liner, in addition the space can be used to relieve pressure from expanding gasses from the detonation of the HE.

Detonation wave control is very important to form stable jetting from shaped charges. Reflected shock waves can negatively affect jet formation and the overall performance of the shape charge.

The SCSC design in this embodiment has various features incorporated into it to minimize and redirect reflected shock waves. One method of control is using a hollow center body **145** that incorporates an ESA **140** made from a low sound velocity material that serves as a shock wave dampener or attenuator. The design of the outer and inner HE billet containment bodies (body **110** and center body **145**) including shape, material type (i.e., powdered metal) and thickness, will both have specific designs to minimize reflected shock waves that would return and disturb jet formation. The SCSC devices can use cast, pressed, extruded, or even hand packed HE from any high quality explosive that is capable of 4-10 km/s detonation rate.

Initiation of a SCSC detonation requires a two stage initiation process that accurately aligns the detonation wave with the SCP liner **105**. This accuracy is obtained by first coupling a single point detonation from a detonator that initiates the CPIC HE **120** that is in the shape of a shallow circular cup which forms a non-broken simultaneous ring detonation. During the second stage of initiation, the simultaneous detonation ring from the CPIC HE **120** initiates detonation at the aft end of the main HE billet **115**. The diameter of the ring initiation of the main HE billet **115** is critical to obtain the desired direction of jet projection and must be tailored to each liner design.

As the ring detonation wave travels through the HE billet **115**, the pressures created on the liner walls (**165** and **170**) cause them to collapse and converge onto a collapse axis **190** forming the hollow cylindrical jet wall. As this process continues, the jetting material forms a stretching hollow cylinder jet with its median diameter equal to the diameter of the apex of the SCP liner **105**.

FIG. **1**A shows SCP liner **105** that is used in device **100** of FIG. **1**. The SCP liner **105** consist of an outer base end **180**, outside wall **165**, apex **160**, inner base end **181**, inside wall **170**, axis of symmetry **185**, collapse axis **190**, an outer surface **178**, an inner surface **175**, and included angle A. Collapse axis **190** is shown parallel to the axis of symmetry **185**, but can be almost any angle relative to the axis of symmetry **185** that would represent a converging or diverging jet trajectory formed by the detonation wave and SCP liner **105**. The thickness of inside wall **170** gradually increases from the apex **160** to the inner base end **181**, and the thickness of outside wall **165** gradually decreases from apex **160** to the outer base end **180**. The wall thickness is varied in this way to balance the explosive charge to SCP liner **105** mass ratios, which also balances the momentum of the collapse of the SCP liner **105** walls. Liner wall momentum balancing will insure that inside wall **170** and outside wall **165** will meet at the collapse axis **190** in concert to produce stable jetting. SCP liners can be challenging to balance since the mass of the outer wall **170** increases as the diameter increases from apex **160** to base end **180** and the mass of the inner wall **165** decreases as the diameter decreases from apex **160** to base end **181**.

Liner thickness of shaped charges are dependent on the overall diameter of the device, the liner wall should increase in thickness as the device diameter increases and decrease in thickness as the device diameter decreases. Shaped charges scale very nicely and for the person skilled in this craft making this device in any size would be evident based on the information given. Shaped charges by their very nature have varying wall thicknesses and profiles depending on material, density, and desired effect on a target.

For example, a 5 inch diameter liner of the SCSC the inside wall needs to be between 1-3 mm at the apex and taper toward the base end to between 2-5 mm. The outside wall must taper the reverse direction from between 1.5-3 mm at the apex and tapering down to between 1-2.5 mm at the base. These dimensions will be refined with numerical code and experiment to give the most tailored jet to address the specific target material.

The outside wall **165** and inside wall **170** of SCP liner **105** are set at an included angle A that can be changed to produce desired jetting characteristics (i.e., jet mass, and velocity). SCP liners require approximately a 30-120 degree included angle A between the outside wall **165** and inside wall **170** for optimum jetting. Greater included angles shorten the length of the SCP liner **105** along the axis of symmetry and shortens the length of the inside wall **170** and outside wall **165**, this shortening forces the diameter and mass of the outside wall **165** to increase at a higher rate from apex **160** to outer base end **180**, inversely the inside wall **170** decreases at a higher rate in diameter and mass from apex **160** to inner base end **181**. The included angle A and mass distribution of the inside wall **170** and outside wall **165** must be tailored to each other to produce a straight axisymmetric hollow cylindrical jet on collapse axis **190**, that projects in the direction of the collapse axis **190** arrow and is parallel with symmetrical axis **185** of the SCP liner **105**.

Detonation pressures from the high explosive collapse the SCP liner **105** outside wall **165** moving it into a smaller volume thusly increasing its bulk density and velocity, while being driven toward the collapse axis **190**. At the same time the SCP liner **105** inside wall **170** is driven toward the collapse axis **190** by the high explosive; the inside wall **170** driven material is moved, decreasing in bulk density and velocity due to an increase in diameter as it moves toward the collapse axis **190**. This process further explains the important and tedious task of momentum balancing the high velocity collapsing SCP liner **105** walls in order to produce a viable hollow cylindrical jet.

FIG. **1**B is a cross-sectional view of a typical hollow cylindrical projectile (HCP) **106** produced by a SCSC. The HCP **106** consists of a jet **191**, slug **192**, jet tail **193**, jet tip **194**, projection axis **195**, and symmetrical axis **185**. Jet **191** and slug **192** velocities, angle of projection, thickness, length and inside diameter can vary depending on the design of the SCSC. This depiction of HCP **106** is at a finite time after the detonation of a SCSC. The HCP **106** at an earlier time frame after detonation would show the jet **191** and slug **192** shorter in length and possible still connected. At a later time frame, jet **191** and slug **192** would become longer, thinner and further separated because of the ductile stretching of the HCP material. The projection axis **195** is shown parallel to symmetrical axis **185** but could be almost any angle either converging or diverging depending on the SCSC design and intended use.

The SCSC is balancing the momentums of the collapsing inner **170** and outer **165** liner walls producing a large diameter stable projectile that will remove the full diameter of target material creating a hole without leaving behind a center core. If the momentums of a SCSC are not matched correctly, the jet will not follow the desired trajectory, be of insufficient mass for desired target penetration or not form at all.

The swept tulip shaped charge device (STUSC) **200**, having an aft area and a fore area, is shown in FIG. **2** and consists of a STUP liner **205**, a body **210**, a high explosive (HE) billet **215** which is a mass of high explosive, a Circular Precision Initiation Coupler (CPIC) HE **220**, an explosive shock attenuator (ESA) **240**, a center body **245**, an inner retaining ring **250**, and an outer retaining ring **255**. All components of device **200** share a common symmetrical axis **285**.

The STUP liner **205** is the working material of the shaped charge and is located about the fore area of the STUSC. Preferably the liner uses a copper material, but liners may be made from most any metal, ceramic, powdered metals, tungsten, silver, copper or combination of many materials.

The STUP liner **205**, as singularly shown in FIG. **2**A, has an inside wall **270**, an outside wall **265**, an apex **260** an outer base end **280**, an inner base end **281**, an outer surface that faces away from collapse axis **290**, an inner surface that faces toward collapse axis **290**, and an included angle A. The walls of the STUP liner **205** have a wall curvature.

For a 5 inch diameter liner of the STUSC, the inside wall **270** needs to be between 1-3 nun at the apex **260** and taper toward the inner base end **281** to between 2-5 mm. The outside wall **265** must taper the reverse direction from between 1.5-3 mm at the apex **260** and tapering down to between 1-2.5 mm at the outer base end **280**. These dimensions will be refined with numerical code and experiment to give the most tailored jet to address the specific target material. Included angles for attaining the Munroe effect from two colliding walls ranges from 36 to 120 degrees. The jet velocity achieved from a shaped charge is dependent on the included angle of the liner; the narrower the angle the faster the jet but the lower the jet mass. A zero included angle (i.e., cylinder liner) can be made to jet but the jet mass is so low, the efficiency is reduced. Jet velocities can vary from 4 to 10 km/s depending on the liner material, included angle, wall thickness and other geometries.

The HE billet **215** of the STUSC device **200**, located proximate the outer surface of the STUP liner **205**, provides the energy to collapse the STUP liner **205**, increase the ductility, and focus the flowing material causing it to jet in the shape of a hollow cylinder at very high velocity. The STUSC body **210** provides an outer mounting surface for the STUP liner **205** which is held to body **210** by outer retaining ring **255** about the outer base end **280**. Body **210** also serves as a containment vessel for the delicate HE billet **215** and protects from damage or impact by supporting the outer diameter of HE billet **215**. Body **210** can provide tamping for the HE billet **215** depending on body **210** thickness and density. The outer diameter of the HE billet **215** can range from about 0-25% of liner outer diameter larger than the STUP liner **205** outer diameter and still produce a proper jet. The inner diameter of the HE billet **215** can range from about 0-25% of liner inner diameter smaller than the STUP liner **105** inner diameter and still produce a proper jet. If the swept liner wall thickness and the amount of HE used are not correctly matched for the application it will result in an under driven or over driven liner, neither event will produce proper jetting. Adequate charge to mass ratios of HE to liner as per Gurney equations should be adhered to as close as the application size restrictions will allow to prevent underdriving or overdriving the liner.

The CPIC, located in the aft area of the STUSC, consists of a CPIC HE **220**, charge cover **225**, detonator **230**, and CPIC HE cover **235**. Detonator **230**, located about the aft of the CPIC, provides the initial detonation impulse to the shallow cup shaped CPIC HE **220**. Charge cover **225** provides a mounting cavity for detonator **230** and CPIC HE **220**, and provides the critical alignment of detonator **230** with CPIC HE **220** on the symmetrical axis **285**. Charge cover **225** also provides the critical alignment of CPIC HE **220** with HE billet **215**, which allows for a precise ring initiation of HE billet **215**. Charge cover **225** also serves to cover and protect the aft side of the HE billet **215** and maintains intimate contact of CPIC HE **220** with the HE billet **215**. The CPIC function is to transform a single point initiation from detonator **230** into a ring detonation of the CPIC HE **220** that will ring initiate the aft end of the HE billet **215** which is precisely aligned with the collapse axis **290** and apex of STUP liner **205**. The CPIC HE cover **235** provides a stable platform for the CPIC HE **220**, houses the ESA **240**, and provides a mounting structure to the aft end of the center body **245**.

An explosive shock attenuator (ESA) **240** is made from a low sound velocity material and serves as a detonation wave dampener. Center body **245** supports the inner diameter of HE billet **215**, provides space for ESA **240**, a path for escaping detonation gases, and other devices (i.e., secondary projectile forming devices). Center body **245** provides an inner mounting surface for STUP liner **205** and aligns it with symmetrical axis **285**. STUP liner **205** is held to center body **245** by inner retaining ring **250** about the liner inner base end **181**. Device **200** is capable of producing a hollow cylindrical jet from the STUP liner **205** that will produce a full charge diameter or larger hole in the target.

The center body **245** is encompassed by the explosive charge or main high explosive (HE) billet and can be solid or hollow. The hollow center body **245** being an essential part of the swept profile design could contain shock attenuation materials used to dampen, reflect, and absorb shock waves that would have a detrimental effect on the formation of a stable jet. The hollow center body **245** space can also be used to contain a center projectile producing device or for adjusting HE billet quantity driving the inside wall of the liner, in addition the space can be used to relieve pressure from expanding gasses from the detonation of the HE.

Detonation wave control is very important to form stable jetting from shaped charges. Reflected shock waves can negatively affect jet formation and the overall performance of the shape charge.

The STUSC design in this embodiment has various features incorporated into it to minimize and redirect reflected shock waves. One method of control is using a hollow center body **245** that incorporates an ESA **240** made from a low sound velocity material that serves as a shock wave dampener or attenuator. The design of the outer and inner HE billet containment bodies (body **210** and center body **245**) including shape, material type (i.e., powdered metal) and thickness, will both have specific designs to minimize reflected shock waves that would return and disturb jet formation. The STUSC devices can use cast, pressed, extruded, or even hand packed HE from any high quality explosive that is capable of 4-10 km/s detonation rate.

Initiation of a STUSC detonation requires a two stage initiation process that accurately aligns the detonation wave with the STUP liner **205**. This accuracy is obtained by first coupling a single point detonation from a detonator that initiates the CPIC HE **220** that is in the shape of a shallow circular cup which forms a non-broken simultaneous ring detonation. During the second stage of initiation, the simultaneous detonation ring from the CPIC HE **220** initiates detonation at the aft end of the main HE billet **215**. The diameter of the ring initiation of the main HE billet **215** is critical to obtain the desired direction of jet projection and must be tailored to each liner design.

As the ring detonation wave travels through the HE billet **215**, the pressures created on the liner walls (**265** and **270**) cause them to collapse and converge onto the collapse axis **290** forming the hollow cylindrical jet wall. As this process continues, the jetting material forms a stretching hollow cylinder jet with its median diameter equal to the diameter of the apex of the STUP liner **205**.

FIG. **2**A shows STUP liner **205** that is used in device **200** of FIG. **2**. The STUP liner **205** consist of an outer base end **280**, outside wall **265**, apex **260**, inner base end **281**, inside wall **270**, axis of symmetry **285**, collapse axis **290**, an outer surface **278**, an inner surface **275**, and included angle A. Collapse axis **290** is shown parallel to the axis of symmetry **285**, but can be almost any angle relative to the axis of symmetry **285** that would represent a converging or diverging jet trajectory formed by the detonation wave and STUP liner **205**. The arched walls of the STUP liner **205** can outperform the straight walls of a conical liner since the arc of the liner walls tends to reduce the included angle A from apex **260** to the inner base end **281** and outer base end **208**. The radius of arched STUP liner **205** walls can be increased or decreased to obtain desired jet velocity, length and mass. Outside wall **265** has on outward concave curvature relative to symmetrical axis **285** and inside wall **270** has an inward convex curvature relative to symmetrical axis **285**. Compared to planer wall liners the STUP liner **205** design reduces the jet stretch rate by speeding up the aft end or tail of the jet making the jet shorter more robust and perform better at longer target standoff.

The thickness of inside wall **270** gradually increases from the apex **260** to the inner base end **281**, and the thickness of outside wall **265** gradually decreases from apex **260** to the outer base end **280**. The wall thickness is varied in this way to balance the explosive charge to STUP liner **205** mass ratios, which also balances the momentum of the collapse of the STUP liner **205** walls. Liner wall momentum balancing will insure that inside wall **270** and outside wall **265** will meet at the collapse axis **290** in concert to produce stable jetting. STUP liners can be challenging to balance since the mass of the outer wall **270** increases as the diameter increases from apex **260** to base end **280** and the mass of the inner wall **265** decreases as the diameter decreases from apex **260** to base end **281**.

Liner thickness of shaped charges are dependent on the overall diameter of the device, the liner wall should increase in thickness as the device diameter increases and decrease in thickness as the device diameter decreases. Shaped charges scale very nicely and for the person skilled in this craft making this device in any size would be evident based on the information given. Shaped charges by their very nature have varying wall thicknesses and profiles depending on material, density, and desired effect on a target.

For example, a 5 inch diameter liner of the STUSC the inside wall needs to be between 1-3 mm at the apex and taper toward the base end to between 2-5 mm. The outside wall must taper the reverse direction from between 1.5-3 mm at the apex and tapering down to between 1-2.5 mm at the base. These dimensions will be refined with numerical code and experiment to give the most tailored jet to address the specific target material.

The outside wall **265** and inside wall **270** of STUP liner **205** are set at an included angle A that can be changed to produce desired jetting characteristics (i.e., jet mass, and velocity). STUP liners require approximately a 30-120 degree included angle A between the outside wall **265** and inside wall **270** for optimum jetting. Greater included angles shorten the length of the STUP liner **205** along the axis of symmetry **285** and shortens the length of the inside wall **270** and outside wall **265**, this shortening forces the diameter and mass of the outside wall **265** to increase at a higher rate from apex **260** to outer base end **280**, inversely the inside wall **270** decreases at a higher rate in diameter and mass from apex **260** to inner base end **281**. The included angle A and mass distribution of the inside wall **270** and outside wall **265** must be tailored to each other to produce a straight axisymmetric hollow cylindrical jet on collapse axis **290**, that projects in the direction of the collapse axis **290** arrow and is parallel with symmetrical axis **285** of the SCP liner **205**.

Detonation pressures from the explosive collapse of the STUP liner **205** outside wall **265** moving it into a smaller volume thusly increasing its bulk density and velocity, while being driven toward the collapse axis **290**. At the same time the STUP liner **205** inside wall **270** is driven toward collapse axis **290** by the explosive; the inside wall **270** driven material is moved, decreasing in bulk density and velocity due to an increase in diameter as it moves toward the collapse axis **290**. This process further explains the important and tedious task of momentum balancing the high velocity collapsing STUP liner **205** walls in order to produce a viable hollow cylindrical jet.

FIG. **2**B is a cross-sectional view of a typical hollow cylindrical projectile (HCP) **206** produced by a STUSC. The HCP **206** consist of a jet **291**, slug **292**, jet tail **293**, jet tip **294**, projection axis **295**, and symmetrical axis **285**. Jet **291** and slug **292** velocities, angle of projection, thickness, length and inside diameter can vary depending on the design of the STUSC. This depiction of HCP **206** is at a finite time after the detonation of a STUSC. The HCP **206** at an earlier time frame after detonation would show the jet **291** and slug **292** shorter in length and possible still connected. At a later time frame, jet **291** and slug **292** would become longer, thinner and further separated because of the ductile stretching of the HCP material. The projection axis **295** is shown parallel to symmetrical axis **285** but could be almost any angle either converging or diverging depending on the STUSC design and intended use.

The trumpet (not shown) and the tulip swept liner designs both have inner and outer liner wall curvatures but the direction of curvatures are opposite. A trumpet liner has outside wall **265** and inside wall **270** convex to the collapse axis **290**. Whereas a tulip liner outside wall **265** and inside wall **270** is concave to the collapse axis **290**.

The STUSC is balancing the momentums of the collapsing inner and outer liner walls producing a large diameter stable projectile that will remove the full diameter or larger of target material creating a hole without leaving behind a center core. If the momentums of a STUSC are not matched correctly the jet will not follow the desired trajectory, be of insufficient mass for desired target penetration or not form at all.

Device **300** in FIG. **3** is a swept converging conical shaped charge device (SCCSC), having an aft area and a fore area, and consists of a swept converging conical profile (SCCP) liner **315**, a body **305**, a high explosive (HE) billet **310** which is a mass of high explosive, and a peripheral initiation (PI) HE **330**, all components of device **300** share a common symmetrical axis **320**.

The SCCP liner **315** is the working material of the shaped charge and is located about the fore area of the SCCSC. Preferably the liner uses a copper material, but liners may be made from most any metal, ceramic, powdered metals, tungsten, silver, copper or combination of many materials.

The SCCP liner **315** has an inside wall **370**, an outside wall **365**, an apex **360** an outer base end **380**, an inner base end **381**, an outer surface **378**, an inner surface **375**, and an included angle A. Liner thickness of shaped charges are dependent on the overall diameter of the device, the liner wall should increase in thickness as the device diameter increases and decrease in thickness as the device diameter decreases. Shaped charges scale very nicely and for the person skilled in this craft making this device in any size would be evident based on the information given. Shaped charges by their very nature have varying wall thicknesses and profiles depending on material, density, and desired effect on a target.

For a 5 inch diameter liner of the SCCSC, the inside wall **370** needs to be between 1-3 mm at the apex **360** and taper toward the inner base end **381** to between 2-5 mm. The outside wall **365** must taper the reverse direction from between 1.5-3 mm at the apex **360** and tapering down to between 1-2.5 mm at the outer base end **380**. These dimensions will be refined with numerical code and experiment to give the most tailored jet to address the specific target material.

Included angles for attaining the Munroe effect from two colliding walls ranges from 36 to 120 degrees. The jet velocity achieved from a shaped charge is dependent on the included angle of the liner; the narrower the angle the faster the jet but the lower the jet mass. A zero included angle (i.e., cylinder liner) can be made to jet but the jet mass is so low, the efficiency is reduced. Jet velocities can vary from 4 to 10 km/s depending on the liner material, included angle, wall thickness and other geometries.

The HE billet **310** of the SCCSC device **200**, located proximate the outer surface **378** of the SCCP liner **315**, provides the energy to collapse the SCCP liner **315**, increase the ductility of the SCCP liner **315**, and focus the flowing material causing it to jet in the shape of a hollow cone at very high velocity. The SCCSC body **305** provides an outer mounting surface for the SCCP liner **315** about the outer base end **380**. Body **305** also serves as a containment vessel for the delicate HE billet **310** and protect from damage or impact by supporting the outer diameter of HE billet **310**. Body **305** can provide tamping for the HE billet **310** depending on body **305** thickness and density. The outer diameter of the HE billet **315** can range from about 0-25% of liner outer diameter larger than the SCCP liner **305** outer diameter and still produce a proper jet. The inner diameter of the HE billet **315** can range from about 0-25% of liner inner diameter smaller than the SCCP liner **305** inner diameter and still produce a proper jet. If the swept liner wall thickness and the amount of HE used are not correctly matched for the application it will result in an under driven or over driven liner, neither event will produce proper jetting. Adequate charge to mass ratios of HE to liner as per Gurney equations should be adhered to as close as the application size restrictions will allow to prevent underdriving or overdriving the liner.

Detonator **340** provides the initial detonation impulse to the shallow cup shaped peripheral initiation (PI) HE **330**. Body **305** provides a mounting cavity **331** for detonator **340** and PI HE **330**, and provides the critical alignment of detonator **340** with PI HE **330** on the symmetrical axis **320**. Body **305** also provides the critical alignment of PI HE **330** with HE billet **310**, which allows for a precise ring initiation of HE billet **310**. Body **305** also serves to cover and protect the HE billet **310** and maintains intimate contact of PI HE **330** with the HE billet **310**. The PI HE **330** function is to transform a single point initiation from detonator **340** into a ring detonation of the PI HE **330** that will ring initiate the aft end of the HE billet **310** which is precisely aligned with the collapse axis **325** and apex **360** of SCCP liner **315**. The PI HE **330** is isolated from HE billet **310** and held in place by inner body **335**. Inner body **335** can be made from a combination of low sound velocity materials and serves as a detonation wave dampener and HE billet support structure.

This converging version of the swept profile concept can produce an Ultra High Speed Jet. The jetting trajectory from a SCCP liner **315** is represented by collapse axis **325** which is converging at Angle B toward the device symmetrical axis **320** in the direction of the collapse axis **325** at focal point **328**. Angle B will be greater than zero degrees and smaller than 90 degrees. The gain in jet velocity is accomplished by forcing the SCCP liner **315** material to go through a double convergence. The first convergence is on collapse axis **325** and is a process similar to the ACLSC device embodiment described in FIG. **1** and would be peripherally initiated by PI HE **330** or a CPIC as described in FIG. **1** by detonator **340**. The second convergence happens at a focal point **328** on symmetrical axis **320** where the material of the hollow jet formed during the first convergence goes through a second velocity increasing convergence resulting in a smaller diameter ultra-high speed jet.

The SCCSC design in this embodiment has various features incorporated into it to minimize and redirect reflected shock waves. The design of the HE billet **310** containment bodies (body **305** and inner body **335**) including shape, material type (i.e., powdered metal) and thickness, will have specific designs to minimize reflected shock waves that would return and disturb jet formation. The SCCSC devices can use cast, pressed, extruded, or even hand packed HE from any high quality explosive that is capable of 4-10 km/s detonation rate.

Initiation of a SCCSC detonation requires a two stage initiation process that accurately aligns the detonation wave with the SCCP liner **315**. This accuracy is obtained by first coupling a single point detonation from a detonator that initiates the PI HE **330** that is in the shape of a shallow circular cup which forms a non-broken simultaneous ring detonation. During the second stage of initiation, the simultaneous detonation ring from the PI HE **330** initiates detonation at the aft end of the main HE billet **310**. The diameter of the ring initiation of the main HE billet **310** is critical to obtain the desired direction of jet projection and must be tailored to each liner design.

As the ring detonation wave travels through the HE billet **310**, the pressures created on the liner walls (**365** and **370**) cause them to collapse and converge onto a collapse axis **325** forming the hollow cone jet wall. As this process continues, the jetting material of the hollow cone jet converges to a focal point **328** to form a smaller diameter ultra-high speed rod jet.

FIG. **3**A is a Cascading jet **350** formed by SCCSC **300** in FIG. **3** and consists of a primary slug **354**, primary jet **356**, secondary slug **364**, secondary jet **358**, focal point **328**, symmetrical axis **320**, and collapse axis **325**. The primary jet **356** is shaped like a hollow cone with a trajectory represented by collapse axis **325**. An optimum convergence Angle B between the symmetrical axis **320** and collapse axis **325** (greater than zero degrees and smaller than 90 degrees) will produce the maximum velocity and mass secondary jet **358** with the smallest amount of secondary slug **364**. The gain in secondary jet **358** velocity is accomplished by the secondary convergence of the primary jet **356** material at focal point **328**. The first convergence of liner material is on collapse axis **325** and is a process similar to the ACLSC device described in this embodiment. The second convergence at a focal point **328** on symmetrical axis **320** is where the material of the hollow cone primary jet **356** formed during the first convergence goes through a second velocity increasing convergence resulting in a smaller diameter ultra-high speed rod jet **358**.

The SCCSC device produces a ultra-high speed rod jet that exceeds previously attained shaped charge jet velocities.

The invention claimed is:

1. An axisymmetric circular linear shaped charge device, comprising:

a liner configured in a partial toroid with a longitudinal axis intersecting an aperture located near the center of said partial toroid, said partial toroid being open-ended on a plane that intersects said longitudinal axis in a perpendicular manner toward a front end of the shaped charge device, said liner having a hollow conical cross-section extending toward a closed end of the partial toroid as defined by a longitudinal plane that is aligned on said longitudinal axis and an apex of said conical cross-section at a closed end of the partial toroid that extends toward a rear end of said shaped charge device, said liner having an outer surface and an inner surface, said inner surface exposed toward the open end of the front end of the shaped charge device and said liner producing an explosive hollow cylindrical jet stream directed toward said front of said shaped charge device upon detonation of the shaped charge device;

a billet of high explosive material having a front end and a rear end located behind and proximate to the outer surface of said liner, said billet configured as a toroid with an internal aperture located proximate to the aperture of the liner, and said billet producing a high explosive detonation effect applied to said liner to produce said hollow cylindrical jet stream;

a coupler located in a rear portion of the shaped charge device, said coupler coupled to the rear end of the billet and said coupler producing a detonation wave initiating the high explosive detonation effect of the billet; and

a body located around the outer surface of the billet and extending longitudinally the length of the billet, said body having a front end secured to said liner and, said body having a rear end secured to the coupler.

2. The shaped charge of claim **1**, further comprising:
an attenuator located proximate to the aperture in the billet, said attenuator dampening a detonation wave.

3. The shaped charge of claim **1**, wherein said coupler initiates a ring initiation at the rear end of the billet to produce the detonation wave and initiate the high explosive detonation effect of the billet.

4. The shaped charge of claim **1**, wherein the coupler provides the critical alignment of the detonator with the coupler high explosive on the longitudinal axis of the shaped charge and provides the critical alignment of the coupler high explosive with the billet which to allow for a precise ring initiation of the billet.

5. The shaped charge of claim **1**, further comprising:
a center body located proximate to the aperture of said liner and rearward of the billet toward the rear portion of the shaped charge device.

6. The shaped charge of claim **5**, wherein the center body is hollow and provides a space for shock attenuation materials used to dampen shock waves.

7. The shaped charge of claim **6**, wherein the space within the hollow center body can be used to contain a center projectile producing device.

8. An axisymmetric circular linear shaped charge device, comprising:
a liner configured in a partial toroid with a longitudinal axis intersecting an aperture located near the center of said partial toroid, said partial toroid being open-ended on a plane that intersects said longitudinal axis in a perpendicular manner toward a front end of the shaped charge device, said liner having a hollow conical cross-section extending toward a closed end of the partial toroid as defined by a longitudinal plane that is aligned on said longitudinal axis and an apex of said conical cross-section at a closed end of the partial toroid that extends toward a rear end of said shaped charge device, said liner having an outer surface and an inner surface, said inner surface exposed toward the open end of the front end of the shaped charge device and said liner producing an explosive hollow cylindrical jet stream directed toward said front of said shaped charge device upon detonation of the shaped charge device;
a billet of high explosive material having a front end and a rear end located behind and proximate to the outer surface of said liner, said billet configured as a toroid with an internal aperture located proximate to the aperture of the liner, and said billet producing a high explosive detonation effect applied to said liner to produce said hollow cylindrical jet stream;
a coupler located in a rear portion of the shaped charge device, said coupler coupled to the rear end of the billet and said coupler producing a detonation wave initiating the high explosive detonation effect of the billet;
a body located around the outer surface of the billet and extending longitudinally the length of the billet, said body having a front end secured to said liner and, said body having a rear end secured to the coupler; and
said shaped charge device producing an explosive hollow cylindrical jet upon detonation of said shaped charge device, said hollow cylindrical jet forming a hole in a target material that is wider than the outer diameter of the shaped charge device.

9. The shaped charge of claim **8**, further comprising:
an attenuator located proximate to the aperture in the billet, said attenuator dampening a detonation wave.

10. The shaped charge of claim **8**, wherein said coupler initiates a ring initiation at the rear end of the billet to produce the detonation wave and initiate the high explosive detonation effect of the billet.

11. The shaped charge of claim **8**, wherein the coupler provides the critical alignment of the detonator with the coupler high explosive on the longitudinal axis of the shaped charge and provides the critical alignment of the coupler high explosive with the billet which to allow for a precise ring initiation of the billet.

12. The shaped charge of claim **8**, further comprising:
a center body located proximate to the aperture of said liner and rearward of the billet toward the rear portion of the shaped charge device.

13. The shaped charge of claim **12**, wherein the center body is hollow and provides a space for shock attenuation materials used to dampen shock waves.

14. The shaped charge of claim **13**, wherein the space within the hollow center body can be used to contain a center projectile producing device.

15. A method of producing an axisymmetric cylindrical jet stream from a circular linear shaped charge device, comprising the steps of:
providing a liner configured in a partial toroid with a longitudinal axis intersecting an aperture located near the center of said partial toroid, said partial toroid being open-ended on a plane that intersects said longitudinal axis in a perpendicular manner toward a front end of the shaped charge device, said liner having a hollow conical cross-section extending toward a closed end of the partial toroid as defined by a longitudinal plane that is aligned on said longitudinal axis and an apex of said conical cross-section at a closed end of the partial toroid that extends toward a rear end of said shaped charge device, said liner having an outer surface and an inner surface, said inner surface exposed toward the open end of the front end of the shaped charge device;
positioning a billet of high explosive material behind and proximate to the outer surface of said liner, said billet being proximate to the aperture of the liner, and said billet producing a high explosive detonation effect applied to said liner to produce said hollow cylindrical jet stream;
positioning a coupler at a rear portion of the shaped charge device in contact with the rear of the billet, said coupler producing a detonation wave and initiating the high explosive detonation effect of the billet;
surrounding the shaped charge device with a body around the outer diameter of the billet and extending longitudinally the length of the billet; and
producing an explosive hollow cylindrical jet stream with the liner that is directed toward said front of said shaped charge device upon detonation of the shaped charge device.

16. The method of claim **15**, further comprising the step of:
providing an attenuator proximate to the aperture in the billet, said attenuator dampening a detonation wave.

17. The method of claim **15**, wherein said coupler initiates a ring initiation at the rear end of the billet to produce the detonation wave and initiate the high explosive detonation effect of the billet.

18. The method of claim **15**, wherein the coupler provides the critical alignment of the detonator with the coupler high explosive on the longitudinal axis of the shaped charge and provides the critical alignment of the coupler high explosive with the billet which to allow for a precise ring initiation of the billet.

19. The method of claim **15**, further comprising the step of:
- positioning a center body proximate to the aperture of said liner and rearward of the billet toward the rear portion of the shaped charge device.

20. The method of claim **19**, wherein the center body is hollow and provides a space for shock attenuation materials used to dampen shock waves.

21. The method of claim **20**, wherein the space within the hollow center body can be used to contain a center projectile producing device.

22. The method of claim **15**, further comprising the step of:
- producing an explosive hollow cylindrical jet upon detonation of said shaped charge device, said hollow cylindrical jet forming a hole in a target material that is wider than the outer diameter of the shaped charge device.

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